**3GPP TSG RAN WG1 #112bis-e**  **R1-23XXXXX**

**e-Meeting, April 17th – April 26th, 2023**

**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 latest updated SID was approved in RAN plenary #97 e-meeting [2].

In this contribution, we summarized the related issues and proposals based on the contributions submitted in RAN1#112bis-e under the agenda item 9.3.1 [5] –[30].

The following sections are structured as follows. From section 2 to 6, we categorize the key issues raised by contributions into 5 kinds and some sections may cover more than one sub-issue. For each issue/sub-issue, the related submitted proposals, the summary and initial proposals/questions suggested by moderator are provided in sub-sections. For each identified proposal/question, one table is provided.

1. **Issue#1: Draft TR**
   1. Issue#1-1: TR update
      1. Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| CMCC | R1-2303230 TR 38.858 v0.3.0 for study on evolution of NR duplex operation |
| CATT, CMCC, Samsung | R1-2303639 TP on SBFD for TR 38.858 |

* + 1. Summary

An updated TR38.858 v0.2.0 (R1-2300997) [3] was agreed in principle in RAN1#112.

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| **Agreement**  Agree the updated TR for RAN1 in [R1-2300997](file:///C:\Users\cmcc\AppData\Local\Docs\R1-2300997.zip) in principle. |

In this meeting, an updated draft TR38.858 v0.3.0 (R1-2303230) [5] is submitted by CMCC to capture the latest agreements achieved in RAN1#112 on AI 9.3.1.

A TP on SBFD for TR 38.858 (R1-2303639) [6] is submitted by CATT, CMCC and Samsung to capture the agreements achieved up to RAN1#112 on AI 9.3.2. This TP will be discussed in AI 9.3.2

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

* + 1. 1st Round Proposals

***Initial proposal 1-1-1:***

Agree the updated TR38.858 in R1-2303230 in principle.

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| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | Support the proposal |
| ZTE | Support |
| Huawei, HiSilicon | Support |
| NTT DOCOMO | We support. |
| Spreadtrum | Support |
| OPPO | Support |
| Xiaomi | We are fine with the proposal with some modifications.   * For section 9, the same structure as FR1 should be applied to FR2. The reason is that at least dense urban and indoor scenaro are supported for FR2 as address in section 7.1. But for indoor scenario, we don’t need to study co-site iner-sector interference. Accordingly, there should be two sub-clause for FR2, such as local Area BS and medium range BS. * The note for in Section A.2.3 Inter-site gNB-gNB co-channel inter-subband CLI can be removed if initial proposal 2-3-2 is agreeable. . * Section A.2.4 UE-UE co-channel inter-subband CLI should be updated if initial proposal 2-3-4 agreeable. |
| Intel | Support |
| Nokia/NSB | Support |
| Sony | Support |
| QC | We are okay with the RAN1 updates in Annex A, B and C.  For updating the TR Skelton of sections 9 to 12, we believe it should be done by RAN4 WG. |
| Moderator | @Xiaomi, Regading the first comment, Section 9 is up to RAN4. For the other two comments, Section A.2.3 and A.2.4 can be further updated based on the progress in this meeting. |

* 1. Issue#1-2: Summary on SLS calibration
     1. Submitted proposal

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| **Company** | **Proposals** |
| CMCC | R1-2303231 Updated summary on SLS calibration results for NR duplex evolution |
| Intel (R1-2302794) | **Observation 1:** From the coupling loss statistics of calibration results, it can be observed:   * Decision to model large-scale only or large-scale plus small-scale channel may have substantial impact on results, especially in FR2 cases. * In FR1 Urban Macro scenario, the serving link coupling loss shows poor link quality due to 80% of UEs indoor and on the ground floor. * In FR1 Urban Macro scenario, it is expected that UE-UE interference from same cluster UEs may dominate SBFD performance due to good coupling loss. |
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* + 1. Summary

In RAN1#110b e-meeting, RAN1 agreed to conduct SLS calibration for evaluation of SBFD operation.

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

A SLS calibration for NR duplex was conducted in RAN1#112. The calibration results were uploaded under the following draft folder. In RAN1#112, an initial SLS calibration results for NR duplex evolution was summarized in R1-2301813 [4] based on “SBFDCalibration-v024-Sony-MTK2.xlsx” from 16 companies’ inputs.

<ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_111/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Calibration#112/>

After RAN1#112, some companies provided updated calibration results. In this meeting, an updated SLS calibration results for NR duplex evolution is summarized in R1-2303231 [7] based on “SBFDCalibration-v037-IDC4-DCM.xlsx” from 21 companies’ inputs.

Until 2023-4-14, the latest version of the SLS calibration results is “SBFDCalibration-v043-CEWiT2-Moderator.xlsx”.

Based on “SBFDCalibration-v043-CEWiT2-Moderator.xlsx”, twenty-three 3GPP entities provided the calibration results *for* scenarios of Urban Macro (FR1), Dense Urban Macro Layer (FR2-1), Indoor office (FR1) and Indoor office (FR2-1), including Samsung, Spreadtrum, Huawei, Nokia, CATT, Xiaomi, ZTE, Sharp, Qualcomm, MTK, Ericsson, CEWiT, vivo, Intel, Sony, IDC, Fujitsu, OPPO, MediaTek, DOCOMO, LG, Panasonic and CMCC.

A summary of the collected samples for calibration of each scenario is shown in Table C.3-1.

Table C.3-1: Sample statistics for calibration

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenario** | **Metric** | **Number of sources** | **CL difference compared to average CL**  **(at 50%-tile CDF point)** |
| **Urban Macro (FR1)** | **gNB-UE CL** | 21 | <4.35 dB (21 sources), <3.15 dB (20 sources) |
| **gNB-gNB CL** | 20 | <6.45 dB (20 sources), <2.07 dB (18 sources) |
| **UE-UE CL** | 21 | <4.85 dB (21 sources), <3.27 dB (20 sources) |
| **Dense Urban Macro Layer (FR2-1)** | **gNB-UE CL** | 12 | <3.36 dB (12 sources) |
| **gNB-gNB CL** | 12 | <8.62 dB (12 sources), <3.55 dB (7 sources) |
| **UE-UE CL** | 12 | <13.38 dB (12 sources), <3.04 dB (10 sources) |
| **Indoor office (FR1)** | **gNB-UE CL** | 18 | <1.18 dB (18 sources) |
| **gNB-gNB CL** | 18 | <6.79 dB (18 sources), <3.65 dB (17 sources) |
| **UE-UE CL** | 18 | <2.60 dB (18 sources) |
| **Indoor office (FR2-1)** | **gNB-UE CL** | 12 | <4.59 dB (12 sources), <1.84 dB (11 sources) |
| **gNB-gNB CL** | 12 | <5.70dB (12 sources), <3.33 dB (8 sources) |
| **UE-UE CL** | 12 | <8.47 dB (12 sources), <3.73 dB (10 sources) |
| Note: We use “< XX dB (YY sources)” to describe the coupling loss difference among YY sources, wherein, , is the maximum 50%-tile value among the YY sources, is the minimum 50%-tile value among the YY sources, and is the average value (in dB scale) of the 50%-tile values of YY sources. | | | |

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

* + 1. 1st Round Proposals

***Initial proposal 1-2-1:***

Capture Table C.3-1 in Annex C.3 “SLS calibration results” in TR38.858 as an example.

* The values in the table can be updated if companies’ calibration results are updated before the first weekend of RAN1#112bis (2023-4-22, 00:00 UTC), after which the SLS calibration results will not be updated.

Table C.3-1: Sample statistics for calibration

|  |  |  |  |
| --- | --- | --- | --- |
| **Scenario** | **Metric** | **Number of sources** | **CL difference compared to average CL**  **(at 50%-tile CDF point)** |
| **Urban Macro (FR1)** | **gNB-UE CL** | 21 | <4.35 dB (21 sources), <3.15 dB (20 sources) |
| **gNB-gNB CL** | 20 | <6.45 dB (20 sources), <2.07 dB (18 sources) |
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| **Dense Urban Macro Layer (FR2-1)** | **gNB-UE CL** | 12 | <3.36 dB (12 sources) |
| **gNB-gNB CL** | 12 | <8.62 dB (12 sources), <3.55 dB (7 sources) |
| **UE-UE CL** | 12 | <13.38 dB (12 sources), <3.04 dB (10 sources) |
| **Indoor office (FR1)** | **gNB-UE CL** | 18 | <1.18 dB (18 sources) |
| **gNB-gNB CL** | 18 | <6.79 dB (18 sources), <3.65 dB (17 sources) |
| **UE-UE CL** | 18 | <2.60 dB (18 sources) |
| **Indoor office (FR2-1)** | **gNB-UE CL** | 12 | <4.59 dB (12 sources), <1.84 dB (11 sources) |
| **gNB-gNB CL** | 12 | <5.70dB (12 sources), <3.33 dB (8 sources) |
| **UE-UE CL** | 12 | <8.47 dB (12 sources), <3.73 dB (10 sources) |
| Note: We use “< XX dB (YY sources)” to describe the coupling loss difference among YY sources, wherein, , is the maximum 50%-tile value among the YY sources, is the minimum 50%-tile value among the YY sources, and is the average value (in dB scale) of the 50%-tile values of YY sources. | | | |

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| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | The proposal only considered the maximum difference from the average at 50%-tile. If one company’s result is far from the average, the value is too large and it may miss-lead our calibration was not performed well.  We propose not to make any conclusions from the calibration results. The calibration results can be referred in TR, as we did in TR38.901 large-scale calibration. For example, the following text is excerpted from TR38.901.  “The calibration results based on TR 38.900 V14.0.0 can be found in R1-165974.” |
| ZTE | We are open to introduce this in the TP for information only. |
| Huawei, HiSilicon | Support |
| Fujitsu | Support. |
| NTT DOCOMO | We are fine with the proposals. |
| Spreadtrum | Support |
| OPPO | Fine with this proposal |
| Xiaomi | We are fine with the proposal. |
| Intel | Generally OK with the proposal and to add the outcome of the calibration exercise in the TR. However, in our view, it may be more informative to provide the whole CDF curves rather than just the 50%ile. |
| Ericsson | Generally ok. IT is important to capture this in the TR. We are ok to also capture 5%ile and 95%ile as additional columns.   One obvious difference between the calibration for SBFD and the calibration done in the past SI/WIs is the gNB-gNB and UE-UE CL which is essential for operation of SBFD. Therefore, it would be good to highlight this aspect in the conclusion. |
| Nokia/NSB | Similar view with Ericsson and Intel. We prefer to provide more information to see better observation. |
| Sony | Support |
| QC | Support.  Also, the TR should capture the calibration results. One observation or conculsion that could be made is that for gNB-gNB, using large-scale only for modeling the CL is understaming the actual CL as compared to LS+SS. |
| Moderator | Based on comments, my plan is to adopt a simple way (similar as in TR38.901), e.g., “The SLS calibration results can be found in R1-XXXXXX.” In R1-XXXXXX, we just provide the excel sheet with the collected SLS calibration results.  Please let me know if you have concern on it. |

# Issue#2: SLS Evaluation Methodology

* 1. Issue#2-1: Scenarios for SBFD
     1. Submitted proposal

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| **Company** | **Proposals** |
| Ericsson (R1-2302769) | Proposal 13: RAN1 to further down-select scenarios where SBFD performance improvements may be realistically possible and can be simulated/evaluated by participating entities.  Observation 9: Dense Urban with 2-layer system has an ISD of 200m, the same needs to be used for the HetNet with Urban Macro and Indoor deployment.  Proposal 14: RAN1 to agree that for evaluation of SBFD deployment 2-layer Scenario B for Case 3-2, Case 4 and dynamic/flexible TDD in FR1 (HetNet with Urban Macro and Indoor) consider the following.   * Layer 1: Urban Macro   + Hexagonal grid with 7 macro sites and 3 sectors per site with wrap around, ISD=200m. |
| Spreadtrum (R1-2302598) | ***Proposal 1: Urban Macro and 2-layer Scenario B should be considered for SBFD Deployment Case 2.***  ***Proposal 2: Urban Macro should be considered for SBFD Deployment Case 3-1.*** |
| Apple (R1-2303481) | **Proposal 3**: Prioritize scenarios for Deployment Case 1, for which assuming the current signaling available at the scheduler to avoid CLI, UE-to-UE CLI is still the most severe case. |
| InterDigital (R1-2302521) | ***Proposal 2.*** *Urban macro and indoor scenarios can be considered for evaluations in this study, where the indoor scenarios represent the most significant UE-to-UE CLI effects.* |
|  |  |

* + 1. Summary

Regarding scenarios,

* Ericsson suggests to further down-select scenarios where SBFD performance improvements may be realistically possible and can be simulated/evaluated by participating entities. Ericsson also suggests to consider 2-layer Scenario B for SBFD Deployment Case 4.
* Apple suggests to prioritize scenarios for SBFD Deployment Case 1.
* Spreadtrum suggests to also consider Urban Macro and 2-layer Scenario B for SBFD Deployment Case 2, and Urban Macro for SBFD Deployment Case 3-1.

Considering there are only 4 meetings left for RAN1 for this SI, moderator suggests not including more scenarios, and focus on the baseline scenarios we have already agreed.

Regarding the Urban macro layer of Scenario B, Ericsson suggests to use ISD=200m instead of ISD=500m, moderator suggests **initial question 2-1-1**.

* + 1. 1st Round Proposals (closed)

***Initial question 2-1-1(closed):***

Do you support to change the ISD from 500m to 200m for the Urban Macro layer of 2-layer Scenario B for SBFD deployment Case 3-2 and dynamic/flexible TDD?

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | We would like to keep 500m for ISD of the Urban Macro layer of 2-layer Scenario B because ISD 500m is typical Urban Macro case |
| LG | We don’t see a strong reason to change the assumption from ISD=500m to ISD=200m. |
| Samsung | We prefer to keep the original assumption unless a critical problem is identified |
| ZTE | We would like to keep the existing simulation assumptions (i.e., 500m) but not preclude other simulation assumptions if companies prefer (e.g., adding another optional value 200m). |
| Huawei, HiSilicon | We don’t see a need to change the previous assumption but would be fine to include ISD with 200m for Urban Macro layer of 2-layer Scenario B which can be reported by companies. |
| Spreadtrum | We are also OK to include ISD with 200m for Urban Macro layer of 2-layer scenario B taking ISD with 500m as baseline. |
| OPPO | ISD=500m is the typical case for Urban Macro Scenario. We prefer to keep the original value for evaluation assumption. |
| Xiaomi | Keep 500m for ISD of the Urban Macro layer of 2-layer Scenario B is preferred. Considering that building size is 120m x 50m x 3m in Urban Macro layer of 2-layer Scenario B, it is high probability that the building cannot be placed within one Macro cell if ISD=200m is used. |
| Intel | We also do not see need to update the previous assumption as companies can always report different values as they wish. |
| Ericsson | We can support Huawei’s suggestion to include ISD for Case 3-2 as a parameter companies can report.  However, from our simulations 500m ISD is not helpful to assess any gains for SBFD in the presence of interference (Macro). It seems like an isolated Indoor deployment which is why we proposed to reduce ISD to 250m. |
| Nokia/NSB | We prefer to keeping the existing assumption, but fine to use it as optional value. |
| Sony | Keep the original ISD=500m assumption. |
| QC | As discussed in our contribution (R1- R1-2303588), we observed that there inter-gNB CLI between Macro-TRP to indoor TRP is insignificant. We believe that RAN1 should reconsider the configurations of HetNet deployment (Case 3-2) for both SBFD/D-TDD evalaution. Reduing the ISD is one possible solution, other solutions include indoor TRP placement (e.g. wall mounted vs ceiling mounted), place InH/InF closer to Macro TRP and considering low-loss for building penetration loss.  At least ISD = 200m should be supported. |
| Moderator | Majority prefer to keep ISD as 500m. Since company still can use other values for ISD and report the value together with the evaluation results, no proposal is needed. |

* + 1. 2nd Round Proposals (open)

***Initial proposal 2-1-1 (open):***

Regarding the 2-layer Scenario B for SBFD deployment Case 3-2 and dynamic/flexible TDD, optionally support ISD=200m for the Urban Macro layer, in which case the building does not need to be confined within one macro cell area.

Companies are encouraged to provide comments in the table below.

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| --- | --- |
| **Company** | **Comment** |
| Moderator | After some offline discussion, I understand that the current agreement does not allow ISD=200m since there is restriction that the building has to be confined within one macro cell area and it is not possible when ISD is set to 200m. To allow companies to use ISD=200m optionally, I provide this proposal. |
| Xiaomi | We are fine with the proposal. |
| New H3C | We are fine with this proposal |
| Huawei, HiSilicon | Okay |
| Samsung | It seems ISD = 200m violates the agreement. Also, the wording “the building does not need to be configured within one macro cell area” is not clear. Does it mean that any building drops are allowed and ignore the following two bullets?   * The minimum 2D distance between macro TRP and indoor office center is 100m * The minimum 2D distance between macro TRP and indoor/outdoor UE is 35m |
| LG | It is better not to increase evaluation options since there are already large enough number of options. Especially for this case, we don’t see a strong need to support this option which requires special exception for the geometrical arrangement. |
| Ericsson | Support. |
| Intel | We feel that since this would be anyway optional, no proposal is really needed since companies can always bring any results they would want. However, if majority would be OK, we are fine with it. |
| Moderator | Thanks for Samsung’s comments.  If the ISD is set to 300m, all the following restrictions can be maintained. Companies can optionally use ISD=300m and report it.   * The building has to be confined within one macro cell area * The minimum 2D distance between macro TRP and indoor office center is 100m * The minimum 2D distance between macro TRP and indoor/outdoor UE is 35m   If the ISD is set to 200m, I think the following restrictions need to be relaxed:   * The building has to be confined within one macro cell area * The minimum 2D distance between macro TRP and indoor office center is 100m   Thus, maybe we do not make more options, and companies just report what they used. |
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* 1. Issue#2-2: General issues
     1. Submitted proposal

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| **Company** | **Proposals** |
| CMCC (R1-2303232) | ***Proposal 1:*** Regarding SLS of potential enhancements on dynamic/flexible TDD in AI 9.3.3,   * The basic evaluation methodologies and assumptions for dynamic/flexible TDD agreed in AI 9.3.1 can be used. * If additional scheme-specific assumptions are needed for some CLI schemes, it is up to companies to report the scheme-specific assumptions.   ***Proposal 6:*** It is recommended that companies to report the UL/DL resource percentage per TDD period together with the evaluation results, which can be calculated as follows:   * UL resource percentage per TDD period = (Number of UL RBs per cell per TDD period excluding guard bands and guard symbols) /(Total number of RBs per cell per TDD period including DL, UL, guard bands and guard symbols ) * DL resource percentage per TDD period = (Number of DL RBs per cell per TDD period excluding guard bands and guard symbols) / (Total number of RBs per cell per TDD period including DL, UL, guard bands and guard symbols ) |
| Ericsson (R1-2302769) | Observation 11: Alt. 1 and Alt.2 SBFD configurations have more UL resources than the reference static TDD pattern it is compared with. Any potential gains in UL for these alternatives need to consider this impact first before drawing conclusions.  Proposal 19: RAN1 should prioritize the alignment of system-level simulation parameters with RAN4, focusing on parameters that are critical for obtaining reliable conclusions for the TR. Deviations in assumptions should be justifiable and documented in TR 38.858. |
| Qualcomm (R1-2303588) | **Proposal 9: For subband full duplex evaluation scenario, support SBFD slot utilization as additional metric.** |

* + 1. Summary

**Evaluation of potential enhancements of dynamic/flexible TDD in AI 9.3.3**

Regarding potential enhancements of dynamic/flexible TDD, the following gNB-gNB / UE-UE co-channel CLI handling schemes are being discussed in AI 9.3.3

* For gNB-to-gNB CLI handling
  + Scheme 1: gNB-to-gNB CLI/channel measurement, e.g., uplink resources muting
  + Scheme 2: Coordinated scheduling
  + Scheme 3: Spatial domain enhancements
  + Scheme 4: Advanced receiver
  + Scheme 5: Enhance power control mechanism
* For UE-to-UE CLI handling
  + Scheme 1: Potential enhancements to UE-to-UE CLI measurement/reporting, e.g., L1/L2 based UE-to-UE CLI measurement and reporting
  + Scheme 2: Coordinated scheduling
  + Scheme 3: Spatial domain enhancements
  + Scheme 4: Enhance UL power control mechanism
* Other schemes and combinations are not precluded.

From moderator’s perspective, for the above schemes, it may not always be the case that SLS is used as the tool for evaluation. For some schemes, maybe LLS or even analysis is more suitable, and for some other schemes SLS is more suitable. If SLS is used for evaluation, the basic evaluation methodologies and assumptions for dynamic/flexible TDD that we have established in AI 9.3.1 can be used. For some CLI schemes, additional scheme-specific assumptions may be needed. It can be up to companies to report these scheme-specific assumptions.

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

**UL/DL resource percentage per TDD period**

[CMCC, Ericsson] suggest companies to report the UL/DL resource percentage per TDD period together with the evaluation results, which can be calculated as follows:

* UL resource percentage per TDD period = (Number of UL RBs per cell per TDD period excluding guard bands and guard symbols) / (Total number of RBs per cell per TDD period including DL, UL, guard bands and guard symbols)
* DL resource percentage per TDD period = (Number of DL RBs per cell per TDD period excluding guard bands and guard symbols) / (Total number of RBs per cell per TDD period including DL, UL, guard bands and guard symbols)

UL/DL resource percentage per TDD period can be useful to investigate the net performance gain/loss of SBFD over legacy TDD. For example, when compared with legacy TDD, if the UL UPT of SBFD is increased by X% (e.g., 100%), and the UL resource percentage per TDD period is increased by Y% (e.g., 80%), then the net UL UPT gain of SBFD over legacy TDD is about (X-Y)% (e.g., 100% - 80% = 20%).

An example of UL/DL resource percentage per TDD period for SBFD slot configuration Alt 2 and Alt 4 is provided below with the assumption that SBFD antenna configuration option 2 is assumed.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Legacy TDD** | **SBFD slot configuration Alt 4 with no guard symbol** | **SBFD slot configuration Alt 2 with 2 guard symbols** | **SBFD Alt 2 slot configuration with no guard symbol** |
| **slot configuration** | DDDSU,  S=12:2:0 | XXXXX | XXXXU  with 2 guard symbols between X and U | XXXXU  with no guard symbol |
| **DL only symbol** | 54 | 0 | 0 | 0 |
| **UL only symbol** | 14 | 0 | 14 | 14 |
| **SBFD symbol** | 0 | 70 | 54 | 56 |
| **DL RB number in DL only symbol** | 273 | 273 | 273 | 273 |
| **UL RB number in UL only symbol** | 273 | 273 | 273 | 273 |
| **DL RB number in SBFD symbol** |  | 208 | 208 | 208 |
| **UL RB number in SBFD symbol** |  | 55 | 55 | 55 |
| **Guard RB number in SBFD symbol** |  | 10 | 10 | 10 |
| **Total DL RB in 5 slots** | 14742 | 14560 | 11232 | 11648 |
| **Total UL RB in 5 slots** | 3822 | 3850 | 6792 | 6902 |
| **Total RB in 5 slots** | 19110 | 19110 | 19110 | 19110 |
| **DL resource percentage per TDD period** | 77.1% | 76.2% | 58.8% | 61.0% |
| **UL resource percentage per TDD period** | 20.0% | 20.1% | 35.5% | 36.1% |
| **DL resource percentage gain over legacy TDD** | - | -1.2% | -23.8% | -21.0% |
| **UL resource percentage gain over legacy TDD** | - | 0.7% | 77.7% | 80.6% |

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

**Alignment of SLS assumptions between RAN1 and RAN4**

Ericsson observed that some assumptions in RAN1 and RAN4 are different, e.g., BS Noise Floor, SBFD configuration, etc. Ericsson suggests RAN1 to prioritize the alignment of system-level simulation parameters with RAN4, focusing on parameters that are critical for obtaining reliable conclusions for the TR. Deviations in assumptions can be justifiable and documented in TR 38.858.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | | **FR1** | | | | **FR2-1** | | |
| **Urban macro** | **Dense Urban Macro layer** | **Dense Urban Micro layer** | **Indoor** | **Dense Urban Macro layer** | **Dense Urban Micro layer** | **Indoor** |
| **BS transmit power for legacy TDD** | *RAN1* | Option 1: 53 dBm  Option 2: 49 dBm | Option 1: 53 dBm  Option 2: 44 dBm | 38 dBm for | 24 dBm | 40 dBm for 100MHz  or 43dBm for 200MHz | 30 dBm for 100MHz  or 33dBm for 200MHz | 23 dBm for both 100MHz  and 200MHz |
| *RAN4* | 49 dBm | - | - | 24 dBm | 30 dBm | [30] dBm | [TBD/24] dBm |
| **BS Noise Figure** | *RAN1* | 5dB | 5dB | 5dB | 5dB | 7dB | 7dB | 7dB |
| *RAN4* | 5dB | - | - | 13dB | 10dB | 10dB | 10dB |

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

* + 1. 1st Round Proposals (closed)

***Initial proposal 2-2-1(closed):***

Regarding SLS for the potential enhancements of dynamic/flexible TDD in AI 9.3.3,

* The basic evaluation methodologies and assumptions for dynamic/flexible TDD agreed in AI 9.3.1 are used.
* If additional scheme-specific assumptions are needed for some enhancement schemes, it is up to companies to report the scheme-specific assumptions.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| ZTE | OK |
| Huawei, HiSilicon | Support in general and same can be applied for SBFD evaluations. Overall, whether gNB-to-gNB as well as UE-to-UE CLI handling can be handled properly is essential to conclude the SI. |
| Xiaomi | We are fine with the proposal. |
| Intel | OK with the proposal |
| Ericsson | OK |
| Nokia/NSB | OK |
| Sony | Support the proposal. |
| QC | Support.  For example, for inter-UE CLI, LLS can be used for specific solution for handling the CLI (e.g. subband filtering, guard gap, ect) that can’t be studies using SLS. |

***Initial proposal 2-2-2(closed):***

Companies are encouraged to report the assumption of UL/DL resource percentage per TDD period together with the evaluation results, which can be calculated as below:

* UL resource percentage per TDD period = (Number of UL RBs per cell per TDD period excluding guard bands and guard symbols) / (Total number of RBs per cell per TDD period including DL, UL, guard bands and guard symbols)
* DL resource percentage per TDD period = (Number of DL RBs per cell per TDD period excluding guard bands and guard symbols) / (Total number of RBs per cell per TDD period including DL, UL, guard bands and guard symbols)
* Note: DL+UL resource percentage may not always be 100% since guard bands and guard symbols may be assumed.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | The motivation behind this proposal is unclear to us.  Our understanding is that if a company provides # of guard symbols, the UL/DL resource percentage per TDD period can be computed. (also, when DUD frequency configuration is reported by each company)  Since we already had clear definitions on RUs, we think additional metrics regarding resource utilization is not necessary to draw a conclusion. |
| ZTE | We are generally open with this proposal. Either to have it or not is fine for us.  However, it seems the DL/UL resource percentage per TDD period itself doesn’t provide much information. Does it mean if companies provide DL/UL resource percentage per TDD period, the net DL/UL UPT gain of SBFD over legacy TDD should also be provided. |
| Huawei, HiSilicon | OK. |
| Fujitsu | Support. |
| Spreadtrum | Support |
| Xiaomi | We are fine with the proposal. |
| Intel | Support. |
| Ericsson | Support. |
| Nokia/NSB | OK with having this metric included in the evaluation. Our understanding is that companies already reported these values on the SLS results collection excel spreadsheet. |
| QC | No strong views on this proposal. Already companies report guard period and % of DL and UL resources per TDD pattern. |

***Initial proposal 2-2-3(closed):***

For evaluation of SBFD and dynamic/flexible TDD, the maximum BS transmit power for legacy TDD in FR2-1 are modified as below.

|  |  |
| --- | --- |
| **FR2-1** | |
| **Dense Urban Macro layer** | * Option 1: ~~40 dBm for 100MHz or 43dBm for 200MHz~~ 30 dBm for both 100MHz and 200MHz. |
| **Dense Urban Micro layer** | * Option 1: 30 dBm for 100MHz ~~or 33dBm for~~ and 200MHz. EIRP should not exceed 68 dBm. |
| **Indoor hotspot** | * Option 1: 23 dBm for both 100MHz and 200MHz. EIRP should not exceed 58 dBm. |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | We are ok that RAN1 strives to align RAN4’s evaluation assumptions. |
| ZTE | Support |
| Huawei, HiSilicon | We understand that RAN4 selected a value of 30 dBm same as the one from TR38.828 but we are not sure whether the same assumption should be followed in RAN1. Base stations with 30dBm Tx power do not seem to target wide area coverage. |
| Fujitsu | Support. |
| NTT DOCOMO | We are fine with the proposal. |
| Xiaomi | We are fine with the proposal. |
| Intel | OK to align assumptions with RAN4’s assumptions. |
| Ericsson | In general ok to align with RAN4 assumptions. As Huawei mentioned, 30 dBm is too low to target a wider coverage area. It also seems that even RAN4 is also considering two different options – low power and high power .  We could consider two options : Low power 30 dBm and High power 40 dBm. |
| Nokia/NSB | It is strange that both Macro and Micro are using the same configuration. We think 40dBm TRP or even higher is already deployed. We think RAN4 is rather limiting the scope for convenience for developing requirement. |
| Sony | Share similar views with Huawei that power may be too low for wide area. It seems from E///’s comment, RAN4 also have 40 dBm, in which case we are already aligned with RAN4. So perhaps we don’t need to change this. |
| QC | Generally okay. It may be good to have two options, 30 dBm and 40 dBm. |

* + 1. 2nd Round Proposals (open)

***Updated proposal 2-2-1a*** ***(open):***

Regarding SLS for the potential enhancements of CLI handling for SBFD and dynamic/flexible TDD in AI 9.3.3,

* The basic evaluation methodologies and assumptions for SBFD and dynamic/flexible TDD agreed in AI 9.3.1 are used.
* If additional scheme-specific assumptions are needed for some enhancement schemes, it is up to companies to report the scheme-specific assumptions.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Updated based on Huawei’s comment. |
| ZTE | OK |
| QC | Support |
| Spreadtrum | Support |
| Xiaomi | Support |
| New H3C | OK |
| Huawei, HiSilicon | Support. |
| LG | We support the proposal. |
| Ericsson | Support. |
| Intel | OK |
| Moderator | Seems Stable. Moved to section 7. |

***Initial proposal 2-2-2 (open):***

Companies are encouraged to report the assumption of UL/DL resource percentage per TDD period together with the evaluation results, which can be calculated as below:

* UL resource percentage per TDD period = (Number of UL RBs per cell per TDD period excluding guard bands and guard symbols) / (Total number of RBs per cell per TDD period including DL, UL, guard bands and guard symbols)
* DL resource percentage per TDD period = (Number of DL RBs per cell per TDD period excluding guard bands and guard symbols) / (Total number of RBs per cell per TDD period including DL, UL, guard bands and guard symbols)
* Note: DL+UL resource percentage may not always be 100% since guard bands and guard symbols may be assumed.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | @Samsung/ZTE, my original intention is that the UL/DL resource percentage per TDD period can be taken as an condition when providing the observation or drawing conclusion for SBFD, since I think UL/DL resource percentage per TDD period is a comprehensive result of several factors (e.g., guard bands, guard symbols and frame structures), and it is more intuitive for understanding the performance gain/loss of SBFD compared to legacy TDD (the UL/DL resource percentage per TDD period is fixed for legacy TDD, but the UL/DL resource percentage per TDD period may be different for different assumptions). But I admit that the UL/DL resource percentage per TDD period can be computed based on guard bands, guard symbols and frame structures, if companies have concern on introducing this, we can leave it for now. |
| ZTE | Thanks moderator for the clarification. We don’t have strong view on this proposal. We can go with the majority view. |
| Ericsson | We think this it is extremely important to state UL and DL resource percentage per TDD in the table. Usually when two systems are compared for gains, the common assumption by any reader is that it is an equal comparison, in the sense that “all other things constant” , just by doing “something else”(SBFD in this case) there are gains/losses compared to a reference system. But this is not true for Alt 2/Alt1 SBFD configuration as the reference static TDD and the SBFD have different UL resources available. RU does not mean anything for the two systems when the denominator in the RU in both the systems are completely different. |
| QC | Okay with proposa as clarification for reporting the resources. |
| Spreadtrum | We agree with Ericsson to provide UL/DL resource percentage per TDD period in the table to show the gain of SBFD excluding the gain introduced by enhancement of UL resource. |
| Xiaomi | Support |
| Huawei, HiSilicon | OK |
| Samsung | As we commented in the 1st round, the UL/DL resource percentage per TDD can be derived by other configurations (TDD configuration, SBFD configuration, guard symbol/RB configuaration). This is not a results of SLS. This is a kind of evaluation assumptions. So, the report of DL/UL resource percentage per TDD period is unnecessary. |
| LG | We are still ok with moderator’s original proposal. |
| Intel | OK |

***Updated proposal 2-2-3a (open):***

For evaluation of SBFD and dynamic/flexible TDD, the maximum BS transmit power for legacy TDD in FR2-1 are modified as below.

|  |  |
| --- | --- |
| **FR2-1** | |
| **Dense Urban Macro layer** | * Baseline: 30 dBm for both 100MHz and 200MHz. * Optional: 40 dBm for both 100MHz and 200MHz. |
| **Dense Urban Micro layer** | * 30 dBm for both 100MHz and 200MHz. |
| **Indoor hotspot** | * 23 dBm for both 100MHz and 200MHz. |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Updated based on comments. I think it is better to have a baseline. |
| ZTE | Alternatively, we can make them as two options without indicating which is baseline. |
| Ericsson | We also think that it can be just two options like we agreed for FR1, instead of baseline and optional. |
| QC | We are fine with either FL proposal or ZTE’s proposal with listing two options. |
| Spreadtrum | No strong views. Either one is OK for us. |
| Xiaomi | Share similar view with ZTE. |
| New H3C | support |
| Huawei, HiSilicon | Agree with ZTE. |
| Samsung | Even though we prefer to define one gNB transmission power as baseline, we are also ok to keep two options without priority. |
| LG | We support the proposal. |
| Intel | We are also fine with either the FL’s proposal and ZTE’s proposal. |
| Moderator | It seems companies are ok to just list the two options as below. I consider it as stable and moved it to section 7 for email approval.  **Updated proposal 2-2-3b:**  For evaluation of SBFD and dynamic/flexible TDD, the maximum BS transmit power for legacy TDD in FR2-1 are modified as below.   |  |  | | --- | --- | | **FR2-1** | | | **Dense Urban Macro layer** | * Option-1: 30 dBm for both 100MHz and 200MHz. * Option-2: 40 dBm for both 100MHz and 200MHz. | | **Dense Urban Micro layer** | * 30 dBm for both 100MHz and 200MHz. | | **Indoor hotspot** | * 23 dBm for both 100MHz and 200MHz. | |

## Issue#2-3: Interference modelling for SBFD

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| CMCC (R1-2303232) | **gNB self-interference modelling**  ***Observation 1:*** The following agreements related to the modelling of gNB self-interference were confirmed by RAN4 according to R1-2300025.   |  | | --- | | [RAN1#110b]  **Agreement**  For SLS of SBFD in RAN1, candidate values for at least can be determined based on the assumption that UL receiver sensitivity degradation due to self-interference is 1dB.   * FFS: UL receiver sensitivity degradation due to self-interference is 0.8dB and 0.1dB * The value of can be calculated based on the UL receiver sensitivity degradation, noise floor of UL subband and maximum gNB DL Tx Power as below   + - For example, for sensitivity degradation of 1dB, can be computed based on , where N is the noise floor over the UL subband given by , assuming 20MHz UL subband and 5dB noise figure. * Note: the feasibility of the determined values can be discussed separately * Companies shall report what values of the individual components are assumed in order to achieve the alpha\_SI value corresponding to 1 dB desense * Other approaches of determining values for are not precluded and can be used and reported by companies.   Send LS to RAN4 to confirm RAN1’s understanding.  **Agreement**  RAN1 assumes frequency isolation value in the overall RSI value ranges provided by RAN4 is based on the assumption of SBFD subband configuration with {DUD=40MHz:20MHz:40MHz} at least for FR1 and all the DL RBs in the DL subbands are allocated with maximum gNB DL Tx Power.   * For SLS of SBFD in RAN1, the RSI is modelled as frequency flat within the UL subband. * Using to denote the overall RSI value provided by RAN4, RAN1 makes the following assumption   + - is the residual self-interference power on the UL subband when all the DL RBs in the DL subbands are allocated with maximum gNB DL Tx Power (in linear scale).     - is the maximum gNB DL Tx Power on the two DL subbands (in linear scale).     - is the total number of DL RBs in the DL subbands.     - is the total number of UL RBs in the UL subband.     - Note: is in linear scale * RAN1 further makes a simple assumption that doesn’t change when DL RBs are not fully allocated for DL transmission, and the residual self-interference power on one UL RB when DL RBs are not fully allocated for DL transmission is computed by   + - is DL transmission power of gNB per RB,     - is the number of DL RBs allocated for DL transmission. * Send LS to RAN4 to confirm RAN1’s assumptions and the subband configuration assumed for FR1/FR2   + Also ask RAN4 if the above is applicable to other subband configurations |   ***Proposal 7:*** For SLS of SBFD, with the assumption of 1dB UL receiver sensitivity degradation and SBFD antenna configuration Option-2, consider the below candidate values for RSI .   |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | |  | *no power boosting*  (BS transmit power for SBFD Option-1) | | | | *with power boosting*  (BS transmit power for SBFD Option-2) | | | | |  | **FR1 (100 MHz),  <104, 55, 5>, 30KHz** | | **FR2-1(200 MHz), <52,26,1>, 120KHz** | | **FR1 (100 MHz),  <104, 55, 5>, 30KHz** | | **FR2-1(200 MHz), <52,26,1>, 120KHz** | | |  | **Tx Power**  **(dBm)** | **αSI (dB)** | **Tx Power**  **(dBm)** | **αSI (dB)** | **Tx Power (dBm)** | **αSI (dB)** | **Tx Power (dBm)** | **αSI (dB)** | | **Urban macro** | 53 | 147.9 |  |  | 53 | 149.1 |  |  | | 49 | 143.9 |  |  | 49 | 145.1 |  |  | | **Dense Urban Macro layer** | 53 | 147.9 | 43 | 133.1 | 53 | 149.1 | 43 | 134.1 | | 44 | 138.9 |  |  | 44 | 140.1 |  |  | | **Dense Urban Micro layer** | 38 | 132.9 | 33 | 123.1 | 38 | 134.1 | 33 | 124.1 | | **Indoor hotspot** | 24 | 118.9 | 23 | 113.1 | 24 | 120.1 | 23 | 114.1 |   **Co-site inter-sector co-channel inter-subband CLI**  ***Observation 2:*** The following agreement related to the modelling of co-site inter-sector co-channel inter-subband CLI was confirmed by RAN4 according to R1-2302262.   |  | | --- | | [RAN1#111]  **Agreement**  For SLS in RAN1, for co-site inter-sector co-channel inter-subband CLI modelling, reuse similar method as gNB self-interference modelling as follows.   * is DL Tx power of sector *x* per RB (in linear scale), * is the maximum DL Tx Power of sector *x* on the two DL subbands (in linear scale). * is the total number of DL RBs in the DL subbands. * is the number of DL RBs allocated for DL transmission of sector *x*. * is the interference suppression capability of co-site inter-sector co-channel inter-subband CLI.   + - Note: and are in linear scale. gNB ACLR (i.e.,) is provided as the candidate for TX leakage, and gNB ACS (i.e.,) is provided as the candidate for Receiver impairment.   + Companies shall report the value of assumed in the simulations with feasibility of how these values were derived.   + Send LS to RAN4 confirming the model and asking the value ranges for spatial isolation, and values of and . |   ***Proposal 8:*** Confirm the below working assumption related to modelling of co-site inter-sector co-channel inter-subband CLI.   |  | | --- | | [RAN1#112]  **Working Assumption:**  For co-site inter-sector co-channel inter-subband CLI modelling, before receiving RAN4’s reply on the value of , RAN1 assume the following only for evaluation:   * FR1:   + 75dB for spatial isolation (RAN4 typical value).   + 93dB for spatial isolation (RAN4 best value).   + 100dB for spatial isolation * FR2:   + 88dB for spatial isolation (RAN4 typical value).   + 98dB for spatial isolation (RAN4 best value).   + 105dB for spatial isolation * In addition to spatial isolation and frequency isolation, companies can use digital cancelation and report the value, e,g., 10dB. Above does not imply that RAN1 assumes or does not assume digital cancelation is feasible. * The feasibility of these values is up to RAN4. These values can be revisited based on further RAN4 inputs. * The 100dB/105dB isolation values for FR1 and FR2 are not from RAN4, but based on RAN4 input that some companies have proposed that isolating material could be added between sectors to increase the isolation. RAN4 has not yet discussed the details whether such approaches can be applied to outdoor sites. |   **Inter-site gNB-gNB co-channel inter-subband CLI**  ***Observation 3:*** The following agreements related to the modelling of inter-site gNB-gNB co-channel inter-subband CLI were confirmed by RAN4 according to R1-2300025.   |  | | --- | | [RAN1#110b]  **Agreement**  For SLS in RAN1, if only large scale fading is modelled and small scale fading is not modelled for gNB-gNB co-channel channel model, the power of inter-site gNB-gNB co-channel inter-subband CLI experienced by the victim gNB on each receiver chain at one UL RB can be modelled as   * + is the power of inter-site gNB-gNB co-channel inter-subband CLI from gNB to gNB on each receiver chain at one UL RB (linear value)   + is DL transmission power of gNB across all transmit chains per RB (linear value). .   + is the number of DL RBs allocated for DL transmission by gNB   + is the coupling loss between gNB and gNB (linear value), accounting for beamforming at the aggressor gNB and victim gNB.     - FFS: the detailed definition of the coupling loss, which can be discussed later   + is the total number of DL RBs in the DL subbands   + Note: and are in linear scale. In RAN4 reply LS, gNB ACLR (i.e., ) is provided as the candidate for TX leakage, and gNB ACS (i.e., ) is provided as the candidate for Receiver impairment.   + Note: the model is based on the assumption that the same transmission power across different DL RBs is used in SLS. This does not prevent companies to use other DL power allocation schemes in SLS.   + Note: This model is not applicable to the RBs in the guardband.   + Note: This model is not applicable for some candidate gNB-gNB CLI handling schemes (for example, spatial digital beam coordination, advanced receivers) * Send LS to RAN4 to confirm RAN1’s understanding   **Agreement**  For SLS in RAN1, if both large scale fading and small scale fading are modelled for gNB-gNB co-channel channel model, the inter-site gNB-gNB co-channel inter-subband CLI signal across all Rx chains at UL RB 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 RB , caused by power leakage at aggressor gNB,   + is the channel matrix between aggressor gNB and victim gNB at UL RB , the beamforming of the aggressor gNB and the victim gNB can be taken into account by ,   + is the unwanted emission across all Tx chains at UL RB at aggressor gNB,     - is the number of Tx chains at aggressor gNB,     - , , is modelled as white Gaussian noise,     - is the total leakage power at UL RB at aggressor gNB,     - is the DL power transmitted across all Tx chains at one DL RB at aggressor gNB,,     - is the number of DL RBs scheduled for DL transmission by aggressor gNB,     - is the total number of DL RBs in the DL subbands   + is the normalized identity matrix with unit norm, ,     - FFS whether can be other values and corresponding conditions * FFS for * Note: and are in linear scale. In RAN4 reply LS, gNB ACLR (i.e., ) is provided as the candidate for TX leakage, and gNB ACS (i.e., ) is provided as the candidate for Receiver impairment. * Note: the model is based on the assumption that the same transmission power across different DL RBs are used in SLS. This does not prevent companies to use other DL power allocation schemes in SLS. * Note: This model is not applicable to the RBs in the guardband. * Send LS to RAN4 to confirm RAN1’s understanding. |   ***Observation 4:*** Regarding the below agreement related to the modelling of inter-site gNB-gNB co-channel inter-subband CLI, RAN1’s assumption on ICSBS (in channel selectivity) to be given by the value of gNB ACS was confirmed by RAN4 according to R1-2302262.   |  | | --- | | [RAN1#111]  **Agreement**  Regarding the modelling of inter-site gNB-gNB co-channel inter-subband CLI agreed in RAN1#110bis for the case that both large scale fading and small scale fading are modelled for gNB-gNB co-channel channel model, the second part of inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at one UL RB, caused by receiver selectivity at victim gNB, can be modelled as     * + , , is modelled as white Gaussian noise   + is the channel matrix between aggressor gNB and victim gNB at DL RB , the analog beams of the aggressor gNB and the victim gNB can be taken into account by ,   + is the digital precoder at DL RB at aggressor gNB, ,   + is the symbol transmitted at DL RB at aggressor gNB with transmission power for each layer as .   + is the total number of DL RBs in the DL subbands,   + RAN1 can assume (in channel selectivity) is given by gNB ACS unless further RAN4 guidance is received.     - Send LS to RAN4 to confirm RAN1 understanding and check whether can be modelled depending on the value of the blocker interference, e.g.,   + Note: can be reported by companies |   ***Proposal 9:*** Update the agreement in RAN1#111 as below:  Regarding the modelling of inter-site gNB-gNB co-channel inter-subband CLI agreed in RAN1#110bis for the case that both large scale fading and small scale fading are modelled for gNB-gNB co-channel channel model, the second part of inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at one UL RB, caused by receiver selectivity at victim gNB, can be modelled as     * + , , is modelled as white Gaussian noise   + is the channel matrix between aggressor gNB and victim gNB at DL RB , the analog beams of the aggressor gNB and the victim gNB can be taken into account by ,   + is the digital precoder at DL RB at aggressor gNB, ,   + is the symbol transmitted at DL RB at aggressor gNB with transmission power for each layer as .   + is the total number of DL RBs in the DL subbands,   + RAN1 can assume (in channel selectivity) is given by gNB ACS ~~unless further RAN4 guidance is received.~~     - ~~Send LS to RAN4 to confirm RAN1 understanding and check whether can be modelled depending on the value of the blocker interference, e.g.,~~   + Note: can be reported by companies.   ***Proposal 10:*** For SLS in RAN1, the BS noise figure is modelled as below     * + - X-axis: Total received power is the linear sum of all received power, including wanted signal, legacy UE-gNB interference, self-interference, inter-gNB interference and inter-sector interference.     - Y-axis: noise figure     - The values of A, B, C and D:       * A = -43dBm for FR1, FFS for FR2-1       * B = -25dBm for FR1, FFS for FR2-1       * C = 5dB for FR1, FFS for FR2-1       * D = 14dB for FR1, FFS for FR2-1     - If the total received power is larger than B, the receiver will be blocked.   **UE-UE co-channel inter-subband CLI**  ***Observation 5:*** Regarding the modelling of UE-UE co-channel inter-subband CLI, according to R1-2302262, RAN4 also adopts IBE-based model, and RAN4 has not reached the agreement for an equivalent frequency flat model.   |  | | --- | | [RAN1#111]  **Agreement**  For SLS in RAN1, regarding Tx leakage model of UE-UE co-channel inter-subband CLI modelling, Option 1 is used as starting point.   * Option 1: RAN1 to take in-band emission (IBE) defined in TS38.101-1 and TS38.101-2 as starting point. * Send LS to RAN4 to ask them whether it can be modelled as an equivalent frequency flat model (e.g., ) based on RAN4 IBE requirement, and if possible, what is the value of |   ***Observation 6:*** The following agreements and working assumptions related to the modelling of UE-UE co-channel inter-subband CLI still wait for RAN4’s confirm.   |  | | --- | | [RAN1#112]  **Agreement**  For SLS in RAN1, if only large scale fading is modelled and small scale fading is not modelled for UE-UE co-channel channel model, the power of UE-UE co-channel inter-subband CLI experienced by the victim UE on each receiver chain at DL RB *n* can be modelled as  where   * is the power of UE-UE co-channel inter-subband CLI from aggressor UE to victim UE on each receiver chain at one DL RB *n* (linear value). * is UL transmission power of UE across all transmit chains over the allocated UL RBs (linear value) * is the coupling loss between UE and UE (linear value), accounting for analog beamforming at the aggressor UE and victim UE * is the total number of UL RBs in the UL subband * is in linear scale. For the value of , it is up to RAN4. Companies can report the value used in their simulation before receiving RAN4’s further input. * , wherein,   + For SBFD Subband configuration with {DUD} pattern, can be ignored   + is UL transmission power of UE across all transmit chains per RB (linear value). , and is the number of UL RBs allocated for UL transmission of UE .   + is the Transmission Bandwidth Configuration, referring to Table 5.3.2-1 in TS 38.101-1 for FR1 and in TS 38.101-2 for FR2-1.     - for FR1 with 100MHz transmission bandwidth and 30kHz SCS     - for FR2-1 with 200MHz transmission bandwidth and 120kHz SCS   + is the starting frequency offset between the allocated UL RBs and the measured non-allocated RB (e.g. *∆RB*= 1 or *∆RB*= -1 for the first adjacent RB outside of the allocated UL RBs)   + EVM is the limit specified in Table 6.4.2.1-1 in TS 38.101-1 for FR1 and in TS 38.101-2 for FR2-1 for the modulation format used in the allocated RBs.   Include the above in the LS to RAN4 to inform them of the agreement and to check if the RAN1 agreement is in line with RAN4’s understanding.  **Working assumption:**  For SLS in RAN1, if both large-scale and small-scale fading are modelled for UE-UE co-channel channel model, the UE-UE co-channel inter-subband CLI signal across all Rx chains at DL RB at victim UE can be modeled as:  where,   * is the first part of UE-UE co-channel inter-subband CLI across all Rx chains at DL RB , caused by power leakage at aggressor UE,   + is the channel matrix between aggressor UE and victim UE at DL RB , the beamforming of the aggressor UE and the victim UE can be taken into account by   + is the number of Rx chains and is the number of Tx chains   + is the normalized wideband UL digital precoder of the aggressor UE, .   + ,     - , , is modelled as white Gaussian noise     - has the same meaning as in the agreement for the case only large-scale fading is modelled * is modelled as frequency flat   + , , is modelled as white Gaussian noise,   + is the channel matrix between aggressor UE and victim UE at UL RB , the analog beams of the aggressor UE and the victim gNB can be taken into account by ,   + is the normalized wideband UL digital precoder of the aggressor UE,   + is the symbol transmitted at UL RB at aggressor UE with transmission power for each layer as .     - has the same meaning as in the agreement for the case only large-scale fading is modelled   + is the total number of UL RBs in the UL subbands,   + is in linear scale. For the value of , it is up to RAN4. Companies can report the value used in their simulation before receiving RAN4’s further input.   Include the above in the LS to RAN4 to inform them of the agreement and to check if the RAN1 agreement is in line with RAN4’s understanding. |   ***Proposal 11:*** Confirm the below working assumption related to the modelling of UE-UE co-channel inter-subband CLI.  **Working assumption:**  For SLS in RAN1, if both large-scale and small-scale fading are modelled for UE-UE co-channel channel model, the UE-UE co-channel inter-subband CLI signal across all Rx chains at DL RB at victim UE can be modeled as:  where,   * is the first part of UE-UE co-channel inter-subband CLI across all Rx chains at DL RB , caused by power leakage at aggressor UE,   + is the channel matrix between aggressor UE and victim UE at DL RB , the beamforming of the aggressor UE and the victim UE can be taken into account by   + is the number of Rx chains and is the number of Tx chains   + is the normalized wideband UL digital precoder of the aggressor UE, .   + ,     - , , is modelled as white Gaussian noise     - has the same meaning as in the agreement for the case only large-scale fading is modelled * is modelled as frequency flat   + , , is modelled as white Gaussian noise,   + is the channel matrix between aggressor UE and victim UE at UL RB , the analog beams of the aggressor UE and the victim gNB can be taken into account by ,   + is the normalized wideband UL digital precoder of the aggressor UE,   + is the symbol transmitted at UL RB at aggressor UE with transmission power for each layer as .     - has the same meaning as in the agreement for the case only large-scale fading is modelled   + is the total number of UL RBs in the UL subbands,   + is in linear scale. For the value of , it is up to RAN4. Companies can report the value used in their simulation before receiving RAN4’s further input.   **Co-site gNB-gNB adjacent-channel CLI**  ***Observation 7:*** Regarding the below agreement related to the modelling of co-site gNB-gNB adjacent-channel CLI, the value of still wait for RAN4’s inputs.   |  | | --- | | [RAN1#112]  **Agreement**  For SLS in RAN1, for co-site gNB-gNB adjacent-channel CLI modelling, reuse similar method as co-site inter-sector co-channel inter-subband CLI modeling as follows.   * is DL Tx power of sector *x* per RB (in linear scale), * is the maximum DL Tx Power of sector *x* in adjacent channel (in linear scale). * is the total number of DL RBs in adjacent channel. * is the number of DL RBs allocated for DL transmission of sector *x* in adjacent channel. * is the interference suppression capability of co-site inter-sector co-channel inter-subband CLI between the aggressor sector *x* and the victim sector.   + FFS the concrete value of   + and are in linear scale.   Send an LS to RAN4 to inquire on the value of . | |
| Huawei (R1-2302347) | ***Proposal 1:*** *The following noise figure model is used at gNB side in SLS to model the receiver selectivity of inter-sector gNB-gNB co-channel inter-subband CLI.*   * *The noise figure model is provided as below:*      * + *X-axis: Total received power is the linear sum of all received power, including wanted signal, self-interference, inter-gNB interference and inter-sector interference.*   + *Y-axis: noise figure*   + *The values of A, B, C and D:*      - *A = -43dBm*     - *B = -25dBm*     - *C = 5dB*     - *D = 14dB*   + *If the total received power is larger than B, the receiver will be blocked.* * *The receiver selectivity model for inter-sector gNB-gNB co-channel inter-subband CLI agreed in RAN1#111 should be replaced by this noise figure model.* |
| Ericsson (R1-2302769) | Proposal 16: RAN1 to adopt the calculation and reporting of the statistic *Pblocker*’, considering the total power at the receiver as derived from the system level simulations.  Proposal 17: RAN1 to adopt the piecewise linear model proposed by RAN4 to model the receiver blocking and distortions caused by non-linearities in the receiver for FR1. Send an LS to RAN4 to confirm the understanding that a model for FR2 will be provided as well.  Proposal 18: If 1 dB desense is assumed to model self-interference, then the self-interference power input to the model should be the value assumed to get 1 dB desense.  Proposal 20: RAN1 to agree adopting RAN4's noise figure values for different BS classes. |
| Qualcomm (R1-2303588) | **Proposal 6: Confirm the working assumption on inter-UE co-channel inter-subband CLI signal based on both large-scale and small-scale fading.**  **Proposal 7: Confirm the working assumption on co-site inter-sector co-channel inter-subband CLI modelling.**  **Proposal 8: The noise figure for the gNB receiver is modelled as piece wise linear based on the average total input power (P) as**   * **For FR1 UMa, A = -43dBm, B = -25dBm, C = 5dB, D = 14dB** * **FFS: values of A, B, C and D for FR2-1 based on RAN4.** * **Note: P is the linear sum of all received power, including wanted signal, self-interference, inter-gNB interference and inter-sector interference** |
| Nokia (R1-2303015) | **Proposal 1: Based on RAN4’s LS reply R4-2302885, the gNB receiver impairment is modelled as a combination of two separate effects:**   * **In-channel selectivity using the model agreed in RAN1#111 with ICSBS (in channel selectivity) given by the value of gNB ACS** * **Receiver blocking and non-linear effects by varying the gNB noise figure as a function of the total received power in the receiver (corresponding to the linear sum of all received power, including wanted signal, self-interference, inter-gNB interference and inter-sector interference).**   **Proposal 2: For modeling the blocking effect in the gNB receiver, the total received power at the *j*-th gNB is defined as follows:**   * **where:**   + **corresponds to the self-interference, where**  **corresponds to the gNB DL transmit power and**  **accounts for analogue suppression mechanisms applied at transmit side e.g. transmit-receive antenna isolation and tx-side beam nulling. Frequency isolation and other receive-side effects are not considered in ;**   + **is the blocker interference generated from gNB *i* to gNB *j*.**      - **Modeling of for each inter-site gNB-pair can be done as with and denoting the precoder and transmitted symbol at the aggressor gNB *i,* and denoting the channel between gNB *i* and gNB *j.***     - **Modeling of for co-site gNB-pairs can be done in a similar manner as for self-interference, i.e. as , with accounting for analogue suppression mechanisms e.g. inter-sector isolation and potentially inter-sector beam nulling if applicable.**   + **is the received power from the *k*-th UE UL transmission at gNB *j*. includes (legacy) inter-cell UL interference as well as the wanted UL signals.** * **Note: Depending on gNB wideband Rx analogue filter implementation, blocker interference increases according to the number of operators deployed in the frequency band. If only a single operator's network is simulated but the gNB supports a frequency range in which *n* operators have networks with similar power and traffic, the formula may consider the factor of *n* for the interference from base stations and UEs in other networks. This may approximate the other networks' effect if they use the same masts, cause the same intra-band co-site interference, and also use SBFD. In other words, this approximation only applies if 0% grid-shift between networks is assumed. Mathematically, this can be expressed as:**   **where:**   * **is the blocking interference generated at the co-site gNB *i* towards the gNB *j*** * **is the blocking interference generated at the inter-site gNB *l* towards the gNB *j*** * **is the blocking interference generated at the UE *k* towards the gNB *j*** |
| Spreadtrum (R1-2302598) | ***Proposal 6: Update the agreement in RAN1#112 as below:***  ***For SLS of SBFD, use the following values for BS ACLR/ACS ( and ).***   |  |  |  | | --- | --- | --- | |  | **FR1** | **FR2-1** | | BS ACLR | 45 dB | 28 dB | | BS ACS | 46 dB | ~~23.5~~24 dB |   ***Proposal 7: In inter-site gNB-gNB co-channel inter-subband CLI modelling, ICSBS is given by value of gNB ACS.***  ***Proposal 8: Noise figure model given by RAN4 should be taken into account to get BS noise figure.***  ***Proposal 9: For the baseline SBFD cases, consider the below candidate values of* αSI *in BS self-interference modelling***   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Scenarios** | **FR1 (100 MHz),  <104, 55, 5> , 30KHz** | | **FR2-1(200 MHz), <47,32,3>, 120KHz** | | |  | **Tx Power (dBm)** | **αSI (dB)** | **Tx Power (dBm)** | **αSI (dB)** | | **Urban macro** | 53 | 147.9 |  |  | | 49 | 143.9 |  |  | | **Dense Urban Macro layer** | 53 | 147.9 | 40 | 130.1 | | 44 | 138.9 |  |  | | **Dense Urban Micro layer** | 38 | 132.9 | 30 | 120.1 | | **Indoor hotspot** | 24 | 118.9 | 23 | 113.1 |   ***Proposal 10: Regarding Tx leakage model of UE-to-UE co-channel inter-subband CLI modelling, deprioritize equivalent frequency flat IBE model.*** |
| Intel (R1-2302794) | **Proposal 1: The working assumption related to spatial isolation is confirmed.** |
| New H3C (R1-2302427) | **Proposal 1: After RAN4 offer response to RAN1, RAN1 can confirm two work assumption on , value and both large-scale and small-scale fading modeling for UE-UE co-channel channel model.** |
|  |  |

### Summary

During the past RAN1 meetings, there are many LS interactions between RAN1 and RAN4 to confirm interference modelling understanding for SBFD.

|  |  |  |
| --- | --- | --- |
| **RAN1 meeting** | **LS from RAN1 to RAN4** | **Reply LS from RAN4 to RAN1** |
| RAN1#109-e | R1-2205543 LS on interference modelling for duplex evolution RAN1, CMCC |  |
| RAN1#110bis-e | R1-2210602 LS on interference modelling for duplex evolution RAN1, CMCC | R1-2208347 Reply LS on interference modelling for duplex evolution *(Reply to R1-2205543)* RAN4, Samsung, CMCC, Qualcomm |
| R1-2210671 LS on maximum number of UL subbands for duplex evolution RAN1, CATT |  |
| RAN1#111 | R1-2212963 LS on interference modelling for duplex evolution RAN1, CMCC |  |
| RAN1#112 | R1-2302087 LS on interference modelling for duplex evolution RAN1, CMCC | R1-2300025 LS response to RAN1 for interference modelling and Sub-band configuration *(Reply to R1-2205543, R1-2210602, R1-2210671)* RAN4, Samsung |
| RAN1#112bis-e |  | R1-2302262 Reply LS on interference modelling *(Reply to R1-2212963)* RAN4, CATT |

Some agreements related to the interference modelling for SBFD has been confirmed by RAN4.

#### **gNB Self-Interference**

The following agreements for modelling of gNB self-interference were confirmed by RAN4 according to R1-2300025.

|  |
| --- |
| [RAN1#110b]  **Agreement**  For SLS of SBFD in RAN1, candidate values for at least can be determined based on the assumption that UL receiver sensitivity degradation due to self-interference is 1dB.   * FFS: UL receiver sensitivity degradation due to self-interference is 0.8dB and 0.1dB * The value of can be calculated based on the UL receiver sensitivity degradation, noise floor of UL subband and maximum gNB DL Tx Power as below   + - For example, for sensitivity degradation of 1dB, can be computed based on , where N is the noise floor over the UL subband given by , assuming 20MHz UL subband and 5dB noise figure. * Note: the feasibility of the determined values can be discussed separately * Companies shall report what values of the individual components are assumed in order to achieve the alpha\_SI value corresponding to 1 dB desense * Other approaches of determining values for are not precluded and can be used and reported by companies.   Send LS to RAN4 to confirm RAN1’s understanding.  **Agreement**  RAN1 assumes frequency isolation value in the overall RSI value ranges provided by RAN4 is based on the assumption of SBFD subband configuration with {DUD=40MHz:20MHz:40MHz} at least for FR1 and all the DL RBs in the DL subbands are allocated with maximum gNB DL Tx Power.   * For SLS of SBFD in RAN1, the RSI is modelled as frequency flat within the UL subband. * Using to denote the overall RSI value provided by RAN4, RAN1 makes the following assumption   + - is the residual self-interference power on the UL subband when all the DL RBs in the DL subbands are allocated with maximum gNB DL Tx Power (in linear scale).     - is the maximum gNB DL Tx Power on the two DL subbands (in linear scale).     - is the total number of DL RBs in the DL subbands.     - is the total number of UL RBs in the UL subband.     - Note: is in linear scale * RAN1 further makes a simple assumption that doesn’t change when DL RBs are not fully allocated for DL transmission, and the residual self-interference power on one UL RB when DL RBs are not fully allocated for DL transmission is computed by   + - is DL transmission power of gNB per RB,     - is the number of DL RBs allocated for DL transmission. * Send LS to RAN4 to confirm RAN1’s assumptions and the subband configuration assumed for FR1/FR2   + Also ask RAN4 if the above is applicable to other subband configurations |

Under the assumption of 1dB UL receiver sensitivity degradation and SBFD antenna configuration Option-2, CMCC suggests to consider the below candidate values for RSI .

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | *no power boosting*  (BS transmit power for SBFD Option-1) | | | | *with power boosting*  (BS transmit power for SBFD Option-2) | | | |
|  | **FR1 (100 MHz),  <104, 55, 5>, 30KHz** | | **FR2-1(200 MHz), <52,26,1>, 120KHz** | | **FR1 (100 MHz),  <104, 55, 5>, 30KHz** | | **FR2-1(200 MHz), <52,26,1>, 120KHz** | |
|  | **Tx Power**  **(dBm)** | **αSI (dB)** | **Tx Power**  **(dBm)** | **αSI (dB)** | **Tx Power (dBm)** | **αSI (dB)** | **Tx Power (dBm)** | **αSI (dB)** |
| **Urban macro** | 53 | 147.9 |  |  | 53 | 149.1 |  |  |
| 49 | 143.9 |  |  | 49 | 145.1 |  |  |
| **Dense Urban Macro layer** | 53 | 147.9 | 43 | 133.1 | 53 | 149.1 | 43 | 134.1 |
| 44 | 138.9 |  |  | 44 | 140.1 |  |  |
| **Dense Urban Micro layer** | 38 | 132.9 | 33 | 123.1 | 38 | 134.1 | 33 | 124.1 |
| **Indoor hotspot** | 24 | 118.9 | 23 | 113.1 | 24 | 120.1 | 23 | 114.1 |

#### **Co-site inter-sector co-channel inter-subband CLI**

the following agreement for modelling of co-site inter-sector co-channel inter-subband CLI was confirmed by RAN4 according to R1-2302262.

|  |
| --- |
| [RAN1#111]  **Agreement**  For SLS in RAN1, for co-site inter-sector co-channel inter-subband CLI modelling, reuse similar method as gNB self-interference modelling as follows.   * is DL Tx power of sector *x* per RB (in linear scale), * is the maximum DL Tx Power of sector *x* on the two DL subbands (in linear scale). * is the total number of DL RBs in the DL subbands. * is the number of DL RBs allocated for DL transmission of sector *x*. * is the interference suppression capability of co-site inter-sector co-channel inter-subband CLI.   + - Note: and are in linear scale. gNB ACLR (i.e.,) is provided as the candidate for TX leakage, and gNB ACS (i.e.,) is provided as the candidate for Receiver impairment.   + Companies shall report the value of assumed in the simulations with feasibility of how these values were derived.   + Send LS to RAN4 confirming the model and asking the value ranges for spatial isolation, and values of and . |

Regarding the following working assumption made in RAN1#112, it is aligned with the RAN4 LS (R1-2302262). [Qualcomm, Intel, New H3C, CMCC] suggested to confirm the working assumption.

|  |
| --- |
| [RAN1#112]  **Working Assumption:**  For co-site inter-sector co-channel inter-subband CLI modelling, before receiving RAN4’s reply on the value of , RAN1 assume the following only for evaluation:   * FR1:   + 75dB for spatial isolation (RAN4 typical value).   + 93dB for spatial isolation (RAN4 best value).   + 100dB for spatial isolation * FR2:   + 88dB for spatial isolation (RAN4 typical value).   + 98dB for spatial isolation (RAN4 best value).   + 105dB for spatial isolation * In addition to spatial isolation and frequency isolation, companies can use digital cancelation and report the value, e,g., 10dB. Above does not imply that RAN1 assumes or does not assume digital cancelation is feasible. * The feasibility of these values is up to RAN4. These values can be revisited based on further RAN4 inputs. * The 100dB/105dB isolation values for FR1 and FR2 are not from RAN4, but based on RAN4 input that some companies have proposed that isolating material could be added between sectors to increase the isolation. RAN4 has not yet discussed the details whether such approaches can be applied to outdoor sites. |

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

#### **Inter-site gNB-gNB co-channel inter-subband CLI**

The following agreements for modelling of inter-site gNB-gNB co-channel inter-subband CLI were confirmed by RAN4 according to R1-2300025.

|  |
| --- |
| [RAN1#110b]  **Agreement**  For SLS in RAN1, if only large scale fading is modelled and small scale fading is not modelled for gNB-gNB co-channel channel model, the power of inter-site gNB-gNB co-channel inter-subband CLI experienced by the victim gNB on each receiver chain at one UL RB can be modelled as   * + is the power of inter-site gNB-gNB co-channel inter-subband CLI from gNB to gNB on each receiver chain at one UL RB (linear value)   + is DL transmission power of gNB across all transmit chains per RB (linear value). .   + is the number of DL RBs allocated for DL transmission by gNB   + is the coupling loss between gNB and gNB (linear value), accounting for beamforming at the aggressor gNB and victim gNB.     - FFS: the detailed definition of the coupling loss, which can be discussed later   + is the total number of DL RBs in the DL subbands   + Note: and are in linear scale. In RAN4 reply LS, gNB ACLR (i.e., ) is provided as the candidate for TX leakage, and gNB ACS (i.e., ) is provided as the candidate for Receiver impairment.   + Note: the model is based on the assumption that the same transmission power across different DL RBs is used in SLS. This does not prevent companies to use other DL power allocation schemes in SLS.   + Note: This model is not applicable to the RBs in the guardband.   + Note: This model is not applicable for some candidate gNB-gNB CLI handling schemes (for example, spatial digital beam coordination, advanced receivers) * Send LS to RAN4 to confirm RAN1’s understanding   **Agreement**  For SLS in RAN1, if both large scale fading and small scale fading are modelled for gNB-gNB co-channel channel model, the inter-site gNB-gNB co-channel inter-subband CLI signal across all Rx chains at UL RB 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 RB , caused by power leakage at aggressor gNB,   + is the channel matrix between aggressor gNB and victim gNB at UL RB , the beamforming of the aggressor gNB and the victim gNB can be taken into account by ,   + is the unwanted emission across all Tx chains at UL RB at aggressor gNB,     - is the number of Tx chains at aggressor gNB,     - , , is modelled as white Gaussian noise,     - is the total leakage power at UL RB at aggressor gNB,     - is the DL power transmitted across all Tx chains at one DL RB at aggressor gNB,,     - is the number of DL RBs scheduled for DL transmission by aggressor gNB,     - is the total number of DL RBs in the DL subbands   + is the normalized identity matrix with unit norm, ,     - FFS whether can be other values and corresponding conditions * FFS for * Note: and are in linear scale. In RAN4 reply LS, gNB ACLR (i.e., ) is provided as the candidate for TX leakage, and gNB ACS (i.e., ) is provided as the candidate for Receiver impairment. * Note: the model is based on the assumption that the same transmission power across different DL RBs are used in SLS. This does not prevent companies to use other DL power allocation schemes in SLS. * Note: This model is not applicable to the RBs in the guardband. * Send LS to RAN4 to confirm RAN1’s understanding. |

Regarding the following agreement achieved in RAN1 #111 for the second part of inter-site gNB-gNB co-channel inter-subband CLI (i.e., ) for the case that both large scale fading and small scale fading are modelled,

|  |
| --- |
| [RAN1#111]  **Agreement**  Regarding the modelling of inter-site gNB-gNB co-channel inter-subband CLI agreed in RAN1#110bis for the case that both large scale fading and small scale fading are modelled for gNB-gNB co-channel channel model, the second part of inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at one UL RB, caused by receiver selectivity at victim gNB, can be modelled as     * + , , is modelled as white Gaussian noise   + is the channel matrix between aggressor gNB and victim gNB at DL RB , the analog beams of the aggressor gNB and the victim gNB can be taken into account by ,   + is the digital precoder at DL RB at aggressor gNB, ,   + is the symbol transmitted at DL RB at aggressor gNB with transmission power for each layer as .   + is the total number of DL RBs in the DL subbands,   + RAN1 can assume (in channel selectivity) is given by gNB ACS unless further RAN4 guidance is received.     - Send LS to RAN4 to confirm RAN1 understanding and check whether can be modelled depending on the value of the blocker interference, e.g.,   + Note: can be reported by companies |

RAN4’s reply is as below (ref to LS R1-2302262 (R4-2302885)).

|  |
| --- |
| [R1-2302262 (R4-2302885)]  **Answer from RAN4:** From RAN4 perspective, the following model is provided for simulation purpose:   * + RAN4 can confirm RAN1 can assume ICSBS (in channel selectivity) is given by the value of gNB ACS.   + The noise figure model is provided as below:      * + - X-axis: Total received power is the linear sum of all received power, including wanted signal, self-interference, inter-gNB interference and inter-sector interference.     - Y-axis: noise figure     - The values of A, B, C and D:       * A = -43dBm       * B = -25dBm       * C = 5dB       * D = 14dB     - If the total received power is larger than B, the receiver will be blocked. |

Based on the RAN4’s reply LS R1-2302262 (R4-2302885),

* Regarding In-channel selectivity () modeling,
  + [Nokia, Ericsson, Qualcomm, Spreadtrum, CMCC] suggest to use the model agreed in RAN1#111 with ICSBS (in channel selectivity) given by the value of gNB ACS. In addition, the piecewise linear noise figure model provided by RAN4 should be used
  + [Huawei] suggests In-channel selectivity () to be replaced by the piecewise linear noise figure model provided by RAN4
* Regarding the piecewise linear noise figure model provided by RAN4,
  + CMCC understands the values (i.e., A/B/C/D) given by RAN4 should be used for only FR1 since C=5dB is what we usually assumed for FR1.
    - Furthermore, CMCC understands that total received power in X-axis should also includes legacy UE-gNB interference, in addition to wanted signal, self-interference, inter-gNB interference and inter-sector interference.
  + Ericsson suggests to send an LS to RAN4 to confirm the understanding that a piecewise linear noise figure model for FR2 will be provided as well
    - Regading the self-interference component of the total received power in X-axis, Ericsson suggests if 1 dB desense is assumed to model self-interference, then the self-interference power input to the model should be the value assumed to get 1 dB desense
  + Qualcomm suggests the noise figure for the gNB receiver is modelled as piece wise linear based on the average total input power (P) as
    - For FR1 UMa, A = -43dBm, B = -25dBm, C = 5dB, D = 14dB
    - FFS: values of A, B, C and D for FR2-1 based on RAN4.
    - Note: P is the linear sum of all received power, including wanted signal, self-interference, inter-gNB interference and inter-sector interference
  + Nokia suggests the total received power should include wanted signal, self-interference, UE-gNB interference, inter-gNB interference and inter-sector interference. Nokia also suggests to consider the interference from base stations and UEs in other networks

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

In RAN1#112, it was agreed to use the following values for BS ACLR/ACS

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [RAN1#112]  **Agreement**  For SLS of SBFD, use the following values for BS ACLR/ACS ( and ).   |  |  |  | | --- | --- | --- | |  | **FR1** | **FR2-1** | | BS ACLR | 45 dB | 28 dB | | BS ACS | 46 dB | 23.5 dB | |

Nevertheless, according to RAN4’s reply LS R1-2302262 (R4-2302885), 24 dB is used for BS ACS in RAN4.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| [R1-2302262 (R4-2302885)]   * + Additionally, RAN4 has not yet precluded possible improvements on receiver performance compared to baseline gNB ACS. The ACLR/ACS values for FR1 and FR2 are shown in the table below.  |  |  |  | | --- | --- | --- | | Range | ACLR [dB] | ACS [dB] | | FR-1 | 45 | 46 | | FR-2 | 28 | 24 | |

Based on the above observation, Spreadtrum suggests to update the values used for BS ACS from 23.5dB to 24dB.

But from Moderator’s perspective, there is no need to update BS ACS, since 24dB is just a round number of 23.5dB.

#### **UE-UE co-channel inter-subband CLI**

The following agreements for modelling of UE-UE co-channel inter-subband CLI based on both large-scale still need RAN4’s confirmation.

|  |
| --- |
| [RAN1#112]  **Agreement**  For SLS in RAN1, if only large scale fading is modelled and small scale fading is not modelled for UE-UE co-channel channel model, the power of UE-UE co-channel inter-subband CLI experienced by the victim UE on each receiver chain at DL RB *n* can be modelled as  where   * is the power of UE-UE co-channel inter-subband CLI from aggressor UE to victim UE on each receiver chain at one DL RB *n* (linear value). * is UL transmission power of UE across all transmit chains over the allocated UL RBs (linear value) * is the coupling loss between UE and UE (linear value), accounting for analog beamforming at the aggressor UE and victim UE * is the total number of UL RBs in the UL subband * is in linear scale. For the value of , it is up to RAN4. Companies can report the value used in their simulation before receiving RAN4’s further input. * , wherein,   + For SBFD Subband configuration with {DUD} pattern, can be ignored   + is UL transmission power of UE across all transmit chains per RB (linear value). , and is the number of UL RBs allocated for UL transmission of UE .   + is the Transmission Bandwidth Configuration, referring to Table 5.3.2-1 in TS 38.101-1 for FR1 and in TS 38.101-2 for FR2-1.     - for FR1 with 100MHz transmission bandwidth and 30kHz SCS     - for FR2-1 with 200MHz transmission bandwidth and 120kHz SCS   + is the starting frequency offset between the allocated UL RBs and the measured non-allocated RB (e.g. *∆RB*= 1 or *∆RB*= -1 for the first adjacent RB outside of the allocated UL RBs)   + EVM is the limit specified in Table 6.4.2.1-1 in TS 38.101-1 for FR1 and in TS 38.101-2 for FR2-1 for the modulation format used in the allocated RBs.   Include the above in the LS to RAN4 to inform them of the agreement and to check if the RAN1 agreement is in line with RAN4’s understanding. |

Furthermore, moderator observed there was a typo about in the above formula, since is defined as a linear value, but it is used as dB value is some places. Moderator suggests **Initial proposal 2-3-4**.

Regarding the previous working assumption in RAN1#112 for modelling of UE-UE co-channel inter-subband CLI, [Qualcomm, New H3C, CMCC] suggest to confirm it.

|  |
| --- |
| [RAN1#112]  **Working assumption:**  For SLS in RAN1, if both large-scale and small-scale fading are modelled for UE-UE co-channel channel model, the UE-UE co-channel inter-subband CLI signal across all Rx chains at DL RB at victim UE can be modeled as:  where,   * is the first part of UE-UE co-channel inter-subband CLI across all Rx chains at DL RB , caused by power leakage at aggressor UE,   + is the channel matrix between aggressor UE and victim UE at DL RB , the beamforming of the aggressor UE and the victim UE can be taken into account by   + is the number of Rx chains and is the number of Tx chains   + is the normalized wideband UL digital precoder of the aggressor UE, .   + ,     - , , is modelled as white Gaussian noise     - has the same meaning as in the agreement for the case only large-scale fading is modelled * is modelled as frequency flat   + , , is modelled as white Gaussian noise,   + is the channel matrix between aggressor UE and victim UE at UL RB , the analog beams of the aggressor UE and the victim gNB can be taken into account by ,   + is the normalized wideband UL digital precoder of the aggressor UE,   + is the symbol transmitted at UL RB at aggressor UE with transmission power for each layer as .     - has the same meaning as in the agreement for the case only large-scale fading is modelled   + is the total number of UL RBs in the UL subbands,   + is in linear scale. For the value of , it is up to RAN4. Companies can report the value used in their simulation before receiving RAN4’s further input.   Include the above in the LS to RAN4 to inform them of the agreement and to check if the RAN1 agreement is in line with RAN4’s understanding. |

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

#### **Co-site gNB-gNB adjacent-channel CLI**

Regarding the below agreement for modelling of co-site gNB-gNB adjacent-channel CLI, the value of still needs RAN4’s inputs.

|  |
| --- |
| [RAN1#112]  **Agreement**  For SLS in RAN1, for co-site gNB-gNB adjacent-channel CLI modelling, reuse similar method as co-site inter-sector co-channel inter-subband CLI modeling as follows.   * is DL Tx power of sector *x* per RB (in linear scale), * is the maximum DL Tx Power of sector *x* in adjacent channel (in linear scale). * is the total number of DL RBs in adjacent channel. * is the number of DL RBs allocated for DL transmission of sector *x* in adjacent channel. * is the interference suppression capability of co-site inter-sector co-channel inter-subband CLI between the aggressor sector *x* and the victim sector.   + FFS the concrete value of   + and are in linear scale.   Send an LS to RAN4 to inquire on the value of . |

### 1st Round Proposals (Closed)

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

Confirm the previous working assumption in RAN1#112 meeting as below.

**Working Assumption:**

For co-site inter-sector co-channel inter-subband CLI modelling, before receiving RAN4’s reply on the value of , RAN1 assume the following only for evaluation:

* FR1:
  + 75dB for spatial isolation (RAN4 typical value).
  + 93dB for spatial isolation (RAN4 best value).
  + 100dB for spatial isolation
* FR2:
  + 88dB for spatial isolation (RAN4 typical value).
  + 98dB for spatial isolation (RAN4 best value).
  + 105dB for spatial isolation
* In addition to spatial isolation and frequency isolation, companies can use digital cancelation and report the value, e,g., 10dB. Above does not imply that RAN1 assumes or does not assume digital cancelation is feasible.
* The feasibility of these values is up to RAN4. These values can be revisited based on further RAN4 inputs.
* The 100dB/105dB isolation values for FR1 and FR2 are not from RAN4, but based on RAN4 input that some companies have proposed that isolating material could be added between sectors to increase the isolation. RAN4 has not yet discussed the details whether such approaches can be applied to outdoor sites.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | We are okay to confirm the working assumption. |
| ZTE | OK |
| Huawei, HiSilicon | OK. |
| Fujitsu | Support. |
| NTT DOCOMO | We support. |
| Spreadtrum | Support |
| OPPO | Fine with this proposal |
| Xiaomi | We are fine with the proposal. |
| Intel | OK. |
| Ericsson | OK |
| Nokia/NSB | Support. |
| Sony | Support the proposal. |
| QC | Support |
| Moderator | Seems Stable |

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

Update the previous agreement in RAN1#111 meeting as below:

Regarding the modelling of inter-site gNB-gNB co-channel inter-subband CLI agreed in RAN1#110bis for the case that both large scale fading and small scale fading are modelled for gNB-gNB co-channel channel model, the second part of inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at one UL RB, caused by receiver selectivity at victim gNB, can be modelled as

* + , , is modelled as white Gaussian noise
  + is the channel matrix between aggressor gNB and victim gNB at DL RB , the analog beams of the aggressor gNB and the victim gNB can be taken into account by ,
  + is the digital precoder at DL RB at aggressor gNB, ,
  + is the symbol transmitted at DL RB at aggressor gNB with transmission power for each layer as .
  + is the total number of DL RBs in the DL subbands.
  + RAN1 can assume (in channel selectivity) is given by gNB ACS ~~unless further RAN4 guidance is received.~~
    - ~~Send LS to RAN4 to confirm RAN1 understanding and check whether can be modelled depending on the value of the blocker interference, e.g.,~~
  + Note: can be reported by companies.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | We are okay with the updated part except the blocker power in the last note.  The blocker power defined in the agreement is not necessary since the blocker power (to use Noise figure update in proposal 2-3-3) is sum of all signal powers including SI, inter-sector CLI, gNB-gNB CLI, and UE-gNB CLI. |
| ZTE | OK |
| Huawei, HiSilicon | We do not support the proposal.  After checking with our RAN4 colleagues, we think there may be some different understanding on the RAN4 reply LS “RAN4 can confirm RAN1 can assume ICSBS (in channel selectivity) is given by the value of gNB ACS.”. In our understanding, the Noise Figure model provided by RAN4 has already taken the non-linearity aspects of the selectivity into account. If additional in channel selectivity is added to receiver, it should be mainly dependent on suppression capability of digital filtering and the value is in the order of 60~80dB. Otherwise, the noise power level will be over-estimated especially when the blocking power is large (although it does not matter when the blocking power is larger than -25dBm since the receiver will be blocked). Ideally, we can send an LS to RAN4 again check what is the value of ICSBS (in channel selectivity) and whether it should be considered together with the Noise Figure model provided by RAN4 for SLS.  However, to avoid the delay due to the LS different WGs, we suggest to use three options:   * Option 1: Only use the NF model * Option 2: Both the NF model and the ICS model are used   + ICSBS depends on suppression capability of digital filters, e.g., ICSBS  = 60~80dB * Option 3: Both the NF model and the ICS model are used, and ICSBS = 46dB. |
| Fujitsu | Same as Samsung. |
| NTT DOCOMO | We are fine with the proposal. |
| Spreadtrum | We also want to confirm the usage of noise figure model provided by RAN 4. Whether it will be just used alone to get a not fixed noise figure or as part of inter-site gNB-gNB co-channel inter-subband CLI modelling. |
| Xiaomi | Considering ICS\_BS is independent with P\_blocker, the last note can be removed. |
| Intel | We support the proposal at this stage. We also see the arguments from Huawei/HiSilicon and we are checking with RAN4 on this. |
| Ericsson | Support the proposal in principle.  Agree with Samsung’s comments. This needs to be reflected in the proposal. |
| Nokia/NSB | Fine in general. Share view with Samsung and ,Ericsson. |
| QC | Support.  We have similar understanding of RAN4-LS as stated in the FL proposal. The gNB selectivity is a single value, not dependent on the Power level. Regarding the value of ICS, our understanding that RAN1 will use value of ACS while RAN4 is discussing exact values for SBFD gNB. |

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

For SLS of SBFD in RAN1, the BS noise figure is modelled as piece wise linear based on the total received power (P) as

* For FR1, *A* = -43dBm, *B* = -25dBm, *C* = 5dB, *D* = 14dB
* *P* is in dB scale. The linear value of total received power is the linear sum of all received power, including wanted signal, UE-gNB interference, self-interference, co-site inter-sector interference and inter-site gNB-gNB interference.
* If *P* is larger than *B*, the receiver will be blocked.
* Send LS to RAN4 to ask the following questions:
  + Whether the above values of A, B, C and D can be used for all the BS classes in FR1?
  + What are the values of A, B, C and D for BS classes in FR2-1?

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | Our understanding is that   * This BS noise figure model is from the currently deployed gNB receiver. * If additional interference reduction techniques like subband filtering, the total received power might be reduced but RAN1 has not received such information from RAN4.   So, we would like to suggest the following questions additionally:   * Send LS to RAN4 to ask the following questions:   + Whether the above values of A, B, C and D can be used for all the BS classes in FR1?   + What are the values of A, B, C and D for BS classes in FR2-1?   + The feasibility and applicable scenarios of improved noise figure e.g., by introducing additional interference reduction techniques like subband filtering. |
| ZTE | OK |
| Huawei, HiSilicon | Support. |
| NTT DOCOMO | We are fine with the proposal. |
| Spreadtrum | Support |
| Xiaomi | We are fine with the proposal. |
| Intel | OK with the proposal. |
| Ericsson | Ok with the proposal.  The proposal assumes starting NF of 5 dB which is typical of a WA BS.  Similarly, we need to reconsider 1 dB desense agreement for self-interference where we assumed a 5 dB NF for all BS classes. |
| Nokia/NSB | Support in principle. But we support with following modifications. The total received power should also include the adjacent channel interference.  *P* is in dB scale. The linear value of total received power is the linear sum of all received power, including wanted signal, co-channel and adjacent channel UE-gNB interference, self-interference, co-channel and adjacent channel co-site inter-sector interference, and co-channel and adjacent channel inter-site gNB-gNB interference. |
| Sony | Support |
| QC | Support |

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

Update the previous agreement in RAN1#112 meeting as below.

For SLS in RAN1, if only large scale fading is modelled and small scale fading is not modelled for UE-UE co-channel channel model, the power of UE-UE co-channel inter-subband CLI experienced by the victim UE on each receiver chain at DL RB *n* can be modelled as

where

* is the power of UE-UE co-channel inter-subband CLI from aggressor UE to victim UE on each receiver chain at one DL RB *n* (linear value).
* is UL transmission power of UE across all transmit chains over the allocated UL RBs (linear value)
* is the coupling loss between UE and UE (linear value), accounting for analog beamforming at the aggressor UE and victim UE
* is the total number of UL RBs in the UL subband
* is in linear scale. For the value of , it is up to RAN4. Companies can report the value used in their simulation before receiving RAN4’s further input.
* , wherein,
  + For SBFD Subband configuration with {DUD} pattern, can be ignored
  + is UL transmission power of UE across all transmit chains per RB (linear value). , and is the number of UL RBs allocated for UL transmission of UE .
  + is the Transmission Bandwidth Configuration, referring to Table 5.3.2-1 in TS 38.101-1 for FR1 and in TS 38.101-2 for FR2-1.
    - for FR1 with 100MHz transmission bandwidth and 30kHz SCS
    - for FR2-1 with 200MHz transmission bandwidth and 120kHz SCS
  + is the starting frequency offset between the allocated UL RBs and the measured non-allocated RB (e.g. *∆RB*= 1 or *∆RB*= -1 for the first adjacent RB outside of the allocated UL RBs)
  + EVM is the limit specified in Table 6.4.2.1-1 in TS 38.101-1 for FR1 and in TS 38.101-2 for FR2-1 for the modulation format used in the allocated RBs.

Include the above in the LS to RAN4 to inform them of the agreement and to check if the RAN1 agreement is in line with RAN4’s understanding.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | We are okay with the update. |
| ZTE | OK |
| Huawei, HiSilicon | Support. |
| Spreadtrum | Support |
| Xiaomi | We are fine with the proposal. |
| Intel | OK with the update. |
| Ericsson | OK |
| Nokia/NSB | Support |
| Sony | Support |
| QC | Support |
| Moderator | Seems Stable |

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

Confirm the following working assumption made in RAN1#112 meeting.

**Working assumption:**

For SLS in RAN1, if both large-scale and small-scale fading are modelled for UE-UE co-channel channel model, the UE-UE co-channel inter-subband CLI signal across all Rx chains at DL RB at victim UE can be modeled as:

where,

* is the first part of UE-UE co-channel inter-subband CLI across all Rx chains at DL RB , caused by power leakage at aggressor UE,
  + is the channel matrix between aggressor UE and victim UE at DL RB , the beamforming of the aggressor UE and the victim UE can be taken into account by
  + is the number of Rx chains and is the number of Tx chains
  + is the normalized wideband UL digital precoder of the aggressor UE, .
  + ,
    - , , is modelled as white Gaussian noise
    - has the same meaning as in the agreement for the case only large-scale fading is modelled
* is modelled as frequency flat
  + , , is modelled as white Gaussian noise,
  + is the channel matrix between aggressor UE and victim UE at UL RB , the analog beams of the aggressor UE and the victim gNB can be taken into account by ,
  + is the normalized wideband UL digital precoder of the aggressor UE,
  + is the symbol transmitted at UL RB at aggressor UE with transmission power for each layer as .
    - has the same meaning as in the agreement for the case only large-scale fading is modelled
  + is the total number of UL RBs in the UL subbands,
  + is in linear scale. For the value of , it is up to RAN4. Companies can report the value used in their simulation before receiving RAN4’s further input.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | We support the proposal |
| ZTE | OK |
| Huawei, HiSilicon | Overall, we don’t see the strong need to model both large scale and small scale fading for UE-UE co-channel inter-subband CLI.  One additional comment, the formula can be removed since the is modeled as an interfering signal passing through the UE-UE channel while is modeled as an interference power. |
| NTT DOCOMO | We support the proposal. |
| Xiaomi | We are fine with the proposal. |
| Intel | Ok with the proposal. |
| Ericsson | OK with the proposal. |
| Nokia/NSB | Support |
| Sony | Support the proposal. |
| QC | Support  There are few cases that accurate modelling of inter-UE CLI, e.g. for FR2-1 as discussed in last RAN1 meeting.   |  |  |  | | --- | --- | --- | | **Channel model** | **gNB-gNB co-channel channel model** | Both large scale fading and small scale fading are modelled | | **UE-UE co-channel channel model** | For FR1, at least large scale fading is modelled.  For FR2-1, both large scale fading and small scale fading are modelled |   The leakage and selectivity component, our understanding both are interference signal, similar way as RAN1 agreed for inter-gNB CLI. |

* + 1. 2nd Round Proposals(Open)

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

Update the previous agreement in RAN1#111 meeting as below:

Regarding the modelling of inter-site gNB-gNB co-channel inter-subband CLI agreed in RAN1#110bis for the case that both large scale fading and small scale fading are modelled for gNB-gNB co-channel channel model, consider two options for the second part of inter-site gNB-gNB co-channel inter-subband, and companies to report which option is used:

* Option-1: Only the piece wise BS noise figure model is used.
* Option-2: Both the piece wise BS noise figure model and the ICS model are used. The ICS model is as below:
  + the second part of inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at one UL RB, caused by receiver selectivity at victim gNB, can be modelled as

* + , , is modelled as white Gaussian noise
  + is the channel matrix between aggressor gNB and victim gNB at DL RB , the analog beams of the aggressor gNB and the victim gNB can be taken into account by ,
  + is the digital precoder at DL RB at aggressor gNB, ,
  + is the symbol transmitted at DL RB at aggressor gNB with transmission power for each layer as .
  + is the total number of DL RBs in the DL subbands.
  + RAN1 can assume (in channel selectivity) is given by gNB ACS.
    - Other values for , if provided by RAN4, can be used.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Updated based on comments. |
| ZTE | Basedon our undersanding, option-2 should be the way to go. The noise figure increase is mainly due to the LNA while the selectivity is mainly due to the digital filter. Thus, both these two aspects need to be considered.  If companies have strong interest to apply option-1, then option-2 can be the baseline and option-1 is optionally used. |
| Ericsson | We also support Option 2 as baseline. What values for ACS to be used can be discussed but we prefer to use gNB ACS. The leakage component is usually dominant in this case (ACLR component), so we do not see much impact from the ACS component. Assuming a higher ACS value would also reduce the interference in the system. |
| QC | We don’t support adding option 2. We believe this is miss-understanding of the RAN4 Reply LS. The ICS is single value given by ACS for all power levels and the impact of AGC/blocker is taken into NF PWL modeling.  We urge the proponent of option-2 to double check with their RAN4 colleagues. |
| Spreadtrum | We have a concern on how to use piece wise BS noise figure model to get inter-site gNB-gNB co-channel inter-subband CLI. In the piece wise BS noise figure model, all received power is used as input including inter-site gNB-gNB interference. But the output of noise figure is used as part or all second part of inter-site gNB-gNB co-channel inter-subband CLI. So how can we get the sum of all received power including inter-site gNB-gNB interference while doing inter-site gNB-gNB CLI modelling?  For option 1, can we just consider the leakage part of inter-site gNB-gNB interference as inter-site gNB-gNB interference to calculate received power for noise figure model. For option 2, can we just consider the leakage part and ICS part of inter-site gNB-gNB interference as inter-site gNB-gNB interference to calculate received power for noise figure model. |
| Xiaomi | We are generally fine with the proposal.  However, we see there are two understandings regarding how to modeling ICS, i.e. separately modelling ICS or assuming it is included in piece NF modeling. Maybe LS can be sent to RAN4 to confirm RAN1’s understanding and check which option should be used in the simulation. |
| New H3C | We share the similar view on this proposal with spreadtrum. It is better to send LS on this proposal to RAN4 and let RAN 4 check whether our understnanding on inter-site gNB-gNB interference model is correct or not. |
| Huawei, HiSilicon | As replies in the first round, we suggest to list the two options before further RAN4 inputs. |
| Samsung | As per our RAN4 collegues, RAN4 is now discussing which approach is correct. So, we suggest to pause the discussion till RAN4 makes a progress. |
| LG | About other values for in Option-2, is there any plan to send LS to RAN4? How could we provide it? |
| Intel | We share same view as ZTE and Ericicsson, and our understndign is that per RAN4 guidance option 2 should be the baseline. |

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

For SLS of SBFD in RAN1, the BS noise figure is modelled as piece wise linear based on the total received power (P) as

* For FR1, *A* = -43dBm, *B* = -25dBm, *C* = 5dB, *D* = 14dB
* *P* is in dB scale. The linear value of total received power is the linear sum of all received power, including wanted signal, co-channel and adjacent-channel UE-gNB interference, self-interference, co-channel and adjacent-channel co-site inter-sector interference and co-channel and adjacent-channel inter-site gNB-gNB interference.
* If *P* is larger than *B*, the receiver will be blocked.
* Send LS to RAN4 to ask the following questions:
  + Whether the above values of A, B, C and D can be used for all the BS classes in FR1?
  + What are the values of A, B, C and D for BS classes in FR2-1?
  + The feasibility and applicable scenarios of improved noise figure, e.g., by introducing additional interference reduction techniques like subband filtering.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Updated based on comment.  I’m not sure I get the point of Ericsson’s last comment. |
| ZTE | We are generally fine. |
| QC | Support |
| Spreadtrum | We have similar comment as in 2-3-2a considering self-interference modelling is dependent on noise figure and wonder how to get SI without knowing the noise figure. |
| Xiaomi | We are generally fine. However, we have some clarifications for the proposal.   * Should adjacent-channel UE-gNB interference, adjacent-channel co-site inter-sector interference and adjacent-channel inter-site gNB-gNB interference be considered except for Deployment case 4? * When different filters (e.g., subband filter, CC filter) are used at gNB, the calculations of total received power (P) are different since the bandwidth for calculating total received power (P) is different. We are wondering what kind of filter is assumed in the calculation? |
| New H3C | We share the similar view on this proposal with spreadtrum. It is better to send LS on this proposal to RAN4 and let RAN 4 check whether our understnanding on inter-site gNB-gNB interference model is correct or not. |
| Huawei, HiSilicon | Support |
| Samsung | The adjacent channel is only applied to SBFD deployment case 4.  We think the original text below from RAN4’s agreement is enough. And, if needed, put a note that adjacent channel interference is also considered to derive the blocker power in SBFD deployment case 4.  Regarding the question on Spreadtrum, 5dB NF can be assumed to derive SI power for simplicity. |
| LG | We support the proposal. |
| Ericsson | Reply to Moderator:  In RAN 1#110b-e we had the following agreement  ***Agreement***  *For SLS of SBFD in RAN1, candidate values for at least can be determined based on the assumption that UL receiver sensitivity degradation due to self-interference is 1dB.*   * *FFS: UL receiver sensitivity degradation due to self-interference is 0.8dB and 0.1dB* * *The value of can be calculated based on the UL receiver sensitivity degradation, noise floor of UL subband and maximum gNB DL Tx Power as below*   + - *For example, for sensitivity degradation of 1dB, can be computed based on , where N is the noise floor over the UL subband given by , assuming 20MHz UL subband and 5dB noise figure.* * *Note: the feasibility of the determined values can be discussed separately* * *Companies shall report what values of the individual components are assumed in order to achieve the alpha\_SI value corresponding to 1 dB desense* * *Other approaches of determining values for are not precluded and can be used and reported by companies.*   *Send LS to RAN4 to confirm RAN1’s understanding*.  1 dB desense is based on 5 dB NF for all BS classes. We need to change the agreement to also consider different NF for different BS classes. Would you agree? |
| Intel | OK |

#### ***Updated proposal 2-3-5a(Open):***

Confirm the following working assumption made in RAN1#112 meeting with modifications.

**Working assumption:**

For SLS in RAN1, if both large-scale and small-scale fading are modelled for UE-UE co-channel channel model, the UE-UE co-channel inter-subband CLI signal across all Rx chains at DL RB at victim UE can be modeled as:

where,

* is the first part of UE-UE co-channel inter-subband CLI across all Rx chains at DL RB , caused by power leakage at aggressor UE,
  + is the channel matrix between aggressor UE and victim UE at DL RB , the beamforming of the aggressor UE and the victim UE can be taken into account by
  + is the number of Rx chains and is the number of Tx chains
  + is the normalized wideband UL digital precoder of the aggressor UE, .
  + ,
    - , , is modelled as white Gaussian noise
    - has the same meaning as in the agreement for the case only large-scale fading is modelled
* is modelled as frequency flat
  + , , is modelled as white Gaussian noise
  + is the channel matrix between aggressor UE and victim UE at UL RB , the analog beams of the aggressor UE and the victim gNB can be taken into account by ,
  + is the normalized wideband UL digital precoder of the aggressor UE,
  + is the symbol transmitted at UL RB at aggressor UE with transmission power for each layer as .
    - has the same meaning as in the agreement for the case only large-scale fading is modelled
  + is the total number of UL RBs in the UL subbands,
  + is in linear scale. For the value of , it is up to RAN4. Companies can report the value used in their simulation before receiving RAN4’s further input.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Updated based on comment. @Huawei, is modeled as white Gaussian noise signal instead of interference power. |
| ZTE | OK |
| QC | Support |
| Spreadtrum | Support |
| Xiaomi | Support |
| New H3C | support |
| Huawei, HiSilicon | OK |
| Samsung | OK |
| LG | We support the proposal. |
| Ericsson | Support. |
| Intel | OK |
| Moderator | Seems Stable. Moved to section 7. |

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

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| CMCC (R1-2303232) | ***Proposal 12:*** For SBFD evaluation, deprioritize SBFD subband configuration#2 with {DU} pattern. |
| Ericsson (R1-2302769) | Proposal 1: A SBFD carrier shall have a carrier BW and a UL subband BW consistent with one of the existing supported carrier BW in RAN4 specs. |
| Spreadtrum (R1-2302598) | ***Proposal 3: In deployment case 4, subband configuration with {DU} pattern should be taken into account.***  ***Proposal 4: Update the agreement in RAN1#112 as below:***  ***For SLS evaluation purposes only, Alt 1/2/4 (SBFD UL subband is about 20% of the channel bandwidth) and SBFD Subband configuration#1 with {DUD} pattern, the following is assumed:***   * ***For FR1***    + ***Baseline: 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <104, 55, 5>***   + ***Optional: 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <106, 51, 5>*** * ***For FR2***   + ***Optional: 100MHz channel bandwidth and 120kHz SCS (66 PRB) < ND, NU,NG > = <25, 14, 1>***   + ***Baseline: 200MHz channel bandwidth and 120kHz SCS (132 PRB): < ND, NU,NG > = <~~52~~47, ~~26~~32, ~~1~~3>*** * ***Other values of < ND, NU,NG > are not precluded and can be reported by companies.***   ***Proposal 5:*** ***No guard symbol is used when each UE is either assigned UL traffic or DL traffic.*** |
|  |  |

### Summary

For SBFD evaluation, CMCC suggests to deprioritize SBFD subband configuration#2 with {DU} pattern, while Spreadtrum suggests to consider subband configuration with {DU} pattern in SBFD deployment case 4.

Moderator thinks RAN1 can focus on SBFD subband configuration#1 with {DUD} pattern**.**

Ericsson suggests UL subband BW to be consistent with one of the existing supported carrier BW in RAN4 specs.

Spreadtrum suggests to update the SBFD Subband configuration#1 with {DUD} pattern for 200MHz channel bandwidth and 120kHz SCS (132 PRB) from < ND, NU,NG > = <52, 26, 1> to <47, 32, 3>.

From moderator’s perspective, we had a long discussion on the <ND, NU,NG> values for SBFD Subband configuration#1 with {DUD} pattern over the last meetings, and finally achieved the consensus. Moderator suggests not to revise the agreements.

Spreadtrum suggests no guard symbol to be used when each UE is either assigned UL traffic or DL traffic. Moderator thinks companies should report the guard symbol assumption.

|  |
| --- |
| **Agreement**  For SBFD evaluation, companies should report the guard symbols assumed in the SBFD operation. |

## Issue#2-5: Channel model and penetration loss

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| xiaomi (R1-2302981) | Observation 1: O2I parameters should be used for indoor TRP to outdoor UE in deployment case 3-2 (2-layer Scenario B) if fast fading channel model is applied.  Proposal 1: For fast fading parameters, O2I channel model parameters for UMi-Street canyon/UMa in table 7.5-6 Part-1 in TR 38.901 could be reused for indoor TRP to outdoor UE in Deployment case 3-2 (2-layer Scenario B) when option 2 is adopted.  Proposal 2: When channel model of InH-Office in TR 38.901 is used for indoor TRP to outdoor UE in Deployment case 3-2 (2-layer Scenario B), indoor TRP to indoor TRP and indoor UE to indoor UE in Deployment Case 1 and Deployment case 3-2 (2-layer Scenario B), the 2D distance between BS and UE () for indoor TRP to outdoor UE , 2D distance between BS and BS () for indoor TRP to indoor TRP and 2D distance between UE and UE () for indoor UE to indoor UE, respectively, can be used as for LOS probability in Table 7.4.2-1 in TR 38.901. |
|  |  |

### Summary

In RAN1#112 meeting, the following agreement related to gNB-UE channel modelling for 2-layer Scenario B was achieved:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Agreement**  For Deployment case 3-2 (2-layer Scenario B), update Indoor-TRP to outdoor UE channel model as follows:   |  |  | | --- | --- | | Large-scale channel parameters | Indoor TRP to Outdoor UE:   * ~~Option 1:~~   + ~~A.2.1.2 in TR36.843~~   + ~~Penetration loss between UEs follows Table A.2.1-13 in TR38.802~~ * Option 1:   + UMi-Street canyon in TR 38.901 (hBS =3 m) * Option 2:   + For Indoor office layer: InH-Office in TR 38.901   + For Indoor factory layer: InF in TR 38.901 * For both options, O2I penetration loss between indoor TRP and outdoor UE follows Table A.2.1-12 in TR38.802 ( is the distance between the indoor TRP and the building boundary along the direction from Indoor TRP to outdoor UE. The may be different for different indoor-TRP-outdoor-UE links associated with the same indoor TRP) | | Fast fading parameters | Indoor TRP to Outdoor UE:   * ~~Option 1:~~    + ~~3D UMi, ASD and ZSD statistics updated to be the same as ASA and ZSA.~~ * Option 1:   + UMi-Street canyon in TR 38.901. ASD and ZSD statistics updated to be the same as ASA and ZSA * Option 2:   + For Indoor office layer: InH-Office in TR 38.901   + For Indoor factory layer: InF in TR 38.901 | |

Xiaomi observed that since indoor TRP to outdoor UE is O2I link, it is straightforward that O2I channel model parameters for Macro TRP to indoor UE in TR 38.901 are reused for indoor TRP to outdoor UE if option 1 is adopted. However, O2I channel model parameters are NOT modelled for indoor office and indoor factory in TR 38.901, i.e. only LOS and NLOS are defined. Thus, Xiaomi suggests O2I fast fading channel model parameters table 7.5-6 Part-1 in TR 38.901 for UMi-Street canyon could be reused for indoor TRP to outdoor UE in Deployment case 3-2 (2-layer Scenario B) if option 2 is adopted.

From Moderator’s perspective, the original intention of option 2 is to use the fast fading channel parameters of InH-Office/InF in TR38.901. To be clear, we can simply use the NLOS fast fading channel parameters of InH-Office/InF in TR38.901 for option 2. Moderator suggests **Initial proposal 2-5-1.**

Regarding the d2D-in used to calculate LOS probability, Xiaomi suggests:

* When channel model of InH-Office in TR 38.901 is used for indoor TRP to outdoor UE in Deployment case 3-2 (2-layer Scenario B), indoor TRP to indoor TRP and indoor UE to indoor UE in Deployment Case 1 and Deployment case 3-2 (2-layer Scenario B), the 2D distance between BS and UE () for indoor TRP to outdoor UE , 2D distance between BS and BS () for indoor TRP to indoor TRP and 2D distance between UE and UE () for indoor UE to indoor UE, respectively, can be used as for LOS probability in Table 7.4.2-1 in TR 38.901.

Moderator thinks the above suggestion should be the common understanding, and no clarification is needed.

### 1st Round Proposals(Closed)

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

For Deployment case 3-2 (2-layer Scenario B), update Indoor-TRP to outdoor UE channel model as below.

|  |  |
| --- | --- |
| Large-scale channel parameters | Indoor TRP to Outdoor UE:   * Option 1:   + UMi-Street canyon in TR 38.901 (hBS =3 m) * Option 2:   + For Indoor office layer: InH-Office in TR 38.901   + For Indoor factory layer: InF in TR 38.901 * For both options, O2I penetration loss between indoor TRP and outdoor UE follows Table A.2.1-12 in TR38.802 ( is the distance between the indoor TRP and the building boundary along the direction from Indoor TRP to outdoor UE. The may be different for different indoor-TRP-outdoor-UE links associated with the same indoor TRP) |
| Fast fading parameters | Indoor TRP to Outdoor UE:   * Option 1:   + UMi-Street canyon in TR 38.901. ASD and ZSD statistics updated to be the same as ASA and ZSA * Option 2:   + For Indoor office layer: InH-Office (NLOS) in TR 38.901   + For Indoor factory layer: InF (NLOS) in TR 38.901 |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | We are okay with the proposal |
| ZTE | OK |
| Huawei, HiSilicon | OK. |
| Spreadtrum | Support |
| Xiaomi | Considering that O2I parameters and NLOS parameters in table 7.5-6 Part-1 in TR 38.901 for UMi-Street canyon O2I model are quite different, it is more suitable to use O2I parameters for the indoor TRP to outdoor UE link when option 2 is adopted. However, we are fine with the proposal if majority companies are OK with the proposal. |
| Intel | OK. |
| Ericsson | OK |
| Nokia/NSB | OK |
| Sony | Support. |
| QC | Fine |
| Moderator | Seems Stable |

## Issue#2-6: Others

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Apple (R1-2303481) | **Proposal 2**: RAN1 to consider the impact of potentially reduced transmit power for uplink transmission on SBFD slots to SBFD performance.  **Proposal 4**: Full-duplex operation shall not be supported for macro-to-macro scenarios, at least for FR1. |
| InterDigital (R1-2302521) | ***Observation 1****. Scenarios on subband non-overlapping (as for inter-subband CLI), subband partial overlapping and subband overlapping (as for intra-subband CLI) may achieve different gains based on at least traffic and/or cell sizes.*  ***Proposal 1.*** *Consider evaluating achieved gain and performance in subband non-overlapping scenario based on inter-subband CLI, followed by subband partial overlapping and subband overlapping scenarios based on intra-subband CLI.* |
| Ericsson (R1-2302769) | Observation 12: SBFD antenna configuration Option 2, which has double the antenna elements for SBFD when compared to reference static TDD, is the best-case scenario for SBFD.  Observation 13: SBFD antenna configuration Option 3, which has same number of antenna elements for SBFD when compared to reference static TDD, and only half the TxRUs can be used realistically, it is the practical case for SBFD.  Observation 14: The simulation results obtained from the “Realistic” assumptions can be considered as a more realistic estimation of the performance of SBFD in real-world scenarios, while the results from the “Optimistic” assumptions reflect the best-case scenario for SBFD’s potential performance gains. |
| Apple (R1-2303481) | Proposal 1: RAN1 to consider the impact of separate BS antennas for simultaneous RX/TX operation on SBFD performance, like loss of channel reciprocity, wider beams in DL transmission and UL reception, etc. |

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

## Issue#3-1: Coverage performance evaluation for SBFD

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| CMCC (R1-2303232) | ***Proposal 13:*** For coverage performance evaluation for SBFD, consider the following simulation assumptions for LLS.  Table 4‑1 Simulation assumption for coverage performance evaluation for SBFD for LLS.   |  |  |  | | --- | --- | --- | | Parameter | FR1 | FR2-1 | | Scenario and frequency | Urban Macro (ISD = 500m): 4GHz | Dense Urban Macro Layer (ISD = 200m): 30GHz | | SBFD subband and slot configurations | Legacy TDD: DDDSU, S=[12D:2G:0U]  SBFD: XXXXU, where X denotes SBFD slot.  For SBFD slot, {DUD} pattern is assumed,  For FR1, 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <104, 55, 5>  For FR2-1, 200MHz channel bandwidth and 120kHz SCS (132 PRB): < ND, NU,NG > = <52, 26, 1> | | | Target data rates for eMBB | PUSCH with 1Mbps target data rate | PUSCH with 5Mbps target data rate | | Pathloss model (select from LoS or NLoS) | Urban: NLoS | | | System bandwidth | 100MHz | 200MHz | | Channel model for link-level simulation | TDL-C for NLOS | CDL- A, TDL-A, [urban/suburban: TDL-C]  Note: company can provide simulation results based on either TDL channel or CDL model | | Delay spread | 300ns | 100ns | | UE velocity | 3km/h for indoor | 3km/h for indoor, 30km/h for outdoor. | | Number of antenna elements for BS (Legacy TDD) | 128 antenna elements, (M,N,P,Mg,Ng) = (8,8,2,1,1) | 512 antenna elements, (M,N,P,Mg,Ng) = (4,16,2,2,2) | | Number of TxRUs for BS (Legacy TDD) | gNB architectures to study: 32TxRUs per panel, (Mp,Np)=(2,8)  gNB modeling in LLS for TDL:  - Option 1: 2 or 4 or 8 gNB RF chains per panel in LLS.  - Option 2 (Optional): Number of gNB RF chains = number of TXRUs in LLS.  - Companies can report if and how correlation is modelled. | gNB architectures to study: 2TxRUs per panel  gNB modeling in LLS: gNB RF chains per panel in LLS  Note: Analog beamforming is assumed. | | BS antenna configuration (SBFD) | Same area & same TxRUs (higher priority): SBFD antenna configuration Option 2 | | | Frequency hopping | w/ or w/o frequency hopping | | | BLER | 10% iBLER. | | | Number of antenna elements for UE | 2 antenna elements, (M,N,P,Mg,Ng) = (1,1,2,1,1) | 32 antenna elements, (M,N,P,Mg,Ng) = (2,4,2,1,2) | | Number of TxRUs for UE | UE architectures to study: 2TxRUs per panel, (Mp,Np)=(1,1)  gNB modeling in LLS for TDL:  - Option 1: 1 UE RF chains in LLS.  - Option 2 (Optional): Number of UE RF chains = number of TXRUs in LLS.  - Companies can report if and how correlation is modelled. | UE architectures to study: 2TxRUs per panel, (Mp,Np)=(1,1)  gNB modeling in LLS for TDL:  - Option 1: 1, 2 UE RF chains in LLS.  - Option 2 (Optional): Number of UE RF chains = number of TXRUs in LLS.  - Companies can report if and how correlation is modelled. | | DMRS configuration | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data. | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.  For 30km/h (optional: 120km/h): Type I, 2 or 3 DMRS symbol, no multiplexing with data.  For frequency hopping for PUSCH: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH/PDSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. | | Waveform | DFT-s-OFDM, CP-OFDM (optional) | DFT-s-OFDM | | SCS | 30kHz | 120kHz. | | PUSCH duration | 14 OS | 14 OS | | Repetitions | Legacy TDD: w/o repetition  SBFD: up to company to report | | | HARQ configuration | whether HARQ is adopted is up to company to report | | | PRBs/TBS/MCS | Any value of PRBs, and corresponding MCS index, up to company to report  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. | |   ***Proposal 14:*** For coverage performance evaluation for SBFD, the link budget template in Table A.3 in TR 38.830 with necessary modification as shown in Annex B can be used as a starting point. |
| Huawei (R1-2302347) | ***Proposal 2:*** *Do not support to evaluate PUCCH coverage performance in LLS.*  ***Proposal 3:*** *For LLS, adopt the topology of 7 cells where one victim cell has two co-site inter-sector aggressor cells and four inter-site aggressor cells which are oriented towards the victim cell, as shown in Fig. 1.*    Fig. 1 Topology for LLS.  ***Proposal 4:*** *The inter-site gNB-gNB co-channel inter-subband CLI model in SLS is reused for LLS.*   * *For inter-site gNB-gNB co-channel inter-subband CLI power determination, Alt-2 is preferred.*   ***Proposal 5:*** *The large fading channel and fast fading channel can be modeled in LLS as follows:*   * *Fast fading channel modelling in LLS: CDL channel model defined in TS 38.901 can be used for gNB-gNB channel and gNB-UE channel modelling.* * *For gNB-gNB channel, the parameters of AOA, AOD, ZOA, and ZOD in the CDL channel model should be modified based on the topology in LLS.* * *Large fading channel modelling in LLS: reuse the large fading channel models for gNB-gNB channel defined in SLS.*   + *The large fading can be calculated based on the topology in Fig. 1.*   ***Proposal 6:*** *Adopt the evaluation assumptions in Annex A for LLS.* |
| Samsung (R1-2303126) | *Proposal 1: In addition to new types of interferences for SBFD, UE-gNB interference which has been considered in legacy TDD systems should be taken into consideration in LLS for UL coverage performance evaluation in SBFD systems.*  *Proposal 2: For LLS coverage performance evaluation, the value of inter-site gNB-gNB co-channel inter-subband CLI power is determined based on the model agreed for SLS taking into account the locations of victim gNB and several aggressor gNBs, and the gNB-gNB channel model.*  *Proposal 3: For LLS coverage performance evaluation, RAN1 should consider gNB-UE interference for both a TDD system and a SBFD system as follows*   * *For TDD UL symbol, additive white Gaussian noise with variance of ITDD+N0 is generated, where ITDD = IUE-gNB, and IUE-gNB is UE-gNB interference* * *For SBFD symbol, additive white Gaussian noise with variance of ISBFD+N0 is generated, where ISBFD = ISI+ Iinter-sector-CLI + Iinter-gNB-CLI + IUE-gNB, ISI, Iinter-sector-CLI Iinter-gNB-CLI IUE-gNB are self-interference inter-sector CLI, inter-gNB CLI and UE-gNB interference, respectively*   *Proposal 4: RAN1 considers RU of gNB as a factor when calculating the power of interferences for the UL coverage performance evaluation of SBFD using LLS.*  *Proposal 5: Apply joint channel estimation only for the same symbol type.*  *Proposal 6: Adopt the evaluation parameters in Table D-1 and D-2 in Appendix D for FR1.*  *Proposal 7: For LLS coverage performance evaluation, the following control channels are considered.*   * + *PUCCH format 3 with 22 bit payload for FR1*   + *PUCCH format 1, format 3 with 11 bit payload, and format 3 with 22 bit payload for FR2*   *Proposal 8: Receiver blocking model is not considered in LLS.* |
| Qualcomm (R1-2303588) | **Proposal 1: For link level evaluation of coverage performance for SBFD, RAN1 to utilize**   * **CDL-channel modelling (CLD-C for NLOS and CDL-D for LOS)** * **Same Antenna configuration and TxRUs as Option-2 in SLS**   **Proposal 2: For Case 4 and Case 5 of PUSCH coverage performance, the two alternatives are considered for DMRS bundling:**   * **Alt 1: Joint channel estimation is considered across both SBFD and non-SBFD slots** * **Alt 2: Joint channel estimation is considered across SBFD slots only**   **Proposal 3: For PUCCH UL coverage study, both PUCCH format 1 and format 3 are considered.**   * **For the baseline TDD, single PUCCH in the U slot is assumed** * **For SBFD, five repetitions of the PUCCH with and without DMRS bundling are assumed.** * **UL coverage metrics are obtained using link budget template and TDD/SBFD required SINR to achieve target BLER** |
| CATT (R1-2302701) | **Proposal 2: If different transmission configurations (e.g. frequency resources, UL power control parameters or beam/spatial relations) are applied for SBFD and non-SBFD slots, separate channel estimation is preferred.**  **Proposal 3: If same transmission configuration is used for SBFD and non-SBFD slots, separate channel estimation for SBFD and non-SBFD slots is the baseline while JCE can be optionally used and reported.** |
| xiaomi (R1-2302981) | Proposal 3: For link level evaluation of coverage performance, PUCCH should be evaluated with following assumptions.   * ***PUCCH format 1, 2bits UCI*** * ***PUCCH format 3, 4bits (3 bits A/N + 1 bit SR)/11/22 bits UCI***   Proposal 4: For case 4 and 5, joint channel estimation should not be used across SBFD slot and non-SBFD slot for the following cases:   * When separate resource/ separate FH parameters/ separate UL power control parameters/ separate beam/spatial relations are used for SBFD and non-SBFD slots. * When SBFD antenna configuration option-1/3 is assumed.   Proposal 5: For case 4 and 5, joint channel estimation can be used across SBFD and non-SBFD slots if the following conditions are satisfied:   * Same resource, FH parameters, UL power control parameters, and beam/spatial relations are used for SBFD and non-SBFD slots. * SBFD antenna configuration option-2 is assumed.   Proposal 6: Regarding the schemes for link level evaluation of PUCCH coverage performance,  ***- For baseline legacy TDD, consider***  ***• Single slot PUCCH transmission***  ***- For SBFD, consider the following techniques of coverage enhancement:***  ***• Case 1: SBFD with PUCCH repetition***  ***• Case 2: SBFD with PUCCH repetition and DMRS bundling***  ***o FFS: DMRS bundling across SBFD and non-SBFD slots***  ***- UL coverage metrics are obtained using link budget template and TDD/SBFD required SINR for target data rate.***  ***Note: Evaluation accounts for different SINR level between SBFD and non-SBFD slots*** |
| Intel (R1-2302794) | **Proposal 3: The following metrics are used for evaluation on coverage performance:**   * + **MCL = Total transmit power – Receiver sensitivity + gNB antenna gain (component 2).**   + **MIL = Total transmit power – Receiver sensitivity – Tx loss – Rx loss + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain.**   + **MPL = MIL – Shadow fading margin + BS selection/macro-diversity gain – Penetration margin + Other gains.**   **Proposal 4: For LLS evaluations, coverage enhancement study could be performed on both PUSCH and PUCCH transmissions.**  **Proposal 5: The complete set of assumptions to use for LLS simulations can follow those provided in Table 1 and 2 of Appendix II for FR1 and in Table 3 and 4 of Appendix II.**  **Proposal 6: When accounting for the Inter-site gNB-gNB co-channel inter-subband CLI in the LLS, Alt-1 is preferred (i.e., the value of the interference power is selected based on the INR distribution based on SLS statistics), where the INR is derived using Urban Macro scenario for FR1 and Dense Urban Macro Layer scenario for FR2-1, and related assumptions already agreed for SLS simulations.**  **Proposal 7: For link level evaluation of PUSCH coverage performance, for case 4 (SBFD with PUSCH repetition type A and joint channel estimation) and 5 (SBFD with TBoMS PUSCH and joint channel estimation), no joint channel estimation is performed across SBFD and no-SBFD slots.** |
| New H3C (R1-2302427) | **Proposal 2: For link level evaluation of coverage performance, PUCCH format 1 and format 3 should be evaluated with high priority.**  **Proposal 3: For link level evaluation of coverage performance, PRACH format 4 should be considered for evaluation.**  **Proposal 4: For link level evaluation of coverage performance for SBFD, Receiver blocking model isn’t considered or is considered with low priority into interference components.**  **Proposal 5: Regarding the schemes for link level evaluation of PUSCH coverage performance, joint channel estimation across SBFD and non-SBFD slots for PUSCH repetition type A and TBoMS PUSCH should be considered and evaluated.** |
| NTT DOCOMO (R1-2303710) | Observation 1: In the case of FR1, SINR improvement is not found for SBFD operation with PUSCH repetition, since interference for SBFD is too strong.  Observation 2: In the case of FR2-1, SINR improvement of about 4 dB is expected for SBFD with PUSCH repetition assuming smaller inter-site interference in SBFD slot compared with that in FR1. |

### Summary

#### **PUSCH coverage enhancement schemes**

In RAN1#112 meeting, four cases are considered for SBFD coverage enhancement for PUSCH as below.

|  |
| --- |
| Agreement  Regarding the schemes for link level evaluation of PUSCH coverage performance,   * For baseline legacy TDD, consider   + Single slot PUSCH transmission * For SBFD, consider the following techniques of coverage enhancement:   + ~~Case 1: SBFD with single slot PUSCH~~   + Case 2: SBFD with PUSCH repetition type A   + Case 3: SBFD with TBoMS PUSCH   + Case 4: SBFD with PUSCH repetition type A and joint channel estimation     - FFS: Joint channel estimation across SBFD and non-SBFD slots   + Case 5: SBFD with TBoMS PUSCH and joint channel estimation     - FFS: Joint channel estimation across SBFD and non-SBFD slots * UL coverage metrics are obtained using link budget template and TDD/SBFD required SINR for target data rate.   Note: Evaluation accounts for different SINR level between SBFD and non-SBFD slots |

Regarding the FFS for case 4 and 5,

* [Samsung, Intel] proposes to apply joint channel estimation only for the same symbol type.
* [Qualcomm] proposes to consider the two alternatives for DMRS bundling:
  + Alt 1: Joint channel estimation is considered across both SBFD and non-SBFD slots
  + Alt 2: Joint channel estimation is considered across SBFD slots only
* [CATT] thinks if different transmission configurations (e.g. frequency resources, UL power control parameters or beam/spatial relations) are applied for SBFD and non-SBFD slots, separate channel estimation is preferred, and if same transmission configuration is used for SBFD and non-SBFD slots, separate channel estimation for SBFD and non-SBFD slots is the baseline while JCE can be optionally used and reported. [xiaomi] also thinks joint channel estimation should not be used across SBFD slot and non-SBFD slot for some cases, and joint channel estimation can be used across SBFD and non-SBFD slots if some conditions are satisfied.
* [New H3C] proposes joint channel estimation across SBFD and non-SBFD slots for PUSCH repetition type A and TBoMS PUSCH should be considered and evaluated.

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

#### **Target uplink channels**

In RAN1#112 meeting, it was agreed to focus on PUSCH, and FFS: PUCCH.

|  |
| --- |
| **Agreement**  For link level evaluation of coverage performance, focus on the following uplink channels.   * PUSCH with 1Mbps target data rate for FR1 * PUSCH with 5Mbps target data rate for FR2-1 * FFS: PUCCH * Note: the data rate is based on TR38.830 |

[Samsung, Qualcomm, xiaomi, Intel, New H3C] suggest to consider PUCCH:

* PUCCH format 1: Qualcomm, New H3C (high priority), Samsung (PUCCH format 1 for FR2-1), xiaomi (PUCCH format 1 with 2 bit UCI)
* PUCCH format 3: Qualcomm, New H3C (high priority), Samsung (PUCCH format 3 with 22 bit payload for FR1, PUCCH format 3 with 11 / 22 bit payload for FR2-1), xiaomi (PUCCH format 3 with 4bits (3 bits A/N + 1 bit SR)/11/22 bits UCI)
* PRACH format 4: New H3C

[Huawei] proposes to not support evaluating PUCCH coverage performance in LLS.

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

Regarding the schemes for link level evaluation of PUCCH coverage performance, Qualcomm suggests:

* For the baseline TDD, consider single PUCCH in the U slot
* For SBFD, consider 5 repetitions of the PUCCH with and without DMRS bundling
* UL coverage metrics are obtained using link budget template and TDD/SBFD required SINR to achieve target BLER

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

#### **Interference modeling**

In RAN1#112 meeting, high level agreements were achieved for interference modeling for link level evaluation of coverage performance.

|  |
| --- |
| **Agreement**  For link level evaluation of coverage performance for SBFD, the following interference components are added per each receive chain to the UL channel at SBFD symbols:   * Self-interference, modelled as additive white gaussian noise with fixed INR = - 6 dB targeting 1 dB desense similar to SLS. * Co-site inter-sector interference, modelled as additive white gaussian noise with fixed INR = - X dB based on assumption of co-site isolation * Inter-site gNB-gNB co-channel inter-subband CLI,   + - Alt-1: the value of interference power is selected according to the INR distribution drawn based on the statistics from SLS.     - Alt-2: the value of interference power is determined based on the inter-site gNB-gNB co-channel inter-subband CLI model agreed for SLS taking into account the locations of victim gNB and several aggressor gNBs, and the gNB-gNB channel model * FFS: Receiver blocking model |

[Samsung] proposes in addition to new types of interferences for SBFD, UE-gNB interference which has been considered in legacy TDD systems should be taken into consideration in LLS for UL coverage performance evaluation in SBFD systems. Based on moderator’s understanding, [Samsung] suggests to calculate the UE-gNB interference power level based on link budget analysis assuming a distance of 500m between the UE and the gNB and a UE transmission power of 23 dBm.

Furthermore, [Samsung] proposes for LLS coverage performance evaluation RAN1 should consider gNB-UE interference for both TDD system and SBFD system as follows

* For TDD UL symbol, additive white Gaussian noise with variance of ITDD+N0 is generated, where ITDD = IUE-gNB, and IUE-gNB is UE-gNB interference
* For SBFD symbol, additive white Gaussian noise with variance of ISBFD+N0 is generated, where ISBFD = ISI+ Iinter-sector-CLI + Iinter-gNB-CLI + IUE-gNB, ISI, Iinter-sector-CLI, Iinter-gNB-CLI,IUE-gNB are self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference, respectively

Regarding the two alternatives for inter-site gNB-gNB co-channel inter-subband CLI power modelling, [Huawei, Samsung] prefers Alt-2, [Intel] prefers Alt-1. In moderator’s understanding, even for the proponents of Alt-2, it seems they still use different methodologies for Alt-2. For example, both Huawei and Samsung propose to adopt the topology of 7 cells where one victim cell has two co-site inter-sector aggressor cells and four inter-site aggressor cells which are oriented towards the victim cell, as illustrated in the following figure. However, [Huawei] proposes to model the inter-site gNB-gNB co-channel inter-subband CLI explicitly in LLS with both large scale channel and small scale channel (CDL channel model) modelled in LLS, while [Samsung] proposes to calculate the power of inter-gNB CLI power by using link budget template with only large scale channel modelled.



Figure: Topology for LLS.

Based on the proposals, moderator’s understanding is that, for LLS coverage performance evaluation, RAN1 should consider self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI, UE-gNB interference and noise in TDD system and SBFD system. One simple method is as below:

* For TDD UL symbol, additive white Gaussian noise with variance of is generated, where
  + is UE-gNB interference and is noise (in linear scale).
* For SBFD symbol, additive white Gaussian noise with variance of is generated, where
  + ,, , are self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference (in linear scale), respectively
* Companies to report the details of deriving ITDD and ISBFD. Some examples are as below:
  + Example-1: IUE-gNB and Iinter-gNB-CLI are derived based on link budget analysis ( and can be derived based on 1dB desense and as in last meeting agreement).
  + Example-2: can be derived based on statistic in SLS, and then is used in LLS to increase the Gaussian noise power in SBFD symbol compared to TDD UL symbol.

**Moderator suggests initial proposal 3-1-4**.

Regarding the FFS: Receiver blocking model,

* [Samsung, New H3C] suggest that receiver blocking model isn’t considered or is considered with low priority.

**Moderator suggests initial proposal 3-1-5**.

#### **Performance metric**

[Intel] proposes the following metrics are used for link level evaluation of coverage performance.

* MCL = Total transmit power – Receiver sensitivity + gNB antenna gain (component 2).
* MIL = Total transmit power – Receiver sensitivity – Tx loss – Rx loss + gNB antenna gain (component 2 + 3 + 4) + UE antenna gain.
* MPL = MIL – Shadow fading margin + BS selection/macro-diversity gain – Penetration margin + Other gains.

Moderator suggests **initial proposal 3-1-6**.

#### **LLS evaluation assumption for coverage performance evaluation for SBFD**

[CMCC, Huawei, Samsung, QC, Intel] proposed the evaluation assumptions for LLS for coverage performance evaluation. Based on the proposals, moderator suggests **initial proposal 3-1-7**.

#### **Link budget template for coverage performance evaluation for SBFD**

[CMCC] proposes for coverage performance evaluation for SBFD, the link budget template in Table A.3 in TR 38.830 with necessary modification can be used as a starting point. Moderator suggests **initial proposal 3-1-8.**

Regarding the format of capturing companies’ coverage performance evaluation results, Moderator suggests **initial proposal 3-1-9.**

* + 1. 1st Round Proposals(Closed)

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

Regarding the Case 4 and Case 5 of schemes for PUSCH LLS coverage evaluation, the baseline assumption is that joint channel estimation is applied only for the same symbol type, i.e., joint channel estimation is not considered across SBFD and non-SBFD slots.

* Companies can report if joint channel estimation is applied across SBFD and non-SBFD slots

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| Samsung | We support the proposal. |
| ZTE | OK |
| Huawei, HiSilicon | Support. |
| NTT DOCOMO | We are fine with the proposal. |
| Spreadtrum | Support |
| Xiaomi | We are fine with the proposal. |
| Intel | OK with the proposal. |
| Ericsson | Does this assume that PUSCH repetition occurs only in the same symbol types? |
| QC | Two options can be listed as below with option 1 as baseline.   * Option 1 (baseline): joint channel estimation is applied only for the same symbol type * Option 2: joint channel estimation is applied across SBFD and non-SBFD slots |

***Initial proposal 3-1-2******(Suspended):***

For LLS coverage performance evaluation, the following control channels are considered.

* PUCCH format 3 with 22 bit payload for FR1
* PUCCH format 1, format 3 with 11 bit payload, and format 3 with 22 bit payload for FR2-1

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| Samsung | We support the proposal. |
| ZTE | We are open to consider PUCCH simulation. |
| Huawei, HiSilicon | We don’t see a strong need to evaluate PUCCH. The main expected benefit of SBFD is to improve the coverage performance of PUSCH, but not PUCCH. |
| Xiaomi | We are fine with the proposal. |
| Intel | We are OK with the proposal. |
| QC | Support |
| Moderator | Huawei has concern on this proposal. We can discuss it later. |

***Initial proposal 3-1-3(Suspended):***

Regarding PUCCH UL coverage study,

* For baseline legacy TDD, single PUCCH in the U slot is assumed
* For SBFD, five repetitions of the PUCCH with and without DMRS bundling are assumed.
* UL coverage metrics are obtained using link budget template and TDD/SBFD required SINR to achieve target BLER

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| Samsung | Similarly as in the JCE for PUSCH repetition, we need to capture the JCE is applicable to the same symbol type.  Also, we may discuss how to use frequency hopping for PUCCH. For example, which frequency hopping mode is used (intra-slot? or Inter-slot?) or How to arrange PUCCH frequency hop in frequency domain across SBFD symbols and UL symbols). Since the PUCCH FH is still under discussion in AI9.3.2, we prefer to report PUCCH FH assumption by each company. |
| ZTE | OK |
| Huawei, HiSilicon | See our comment to ***proposal 3-1-2*** |
| Xiaomi | Considered initial proposal 3-1-1, initial proposal 3-1-3 could be updated as follows.  Regarding PUCCH UL coverage study,   * For baseline legacy TDD, single PUCCH in the U slot is assumed * For SBFD, ~~five~~ repetitions of the PUCCH with and without DMRS bundling are assumed.   + - * For PUCCH with DMRS bundling, the baseline assumption is that DMRS bundling is applied only for the same symbol type, i.e., DMRS bundling is not considered across SBFD and non-SBFD slots.         + Companies can report if DMRS bundling is applied across SBFD and non-SBFD slots * UL coverage metrics are obtained using link budget template and TDD/SBFD required SINR to achieve target BLER |
| Intel | Ok with the proposal and have same comment as Samsung regarding capturing JCE to the same symbol type. As for frequency hopping assumption, we are OK to leave it up to companies to report. |
| QC | Support. |
| Moderator | Huawei has concern on this proposal. We can discuss it later. |

***Initial proposal 3-1-4(Closed):***

For LLS coverage evaluation, RAN1 should consider self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference in TDD system and SBFD system. One modelling method is as below:

* For TDD UL symbol, additive white Gaussian noise with variance of is generated, where
  + is UE-gNB interference and is noise (in linear scale).
* For SBFD symbol, additive white Gaussian noise with variance of is generated, where
  + ,, , are self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference (in linear scale), respectively
* Companies to report the details of deriving and . Some examples are as below:
  + Example-1: , and are derived based on link budget analysis based on a certain assumption of the topology of gNBs and UEs ( is derived based on 1dB desense and is derived based on as agreed in last meeting).
  + Example-2: is derived based on statistic in SLS, and then is used in LLS to increase the Gaussian noise power in SBFD symbol compared to TDD UL symbol.

Note: Other modelling methods for UE-gNB interference and inter-site gNB-gNB co-channel inter-subband CLI in LLS coverage evaluation (e.g., by explicitly modelling the topology of aggressor gNBs and gNB-gNB fast fading channels in LLS) are not precluded and can be reported by companies.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| Samsung | We have several comments below.  First, we would like to clarify the definition of “SNR” to be used in the proposal 3-1-9.   * “SNR” is defined as “received signal power/noise power” where the noise power only takes into account N0 (not consider interference terms)   Second, the INR we agreed in the last RAN1 meeting is defined as   * “INR of self-interference” is defined as “sum of interference powers from TX panel in the same sector/noise power” and * “INR of inter-sector interference” is defined as “sum of interference powers from two sectors (Ico-site)/noise power”, where again the noise power only takes into account N0 (not consider interference terms)   Third, the time-domain correlation of the interference is not determined so far.   * It is unclear that the interference is independently updated/generated in each slot or the generated interference is kept within a TDD period (5slots). Or, in Example-2, is the time-domain correlation of the interference also obtained from SLS? For simplicity, we prefer to update/generate interference in each slot.   Last, whether/how to consider RU in Example-1 is needed to be discussed.   * Since the interference level is determined by a specific RU (i.e., lower RU means lower SI/inter-sector CLI/gNB-gNB CLI), the RU may change SBFD UL coverage gain. This RU is naturally included in Example-2, but Example-1 only considers full power transmission which may over-estimate interference power. |
| ZTE | We were wondering what’s the difference between and ? Based on our understanding,   * + - * + In the legacy coverage enhancement study, UE-gNB interference is not applied, it is suggested not to apply it here as well to avoid redo the previous simulation;         + and may be with the similar (or same) value. It is equivalent to not consider them in both TDD and SBFD.   Thus, we propose to not consider and in this LLS. |
| Huawei, HiSilicon | We do not support this proposal.  For UE-gNB interference, we are not sure about the need to model it in LLS given that it has not been considered the Rel-17 Coverage Enhancement.  For inter-site gNB-gNB co-channel inter-subband CLI, it is technically incorrect to model it as additive white Gaussian noise especially for SBFD evaluations since at least the leakage part are not spatially white. If it is modeled as additive white Gaussian noises, we don’t even see the need of evaluations. The gains of repetitions over single slot transmission can be simply derived based on evaluations in previous studies such as Rel-17 coverage enhancement.  In summary, we propose not to consider UE-gNB interference and the inter-site gNB-gNB co-channel inter-subband CLI models defined in SLS can be reused for LLS. |
| NTT DOCOMO | Our understanding is that the modeling of gNB-UE interference is unclear. In case of example 2, if legacy TDD and SBFD use the common topology, can and be considered as the similar value? |
| Xiaomi | We are fine with the proposal with modifications.  In the modelling, is per RB UE-gNB interference and is per RB noise (in linear scale). ,, , are per RB self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference (in linear scale), respectively. |
| Intel | Support the proposal. |
| QC | We are generally fine with the direction of the proposal. For fair comparison, RAN1 should consider the impact of legacy UE-gNB interference on the total interference for both TDD and SBFD. |

***Initial proposal 3-1-5(Closed):***

Receiver blocking model is not considered in LLS.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| Samsung | Support the proposal |
| ZTE | OK |
| Huawei, HiSilicon | Generally fine not to consider the receiver blocking model in LLS. We are open to discuss whether it can be considered in link budget analysis. |
| Xiaomi | We are fine with the proposal. |
| Intel | Support |
| QC | Support |
| Moderator | Seems Stable |
| Ericsson | We think the receiver blocking model should be included in the link budget analysis to model this practical impairment. This is also simple to do since there is already a line item in the link budget for NF, and it would then be adjusted based on the total power at the receiver input. |

***Initial proposal 3-1-6(Closed):***

For link level evaluation of coverage performance, MPL, MCL and MIL as defined in TR38.830 are used as the performance metrics.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| Samsung | Support the proposal |
| ZTE | OK |
| Huawei, HiSilicon | Support. |
| NTT DOCOMO | We are fine with the proposal. |
| Spreadtrum | Support |
| Xiaomi | We are fine with the proposal. |
| QC | Support |
| Moderator | Seems Stable |

***Initial proposal 3-1-7(Closed):***

Adopt the following evaluation assumptions for LLS for coverage performance evaluation.

Table X-1: General parameters for FR1

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario and frequency | Urban Macro: 4GHz |
| Frame structure for TDD | TDD: DDDSU (S: 10D:2G:2U)  SBFD: XXXXU with 20% UL subband |
| Target data rates for eMBB | UL 1Mbps |
| Pathloss model (select from LoS or NLoS) | gNB-UE: NLOS  gNB-gNB (if modelled in LLS): LOS: NLOS = 3:1 |
| BWP | 100MHz |
| Channel model for link-level simulation | gNB-UE: TDL-C, CDL-C  Note: Company can provide simulation results based on either TDL channel or CDL model  Note: Companies can report gNB-gNB channel model if modelled in LLS. |
| Delay spread | 300ns |
| UE velocity | 3km/h for indoor |
| Number of antenna elements for BS | SBFD antenna configuration option-2,  - 192 antenna elements  - (M,N,P,Mg,Ng) = (12,8,2,1,1)  - (optional) 128 antenna elements  - (M,N,P,Mg,Ng) = (8,8,2,1,1)  - Note: it is the same for both SBFD and non-SBFD slots  Note: Companies to report the details if other antenna configurations are used. |
| Number of TxRUs for BS | gNB architectures to study:  SBFD antenna configuration option-2,  - 64 TxRUs  - Note: it is the same for both SBFD and non-SBFD slots  Note: Companies to report the details if other antenna configurations are used.  gNB modelling in LLS for TDL:  - Option 1: 2 or 4 gNB RF chains in LLS.  - Option 2 (Optional): Number of gNB RF chains = number of TXRUs in LLS.  - Companies can report if and how correlation is modelled. |

Table X-2: Channel-specific parameters for PUSCH for FR1

|  |  |
| --- | --- |
| Parameter | Value |
| Frequency hopping | w/ or w/o frequency hopping |
| BLER | For eMBB, w/ HARQ, 10% iBLER; w/o HARQ, 10% iBLER. |
| Number of UE transmit chains | 1, 2 (optional) |
| DMRS configuration | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.  For frequency hopping: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. |
| Waveform | DFT-s-OFDM |
| SCS | 30kHz |
| PUSCH duration | 14 OS |
| HARQ configuration | For eMBB, whether HARQ is adopted is reported by companies.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| PRBs/TBS/MCS for eMBB | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use 30 PRBs for 1Mbps as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |

Table X-3: General parameters for FR2

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario and frequency | Dense Urban Macro: 30GHz |
| Frame structure for TDD | TDD: DDDSU (S: 10D:2G:2U)  SBFD: XXXXU |
| Target data rates for eMBB | UL: 5Mbps |
| BWP | 100MHz |
| Channel model for link-level simulation | CDL- A, TDL-A  Note: Company can provide simulation results based on either TDL channel or CDL model |
| Delay spread | 100ns |
| UE velocity | 30 km/h for outdoor |
| Number of antenna elements for BS | SBFD antenna configuration option-2,  256 antenna elements  (M,N,P,Mg,Ng) = (16,8,2,1,1)  Note: it is the same for both SBFD and non-SBFD slots |
| Number of TxRUs for BS | 2  Note: Analog beamforming is assumed. |
| Number of UE antenna elements | 8, one panel:(M, N, P) = (2,2,2) |

Table X-4: Channel-specific parameters for PUSCH for FR2

|  |  |
| --- | --- |
| Parameter | Value |
| Frequency hopping | w/ or w/o frequency hopping |
| BLER | For eMBB,  w/ HARQ, 10% iBLER, Optional: companies report iBLER.  w/o HARQ, 10% iBLER. |
| Number of UE Tx/Rx chains | 1T2R, 2T2R |
| DMRS configuration | For 30km/h: Type I, 2 or 3 DMRS symbol, no multiplexing with data.  For frequency hopping for PUSCH: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH/PDSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. |
| Waveform | DFT-s-OFDM |
| SCS | 120kHz. |
| PUSCH duration | 14 OS |
| HARQ configuration | For eMBB, whether HARQ is adopted is reported by companies.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| PRBs/TBS/MCS for eMBB | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use 30 PRBs for 5Mbps for PUSCH as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| ZTE | OK |
| Huawei, HiSilicon | We have the following two comments   * For SBFD, XXXXX can also be evaluated in LLS for both FR1 and FR2 * To evaluate spatial domain enhancements, the CDL channel models should be used for gNB-gNB channel and gNB-UE channel modelling, but not TDL. |
| NTT DOCOMO | We are fine with the proposal.  As a minor detail, we may consider that in the case of FR2, the number of RBs in UL is only 26 RBs in simulation assumptions of SLS. |
| Xiaomi | Update the evaluation assumptions for LLS for coverage performance evaluation as follows.  Table X-1: General parameters for FR1   |  |  | | --- | --- | | Parameter | Value | | Scenario and frequency | Urban Macro: 4GHz | | Frame structure for TDD | TDD: DDDSU (S: 10D:2G:2U)  SBFD: XXXXU ~~with 20% UL subband~~, where X denotes SBFD slot.  For SBFD slot, {DUD} pattern is assumed,  For FR1, 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <104, 55, 5> | | Target data rates for eMBB | UL 1Mbps | | Pathloss model (select from LoS or NLoS) | gNB-UE: NLOS  gNB-gNB (if modelled in LLS): LOS: NLOS = 3:1 | | BWP | 100MHz | | Channel model for link-level simulation | gNB-UE: TDL-C, CDL-C  Note: Company can provide simulation results based on either TDL channel or CDL model  Note: Companies can report gNB-gNB channel model if modelled in LLS. | | Delay spread | 300ns | | UE velocity | 3km/h for indoor | | Number of antenna elements for BS | SBFD antenna configuration option-2,  ~~- 192 antenna elements~~  ~~- (M,N,P,Mg,Ng) = (12,8,2,1,1)~~  ~~- (optional)~~ 128 antenna elements  - (M,N,P,Mg,Ng) = (8,8,2,1,1)  - Note: it is the same for both SBFD and non-SBFD slots  Note: Companies to report the details if other antenna configurations are used.  Note: Same as the BS antenna array configuration in SLS calibration. | | Number of TxRUs for BS | gNB architectures to study:  SBFD antenna configuration option-2,  - ~~64 TxRUs~~  - 32TxRUs, (Mp,Np) = (2,8)  - Note: it is the same for both SBFD and non-SBFD slots  Note: Companies to report the details if other antenna configurations are used.  Note: Same as the BS antenna array configuration in SLS calibration.  ~~gNB modelling in LLS for TDL:~~  ~~- Option 1: 2 or 4 gNB RF chains in LLS.~~  ~~- Option 2 (Optional): Number of gNB RF chains = number of TXRUs in LLS.~~  ~~- Companies can report if and how correlation is modelled.~~ |   Table X-2: Channel-specific parameters for PUSCH for FR1   |  |  | | --- | --- | | Parameter | Value | | Frequency hopping | w/ or w/o frequency hopping | | BLER | For eMBB, w/ HARQ, 10% iBLER; w/o HARQ, 10% iBLER. | | Number of antenna elements for UE | 2 antenna elements  (M,N,P,Mg,Ng) = (1,1,2,1,1)  Note: Same as the UE antenna configuration in SLS calibration. | | Number of UE transmit chains | ~~1, 2 (optional)~~  2  Note: Same as the UE antenna configuration in SLS calibration. | | DMRS configuration | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.  For frequency hopping: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. | | Waveform | DFT-s-OFDM | | SCS | 30kHz | | PUSCH duration | 14 OS | | Repetitions | For eMBB, w/o repetition as baseline, w/ repetition (optional).  The actual number of repetitions is reported by companies. | | HARQ configuration | For eMBB, whether HARQ is adopted is reported by companies.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. | | PRBs/TBS/MCS for eMBB | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use 30 PRBs for 1Mbps as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |   Table X-3: General parameters for FR2   |  |  | | --- | --- | | Parameter | Value | | Scenario and frequency | Dense Urban Macro: 30GHz | | Frame structure for TDD | TDD: DDDSU (S: 10D:2G:2U)  SBFD: XXXXU, where X denotes SBFD slot.  For SBFD slot, {DUD} pattern is assumed,  For FR2-1, 200MHz channel bandwidth and 120kHz SCS (132 PRB): < ND, NU,NG > = <52, 26, 1> | | Target data rates for eMBB | UL: 5Mbps | | BWP | ~~100MHz~~200MHz | | Pathloss model (select from LoS or NLoS) | gNB-gNB (if modelled in LLS): LOS: NLOS = 3:1 | | Channel model for link-level simulation | CDL- A, TDL-A  Note: Company can provide simulation results based on either TDL channel or CDL model  Note: Companies can report gNB-gNB channel model if modelled in LLS. | | Delay spread | 100ns | | UE velocity | 30 km/h for outdoor | | Number of antenna elements for BS | SBFD antenna configuration option-2,  ~~256~~ 512 antenna elements  ~~(M,N,P,Mg,Ng) = (16,8,2,1,1)~~  (M,N,P,Mg,Ng) = (4,16,2,2,2)  Note: Same as the BS antenna array configuration in SLS calibration.  Note: it is the same for both SBFD and non-SBFD slots | | Number of TxRUs for BS | ~~2~~  8 TxRUs, (Mp,Np) = (1,1)  Note: Same as the BS antenna array configuration in SLS calibration.  Note: Analog beamforming is assumed. | | Number of UE antenna elements | ~~8, one panel:(M, N, P) = (2,2,2)~~  32, (M,N,P,Mg,Ng) = (2,4,2,1,2)  Note: Same as the UE antenna configuration in SLS calibration. |   Table X-4: Channel-specific parameters for PUSCH for FR2   |  |  | | --- | --- | | Parameter | Value | | Frequency hopping | w/ or w/o frequency hopping | | BLER | For eMBB,  w/ HARQ, 10% iBLER, Optional: companies report iBLER.  w/o HARQ, 10% iBLER. | | Number of UE Tx/Rx chains | ~~1T2R, 2T2R~~  4T4R, (Mp,Np) = (1,1);  Same as the UE antenna configuration in SLS calibration. | | DMRS configuration | For 30km/h: Type I, 2 or 3 DMRS symbol, no multiplexing with data.  For frequency hopping for PUSCH: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH/PDSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. | | Waveform | DFT-s-OFDM | | SCS | 120kHz. | | PUSCH duration | 14 OS | | Repetitions | For eMBB, w/o repetition as baseline, w/ repetition (optional).  The actual number of repetitions is reported by companies.  Only PUSCH repetition type A is considered for baseline performance evaluation.  o Note: companies are not precluded to report results for repetition type B. | | HARQ configuration | For eMBB, whether HARQ is adopted is reported by companies.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. | | PRBs/TBS/MCS for eMBB | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use 30 PRBs for 5Mbps for PUSCH as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. | |

|  |  |
| --- | --- |
| Intel | OK with the above assumptions. |
| QC | Delay spread values for CDL-C (FR1) and CDL-A (FR2-1) are missing. |

***Initial proposal 3-1-8(Closed):***

For coverage performance evaluation for SBFD, the link budget template in Table A.3 in TR 38.830 is reused with the following modifications.

|  |  |
| --- | --- |
| (10) Number of receive antenna elements | SBFD antenna configuration option-2,  FR1:  - 192 antenna elements  - (M,N,P,Mg,Ng) = (12,8,2,1,1)  - (optional) 128 antenna elements  - (M,N,P,Mg,Ng) = (8,8,2,1,1)  FR2:  - 256 antenna elements  - (M,N,P,Mg,Ng) = (16,8,2,1,1)  Note: Companies to report the details if other antenna configurations are used. |
| (10a) Number of receive TxRUs | SBFD antenna configuration option-2,  FR1:  - 64 TxRUs  FR2:  - 2  Note: Companies to report the details if other antenna configurations are used. |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| ZTE | OK |
| Huawei, HiSilicon | Support. |
| NTT DOCOMO | We are fine with the proposal. |
| Xiaomi | BS antenna array configuration in SLS calibration should be reused in LLS. Thus, the parameters can be updated as belows.   |  |  | | --- | --- | | (10) Number of receive antenna elements | SBFD antenna configuration option-2,  FR1:  ~~- 192 antenna elements~~  ~~- (M,N,P,Mg,Ng) = (12,8,2,1,1)~~  ~~- (optional)~~ 128 antenna elements  - (M,N,P,Mg,Ng) = (8,8,2,1,1)  FR2:  - ~~256~~ 512 antenna elements  ~~- (M,N,P,Mg,Ng) = (16,8,2,1,1)~~  - (M,N,P,Mg,Ng) = (4,16,2,2,2)  Note: Companies to report the details if other antenna configurations are used.  Note: Same as the BS antenna array configuration in SLS calibration. | | (10a) Number of receive TxRUs | SBFD antenna configuration option-2,  FR1:  ~~- 64 TxRUs~~  - 32TxRUs, (Mp,Np) = (2,8)  FR2:  ~~- 2~~  - 8 TxRUs, (Mp,Np) = (1,1)  Note: Companies to report the details if other antenna configurations are used.  Note: Same as the BS antenna array configuration in SLS calibration. | |
| Intel | OK. |
| QC | Support  There is a typo (missing word TxRU) in the last row.   |  |  | | --- | --- | | (10a) Number of receive TxRUs | SBFD antenna configuration option-2,  FR1:  - 64 TxRUs  FR2:  - 2 TxRUs  Note: Companies to report the details if other antenna configurations are used. | |

***Initial proposal 3-1-9(Closed):***

The following table is used to collect companies’ link level evaluation results for coverage performance.

* Each company can input multiple groups of evaluation results, and each group corresponds to one kind of key assumptions, e.g., coverage enhancement schemes for SBFD, traffic load, etc.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| PUSCH-FR1-Urban Macro/ PUSCH-FR2-Dense Urban Macro | | | | | | |
| Company name | TDD/SBFD | Required SNR | MCL | MIL | MPL | Key assumptions |
| Source 1 | TDD |  |  |  |  |  |
| SBFD |  |  |  |  |
| Gain |  |  |  |  |
| Source X | TDD |  |  |  |  |  |
| SBFD |  |  |  |  |
| Gain |  |  |  |  |
| … | TDD |  |  |  |  |  |
| SBFD |  |  |  |  |
| Gain |  |  |  |  |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| Samsung | We support the template.  Is it correct understanding that if RAN1 agree to evaluate PUCCH, the similar template can be used. (For example, PUCCH-PF3-FR1-Urban Macro, instead of PUSCH-FR1-Urban Macro in the first row of the table) |
| ZTE | OK |
| Huawei, HiSilicon | We suggest following modifications:   1. Row “SBFD” are divided as two rows:  * SBFD w/o any enhancements. * SBFD w/ gNB-gNB CLI handling scheme reported by companies  1. Row “Gain” is divided as two new rows:    1. Gains of SBFD w/o any enhancements  * Gains of SBFD w/ gNB-gNB CLI handling scheme reported by companies |
| DOCOMO | We are fine with the proposal. |
| Xiaomi | We are fine with the proposal. |
| Intel | We support the template |
| QC | Fine with the template. |

* + 1. 2nd Round Proposals(Closed)

***Updated proposal 3-1-1a(Closed):***

Regarding the Case 4 and Case 5 of schemes for PUSCH LLS coverage evaluation, two options are considered:

* Option 1 (baseline): joint channel estimation is applied only for the same symbol type
* Option 2: joint channel estimation is applied across SBFD and non-SBFD slots

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | @Ericsson, this just restrict the joint channel estimation instead of repetition. My understanding is that PUSCH repetition can still be across SBFD slot and non-SBFD slot. |
| ZTE | OK |
| Ericsson | Generally ok. Perhaps, we can remove the baseline and companies report the option they use. |
| QC | Prefer to remove the baseline and keep the two options. This a study item and objective to evaluate the possible gains for either option. |
| Spreadtrum | We are open to the proposal and the view of Ericsson and QC. |
| Xiaomi | Support |
| New H3C | OK |
| Huawei, HiSilicon | Support |
| Samsung | OK |
| Intel | OK with the proposal, and we would rather prefer to keep the baseline. |

***Updated proposal 3-1-4a(Closed):***

For LLS coverage evaluation, RAN1 should consider self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference in TDD system and SBFD system. One modelling method is as below:

* For TDD UL slot, additive white Gaussian noise with variance of is generated, where
  + is UE-gNB interference and is noise (in linear scale).
* For SBFD slot, additive white Gaussian noise with variance of is generated, where
  + ,, , are self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference (in linear scale), respectively
* Companies to report the details of deriving and . Some examples are as below:
  + Example-1: and are derived based on link budget analysis based on a certain assumption of the topology of gNBs and UEs ( is derived based on 1dB desense and is derived based on as agreed in last meeting).
  + Example-2: is derived based on statistic in SLS, and then is used in LLS to increase the Gaussian noise power in SBFD symbol compared to TDD UL symbol.
  + Companies to report the RU assumption for the interference.
* Note: For simplicity, the interference is independently updated/generated in each slot.

Based on the above modelling, the following high-level evaluation method can be used as an example for coverage performance evaluation:

* Step 1: For legacy TDD system, assume the SNR in UL only slot is , perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL
* Step 2: For SBFD system with frame structure XXXXU, assume the SNR in UL only slot is and the SNR in SBFD slot is . Perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL for a given SBFD coverage enhancement scheme (e.g., SBFD with PUSCH repetition type A, etc.)
* Step 3: Use Link budget template to obtain MPL, MCL and MIL for legacy TDD and SBFD.
  + For legacy TDD, the required SNR () obtained in Step 1 is used to calculate MPL, MCL, MIL.
  + For SBFD, the required SNR () obtained in Step 2 is used to calculate MPL, MCL, MIL.

Note: Other modelling methods for UE-gNB interference and inter-site gNB-gNB co-channel inter-subband CLI in LLS coverage evaluation (e.g., by explicitly modelling the topology of aggressor gNBs and gNB-gNB fast fading channels in LLS) are not precluded and can be reported by companies.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Generally, my understanding is that UE-gNB interference should be considered. If UE-gNB interference is not assumed and only SI, inter-sector interference, inter-gNB CLI and noise are assumed, the summation of SI, inter-sector interference and inter-gNB CLI will be greatly larger than the power of noise. It will be impossible for SBFD with repetition to show coverage gain compared to TDD, since the additionally added interference in SBFD is too large compared to noise in TDD if only noise is considered in TDD. However, in actual, the summation of SI, inter-sector interference and inter-gNB CLI may not be greatly larger than the summation of UE-gNB interference and noise.  @Xiaomi, I think “per RB” may not be necessary, it could be per RB or per subcarrier or others.  @Huawei, this does not exclude your proposal to explicitly model the topology of aggressor gNBs and gNB-gNB fast fading channels in LLS |
| ZTE | Overall, we think it is beneficial to have some discussion on the detailed LLS methodology. However, we think the above is mainly for information instead of forcing every company to use the above methodology. |
| QC | Generally fine with the procedure to include legacy UL interference into the modelling. |
| Xiaomi | As UL bandwidth of TDD UL symbol and SBFD symbol is different, values of noise in and is different when is for the UL bandwidth. Thus, per RB is mentioned in previous reply. However, we are fine with the proposal if majority companies are OK with the proposal. |
| New H3C | OK |
| Huawei, HiSilicon | We suggested earlier that UE-gNB interference is not considered in LLS but we can be open to consider it. However, we have serious concerns on how the interferences should be modeled and and suggest to discuss the methodology a bit further.  For LLS, if we consider gNB self interference, co-site inter-sector CLI, inter-gNB CLI, UE-gNB interference, the signal model can be formulated as follow:  ***(1)***   * **is the received signal vector at the gNB** * **is the channel matrix from target UE to gNB, is the transmitted signal of the target user;** * **, , are the channel matrix and transmitted signal of the UE in the same cell as the target user;** * **and are the channel matrix and transmitted signal of the UEs in the adjacent cell;** * **, and are the channel matrix, the precoding matrix, and leakage CLI signal from gNB to the victim gNB . The power of the signal and interference is included in the channel marix respectively;** * **and are the self-interference vector of the co-site setors and the thermal noise signal vector on the receiving antennas.**   Based on the above signal model, one may notice the UE-gNB interference and inter-gNB CLI signal can be from diferent directions from that of the target user, therefore they can be effectively suppressed at the gNB receiver. However, in the FL proposal, the UE-gNB interferences and inter-gNB CLI are modeled as ***independent Gaussian white noise*** which can not be suppressed at the receiver at all. This does not reflect the reality and the simulation results become much pessimistic.  Moreover, if we follow the FL proposal, it can be anticipated that the performance of SBFD with repetitions would be depedent on the power level of legacy UE-gNB CLI and inter-gNB CLI. Assuming a similar level (in practice, the inter-gNB CLI can be higher than UE-gNB interference according to the SLS results from several companies including ours), the performance degradation is about 3dB. Considering that 5 repetions provides 7 dB coverage gain at maximum then there is only around 4dB left! If further consider channel estimation accuracy and implementation margins, we are not sure how SBFD can be motivated considering the signigicant complexity.  Therefore, we suggest the following  For LLS coverage evaluation, RAN1 should consider self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference in TDD system and SBFD system. One modelling method is as below:  ***(1)***   * **is the received signal vector at the victim gNB,** * **is the channel matrix from target UE to gNB, is the transmitted signal of the target user;** * **, , are the channel matrix and transmitted signal of the UE in the same cell as the target user;** * **and are the channel matrix and transmitted signal of the UEs in the adjacent cell;** * **, and are the channel matrix, the precoding matrix, and leakage CLI signal from gNB to the victim gNB . The power of the signal and interference is included in the channel marix respectively;** * **and are the self-interference vector of the co-site setors and the thermal noise signal vector on the receiving antennas.** |
| Samsung | The updated part is fine with us.  We are open to the proposal from HW/HiSi and using advanced receiver to suppress interference. Without use of advanced receiver (e.g., taking into account interference covariance matrix), the proposal from FL is sufficient. |
| Ericsson | Please see our comment added to proposal 3-1-5 in the 1st round discussions after Moderators comment “Seems stable”  Generally agree to Proposal 3-1-4a. We think it is a good idea to provide the high-level evaluation method for determining required SNR. This is useful for alignment purposes.  We suggest the following update since we think that interference power is determined via a model, not necessarily link budget analysis   * + Example-1: and are derived based on ~~link budget analysis based on~~ a certain assumption of the topology of gNBs and UEs ( is derived based on 1dB desense and is derived based on as agreed in last meeting). |
| Intel | OK, also with the additional part and the procedure. |

***Updated proposal 3-1-7a(Closed):***

Adopt the following evaluation assumptions for LLS for coverage performance evaluation.

Table X-1: General parameters for FR1

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario and frequency | Urban Macro: 4GHz |
| Frame structure for TDD | TDD: DDDSU (S: 10D:2G:2U)  SBFD: XXXXU, where X denotes SBFD slot.   * For SBFD slot, {DUD} pattern is assumed. * 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <104, 55, 5> |
| Target data rates for eMBB | UL 1Mbps |
| Pathloss model (select from LoS or NLoS) | gNB-UE: NLOS  gNB-gNB (if modelled in LLS): LOS: NLOS = 3:1 |
| BWP | 100MHz |
| Channel model for link-level simulation | gNB-UE: TDL-C, CDL-C  Note: Company can provide simulation results based on either TDL channel or CDL model  Note: Companies can report gNB-gNB channel model if modelled in LLS. |
| Delay spread | 300ns |
| UE velocity | 3km/h for indoor |
| Number of antenna elements for BS | SBFD antenna configuration option-2,  ~~- 192 antenna elements~~  ~~- (M,N,P,Mg,Ng) = (12,8,2,1,1)~~  - ~~(optional)~~ 128 antenna elements  - (M,N,P,Mg,Ng) = (8,8,2,1,1)  - Note: it is the same for both SBFD and non-SBFD slots  Note: Companies to report the details if other antenna configurations are used.  Note: Same as the BS antenna array configuration in SLS calibration. |
| Number of TxRUs for BS | gNB architectures to study:  SBFD antenna configuration option-2,  - ~~64 TxRUs~~ 32TxRUs, (Mp,Np) = (2,8)  - Note: it is the same for both SBFD and non-SBFD slots  Note: Companies to report the details if other antenna configurations are used.  Note: Same as the BS antenna array configuration in SLS calibration.  gNB modelling in LLS for TDL:  - Option 1: 2 or 4 gNB RF chains in LLS.  - Option 2 (Optional): Number of gNB RF chains = number of TXRUs in LLS.  - Companies can report if and how correlation is modelled. |

Table X-2: Channel-specific parameters for PUSCH for FR1

|  |  |
| --- | --- |
| Parameter | Value |
| Frequency hopping | w/ or w/o frequency hopping |
| BLER | For eMBB, w/ HARQ, 10% iBLER; w/o HARQ, 10% iBLER. |
| Number of antenna elements for UE | 2 antenna elements  (M,N,P,Mg,Ng) = (1,1,2,1,1)  Note: Same as the UE antenna configuration in SLS calibration. |
| Number of UE transmit chains | ~~1, 2 (optional)~~  2  Note: Same as the UE antenna configuration in SLS calibration. |
| DMRS configuration | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.  For frequency hopping: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. |
| Waveform | DFT-s-OFDM |
| SCS | 30kHz |
| PUSCH duration | 14 OS |
| HARQ configuration | For eMBB, whether HARQ is adopted is reported by companies.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| PRBs/TBS/MCS for eMBB | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use 30 PRBs for 1Mbps as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |

Table X-3: General parameters for FR2

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario and frequency | Dense Urban Macro: 30GHz |
| Frame structure for TDD | TDD: DDDSU (S: 10D:2G:2U)  SBFD: XXXXU where X denotes SBFD slot.   * For SBFD slot, {DUD} pattern is assumed, * 200MHz channel bandwidth and 120kHz SCS (132 PRB): < ND, NU, NG > = <52, 26, 1> |
| Target data rates for eMBB | UL: 5Mbps |
| BWP | ~~100MHz~~ 200MHz |
| Pathloss model (select from LoS or NLoS) | gNB-gNB (if modelled in LLS): LOS: NLOS = 3:1 |
| Channel model for link-level simulation | CDL- A, TDL-A  Note: Company can provide simulation results based on either TDL channel or CDL model  Note: Companies can report gNB-gNB channel model if modelled in LLS. |
| Delay spread | 100ns |
| UE velocity | 30 km/h for outdoor |
| Number of antenna elements for BS | SBFD antenna configuration option-2,  256 antenna elements  (M,N,P,Mg,Ng) = (16,8,2,1,1)  Note: it is the same for both SBFD and non-SBFD slots |
| Number of TxRUs for BS | 2  Note: Analog beamforming is assumed. |
| Number of UE antenna elements | 8, one panel:(M, N, P) = (2,2,2) |

Table X-4: Channel-specific parameters for PUSCH for FR2

|  |  |
| --- | --- |
| Parameter | Value |
| Frequency hopping | w/ or w/o frequency hopping |
| BLER | For eMBB,  w/ HARQ, 10% iBLER, Optional: companies report iBLER.  w/o HARQ, 10% iBLER. |
| Number of UE Tx/Rx chains | 1T2R, 2T2R |
| DMRS configuration | For 30km/h: Type I, 2 or 3 DMRS symbol, no multiplexing with data.  For frequency hopping for PUSCH: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH/PDSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. |
| Waveform | DFT-s-OFDM |
| SCS | 120kHz. |
| PUSCH duration | 14 OS |
| HARQ configuration | For eMBB, whether HARQ is adopted is reported by companies.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| PRBs/TBS/MCS for eMBB | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use ~~30~~ 26 PRBs for 5Mbps for PUSCH as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | @Huawei, we have agreed in RAN1#112 to use Alt-2 (XXXXU) for link level evaluation for coverage. In addition, it is up to companies to report which channel model is used for gNB-gNB if modelled in LLS.  @Xiaomi, For FR2, I didn’t fully reuse the antenna configurations in SLS calibration, since I’m not sure whether companies are OK or not to model more Tx/Rx chains in LLS, but we can hear more views on this. Regarding the schemes for coverage evaluation (e.g., repetition), we have separate proposals for them.  @QC, are 300ns Delay spread for CDL-C (FR1) and 100ns Delay spread for CDL-A (FR2-1) OK for you? |
| ZTE | OK |
| QC | Thanks, FL, for clarifiatoion! The listed values are fine and inline with assumption of R17 coverage enahcnement. We could add a note, companies can report if other delay spread values are used. |
| Xiaomi | We are fine with the proposal if majority companies are OK not to reuse the antenna configuration in SLS calibration in FR2. |
| New H3C | OK |
| Huawei, HiSilicon | Thanks for the reply. We are okay with XXXXU.  On the antenna configuration, we are not sure why the antenna configurations from SLS calibration is used. Given that there is no commonly agreed antenna configurations for formal SLS, we suggest this can be reported by companies in LLS as well. |
| Samsung | We are ok with the proposal.  Regarding the antenna configuration, we supported to reuse Rel-17 Coverage enhancement EVM but we are open to other configurations. |
| Ericsson | WE have a few comments on this proposal for both FR1 and FR2.  UE Tx power is missing which is needed for link budget and also for determining the UL signal to interference ratio in SBFD slots for running link simulation to determine required SNR.   1. We are not sure why “Pathloss model (select from LoS or NLoS)” is needed, since according to Proposal 3-1-4a, “Companies to report the details of deriving and ” 2. It needs to be clarified that the number of BS antenna elements used for receiving is not the same as “Number of antenna elements for BS” We need the number of BS receive antennas, since we are only doing this analysis for UL channels 3. Similarly, we only need the number of transmit antenna elements at UE and not the whole configuration. |
| Intel | OK |

***Updated proposal 3-1-8a(Closed):***

For coverage performance evaluation for SBFD, the link budget template in Table A.3 in TR 38.830 is reused with the following modifications.

|  |  |
| --- | --- |
| (10) Number of receive antenna elements | SBFD antenna configuration option-2,  FR1:  ~~- 192 antenna elements~~  ~~- (M,N,P,Mg,Ng) = (12,8,2,1,1)~~  - ~~(optional)~~ 1128 antenna elements  - (M,N,P,Mg,Ng) = (8,8,2,1,1)  FR2:  - 256 antenna elements  - (M,N,P,Mg,Ng) = (16,8,2,1,1)  Note: Companies to report the details if other antenna configurations are used. |
| (10a) Number of receive TxRUs | SBFD antenna configuration option-2,  FR1:  - ~~64 TxRUs~~ 32TxRUs, (Mp,Np) = (2,8)  FR2:  - 2 TxRUs  Note: Companies to report the details if other antenna configurations are used. |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Updated based on comments |
| ZTE | OK |
| QC | Support |
| Xiaomi | We are fine with the proposal if majority companies are OK not to reuse the antenna configuration in SLS calibration in FR2. |
| New H3C | OK |
| Huawei, HiSilicon | Same comments as above. we suggest the antenna configuration is reported by companies. |
| Samsung | We are ok with the proposal. |
| Ericsson | We also prefer that the companies report the antenna configuration.   One thing that needs to be clarified is whether or not correction factors for the various antenna gain components will be used in the link budget analysis. |
| Intel | OK |

***Updated proposal 3-1-9a(Closed):***

The following table is used to collect companies’ link level evaluation results for coverage performance.

* Each company can input multiple groups of evaluation results, and each group corresponds to one kind of key assumptions, e.g., coverage enhancement schemes for SBFD, traffic load, etc.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| PUSCH-FR1-Urban Macro/ PUSCH-FR2-Dense Urban Macro | | | | | | |
| Company name | TDD/SBFD | Required SNR | MCL | MIL | MPL | Key assumptions |
| Source X | TDD |  |  |  |  |  |
| SBFD w/o any enhancements |  |  |  |  |  |
| SBFD w/ enhancements reported by companies |  |  |  |  |  |
| Gain of SBFD w/o any enhancements |  |  |  |  |  |
| Gain of SBFD w/ enhancements |  |  |  |  |  |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Updated based on comments |
| ZTE | We think the further separation may be confusing and companies may have different understandings on what belongs to “w/o enhancements” vs “w/ enhancements”. For example,   * whether PUSCH repetition across 4 X slots belongs to “w/o enhancements” or “w/ enhancements”? * whether PUSCH repetition across 4 X slots and 1 UL-only slot belongs to “w/o enhancements” or “w/ enhancements”? * whether PUSCH repetition across 4 X slots with joint channel estimination belongs to “w/o enhancements” or “w/ enhancements”? * whether PUSCH repetition across 4 X slots and 1 UL-only slot with joint channel estimination belongs to “w/o enhancements” or “w/ enhancements”?   We think the previous table is good as long as companies can report the detailed schemes that they simulated, that’s sufficient. |
| QC | We prefer the earlier templete and Echo ZTE comment. If companies have specific enahcnement, it can be reported. However, it should’t be a baseline in the template. |
| Xiaomi | We have similar view with QC. Companies can report the enhancement in the key assumptions. |
| New H3C | Slightly prefer previous template |
| Huawei, HiSilicon | Support |
| Samsung | We share the same view with ZTE/QC. The earlier templete seems simpler and enough to capure a specific enhancements in “Key assumptions” column. |
| Ericsson | Agree with ZTE, QC. Prefer the earlier template. |
| Intel | We have same view as ZTE and QC, and we rather prefer the prior template. If companies want to provide results with specific enhancements, they can always do so and can report them separately, as for many companies these entries would be left empty otherwise. |

* + 1. 3rd Round Proposals(Open)

***Updated proposal 3-1-1b(Open):***

Regarding the Case 4 and Case 5 of schemes for PUSCH LLS coverage evaluation, two options are considered:

* Option 1 ~~(baseline)~~: joint channel estimation is applied only for the same symbol type
* Option 2: joint channel estimation is applied across SBFD and non-SBFD slots

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Support |

***Updated proposal 3-1-4b(Open):***

For LLS coverage evaluation, RAN1 should consider self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference in TDD system and SBFD system. One modelling method is as below:

* For TDD UL slot, additive white Gaussian noise with variance of is generated, where
  + is UE-gNB interference and is noise (in linear scale).
* For SBFD slot, additive white Gaussian noise with variance of is generated, where
  + ,, , are self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference (in linear scale), respectively
* Companies to report the details of deriving and . Some examples are as below:
  + Example-1: and are derived based on link budget analysis based on a certain assumption of the topology of gNBs and UEs ( is derived based on 1dB desense and is derived based on as agreed in last meeting).
  + Example-2: is derived based on statistic in SLS, and then is used in LLS to increase the Gaussian noise power in SBFD symbol compared to TDD UL symbol.
  + Companies to report the RU assumption for the interference.
* Note: For simplicity, the interference is independently updated/generated in each slot.

Based on the above modelling, the following high-level evaluation method can be used as an example for coverage performance evaluation:

* Step 1: For legacy TDD system, assume the SNR in UL only slot is , perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL
* Step 2: For SBFD system with frame structure XXXXU, assume the SNR in UL only slot is and the SNR in SBFD slot is . Perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL for a given SBFD coverage enhancement scheme (e.g., SBFD with PUSCH repetition type A, etc.)
* Step 3: Use Link budget template to obtain MPL, MCL and MIL for legacy TDD and SBFD.
  + For legacy TDD, the required SNR () obtained in Step 1 is used to calculate MPL, MCL, MIL.
  + For SBFD, the required SNR () obtained in Step 2 is used to calculate MPL, MCL, MIL.

Note: Other modelling methods for UE-gNB interference and inter-site gNB-gNB co-channel inter-subband CLI in LLS coverage evaluation (e.g., by explicitly modelling the topology of aggressor gNBs and gNB-gNB fast fading channels in LLS) are not precluded and can be reported by companies. One example is as below:

* is the received signal vector at the victim gNB
* is the channel matrix from target UE to gNB, is the transmitted signal of the target user
* , , are the channel matrix and transmitted signal of the UE in the same cell as the target user
* and are the channel matrix and transmitted signal of the UEs in the adjacent cell
* , and are the channel matrix, the precoding matrix, and leakage CLI signal from gNB to the victim gNB . The power of the signal and interference is included in the channel marix respectively
* and are the self-interference vector of the co-site sectors and the thermal noise signal vector on the receiving antennas

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | We still have some questions on the proposed simple model.   * + - 1. Regarding and , we would like to clarify a bit further. in example 1, it seems that the interferences are observed at each antenna port. Is this the correct understanding? It seems that we need to further align the assumptions for the link budget analysis. In example 2, it is not clear what statistic in SLS are actually being used, i.e., the interference observed at each antenna port before the receiver or the residual interference after the MMSE receiver as described in the contribution from the FL. One potential issue that companies may not be well aligned on the interference statistics.       2. Assuming and are the ones observed at each antenna port, the issue with the simple model is that interference suppression cannot be done at gNB receiver since they are modelled as Gaussian white noise. One may anticipate that the SNR-BLER curves for difference cases are shifted versions of each other depending on the interference power level. This is clearly not the case in practice where the interference can be suppressed.       3. As replied earlier, if we follow the simple model, the performance of SBFD with repetitions would be dependent on the power level of legacy UE-gNB CLI and inter-gNB CLI. Assuming they have the same level, the performance degradation is about 3dB. Considering XXXXU, there is at maximum 10\*log10(0.5\*4+1)=4.7 dB coverage gain over legacy TDD. If the inter-gNB interference is higher and further consider channel estimation accuracy and implementation margins, the coverage gain will be reduced even further. In the end, we are not sure how SBFD can be motivated considering the significant complexity. In contrast, with our proposed model, the UL coverage gain can still be obtained even when the inter-gNB CLI is high as long as the interference can be effectively suppressed (not possible in the simple model).   Therefore, we would like to propose the following model:  The UE-gNB interference and inter-site gNB-gNB co-channel inter-subband CLI in LLS coverage evaluation are explicitly modelled based on a given topology of aggressor UEs and gNBs. The UE-gNB and gNB-gNB fast fading channels are explicitly modelled in LLS. The signal model is as follows     * is the received signal vector at the victim gNB * is the channel matrix from target UE to gNB, is the transmitted signal of the target user * , , are the channel matrix and transmitted signal of the UE in the same cell as the target user * and are the channel matrix and transmitted signal of the UEs in the adjacent cell * , and are the channel matrix, the precoding matrix, and leakage CLI signal from gNB to the victim gNB . The power of the signal and interference is included in the channel marix respectively * and are the self-interference vector of the co-site sectors and the thermal noise signal vector on the receiving antennas   Companies to report the topology of gNBs and UEs to derive the detailed signals and interferences above. One example is as below    Based on the above modelling, the following high-level evaluation method can be used as an example for coverage performance evaluation:   * Step 1: For legacy TDD system, perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL * Step 2: For SBFD system with frame structure XXXXU, perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL for a given SBFD coverage enhancement scheme (e.g., SBFD with PUSCH repetition type A, etc.) * Step 3: Use Link budget template to obtain MPL, MCL and MIL for legacy TDD and SBFD.   + For legacy TDD, the required SNR () obtained in Step 1 is used to calculate MPL, MCL, MIL.   + For SBFD, the required SNR () obtained in Step 2 is used to calculate MPL, MCL, MIL. |
|  |  |

***Updated proposal 3-1-5a (Open):***

Companies to report whether receiver blocking model is considered in link budget analysis or not.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Support |
|  |  |

***Updated proposal 3-1-7b(Open):***

Adopt the following evaluation assumptions for LLS for coverage performance evaluation.

Table X-1: General parameters for FR1

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario and frequency | Urban Macro: 4GHz |
| Frame structure for TDD | TDD: DDDSU (S: 10D:2G:2U)  SBFD: XXXXU, where X denotes SBFD slot.   * For SBFD slot, {DUD} pattern is assumed. * 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <104, 55, 5> |
| Target data rates for eMBB | UL 1Mbps |
| Pathloss model (select from LoS or NLoS) | gNB-UE: NLOS  gNB-gNB (if modelled in LLS): LOS: NLOS = 3:1 |
| BWP | 100MHz |
| Channel model for link-level simulation | gNB-UE: TDL-C, CDL-C  Note: Company can provide simulation results based on either TDL channel or CDL model  Note: Companies can report gNB-gNB channel model if modelled in LLS. |
| Delay spread | 300ns  Note: Other values can be reported by companies. |
| UE velocity | 3km/h for indoor |
| Number of antenna elements for BS | SBFD antenna configuration option-2,  - 192 antenna elements  - (M,N,P,Mg,Ng) = (12,8,2,1,1)  - (optional) 128 antenna elements  - (M,N,P,Mg,Ng) = (8,8,2,1,1)  - Note: it is the same for both SBFD and non-SBFD slots  Note: Companies to report the details if other antenna configurations are used. |
| Number of TxRUs for BS | gNB architectures to study:  SBFD antenna configuration option-2,  - 64 TxRUs  - Note: it is the same for both SBFD and non-SBFD slots  Note: Companies to report the details if other antenna configurations are used.  gNB modelling in LLS for TDL:  - Option 1: 2 or 4 gNB RF chains in LLS.  - Option 2 (Optional): Number of gNB RF chains = number of TXRUs in LLS.  - Companies can report if and how correlation is modelled. |

Table X-2: Channel-specific parameters for PUSCH for FR1

|  |  |
| --- | --- |
| Parameter | Value |
| Frequency hopping | w/ or w/o frequency hopping |
| BLER | For eMBB, w/ HARQ, 10% iBLER; w/o HARQ, 10% iBLER. |
| Number of UE transmit chains | 1, 2 (optional) |
| DMRS configuration | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.  For frequency hopping: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. |
| Waveform | DFT-s-OFDM |
| SCS | 30kHz |
| PUSCH duration | 14 OS |
| HARQ configuration | For eMBB, whether HARQ is adopted is reported by companies.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| PRBs/TBS/MCS for eMBB | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use 30 PRBs for 1Mbps as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |

Table X-3: General parameters for FR2

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario and frequency | Dense Urban Macro: 30GHz |
| Frame structure for TDD | TDD: DDDSU (S: 10D:2G:2U)  SBFD: XXXXU where X denotes SBFD slot.   * For SBFD slot, {DUD} pattern is assumed, * 200MHz channel bandwidth and 120kHz SCS (132 PRB): < ND, NU, NG > = <52, 26, 1> |
| Target data rates for eMBB | UL: 5Mbps |
| BWP | ~~100MHz~~ 200MHz |
| Pathloss model (select from LoS or NLoS) | gNB-UE: NLOS  gNB-gNB (if modelled in LLS): LOS: NLOS = 3:1 |
| Channel model for link-level simulation | gNB-UE: CDL- A, TDL-A  Note: Company can provide simulation results based on either TDL channel or CDL model  Note: Companies can report gNB-gNB channel model if modelled in LLS. |
| Delay spread | 100ns  Note: Other values can be reported by companies. |
| UE velocity | 30 km/h for outdoor |
| Number of antenna elements for BS | SBFD antenna configuration option-2,  256 antenna elements  (M,N,P,Mg,Ng) = (16,8,2,1,1)  Note: it is the same for both SBFD and non-SBFD slots |
| Number of TxRUs for BS | 2  Note: Analog beamforming is assumed. |
| Number of UE antenna elements | 8, one panel:(M, N, P) = (2,2,2) |

Table X-4: Channel-specific parameters for PUSCH for FR2

|  |  |
| --- | --- |
| Parameter | Value |
| Frequency hopping | w/ or w/o frequency hopping |
| BLER | For eMBB,  w/ HARQ, 10% iBLER, Optional: companies report iBLER.  w/o HARQ, 10% iBLER. |
| Number of UE Tx/Rx chains | 1T2R, 2T2R |
| DMRS configuration | For 30km/h: Type I, 2 or 3 DMRS symbol, no multiplexing with data.  For frequency hopping for PUSCH: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH/PDSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. |
| Waveform | DFT-s-OFDM |
| SCS | 120kHz. |
| PUSCH duration | 14 OS |
| HARQ configuration | For eMBB, whether HARQ is adopted is reported by companies.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| PRBs/TBS/MCS for eMBB | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use ~~30~~ 26 PRBs for 5Mbps for PUSCH as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | The basic principle is to reuse the assumptions in TR38.830 as much as possible.  Based on comments, I changed the antenna configurations back. I hope it is fine, since anyway we have a note “Companies to report the details if other antenna configurations are used.”  @Ericsson,  1. I think UE Tx power assumption is in the link budget template  2. “Pathloss model (select from LoS or NLoS)” is from TR38.830, it basically refers to whether NLOS or LOS is used for gNB-UE link in LLS.  3. I understand your point, since we only consider uplink here, so the BS antennas can be considered as BS receive antennas and UE antennas can be considered as UE transmit antennas. I think everyone understands. |
| Huawei, HiSilicon | We can decide whether TDL channel model can be used after the decision on proposal 3-1-4b. |

***Initial proposal 3-1-8(Open):***

For coverage performance evaluation for SBFD, the link budget template in Table A.3 in TR 38.830 is reused with the following modifications.

|  |  |
| --- | --- |
| (10) Number of receive antenna elements | SBFD antenna configuration option-2,  FR1:  - 192 antenna elements  - (M,N,P,Mg,Ng) = (12,8,2,1,1)  - (optional) 128 antenna elements  - (M,N,P,Mg,Ng) = (8,8,2,1,1)  FR2:  - 256 antenna elements  - (M,N,P,Mg,Ng) = (16,8,2,1,1)  Note: Companies to report the details if other antenna configurations are used. |
| (10a) Number of receive TxRUs | SBFD antenna configuration option-2,  FR1:  - 64 TxRUs  FR2:  - 2 TxRUs  Note: Companies to report the details if other antenna configurations are used. |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Based on comments, I changed the antenna configurations back. I hope it is fine, since anyway we have a note “Companies to report the details if other antenna configurations are used.” |
| Huawei, HiSilicon | Okay |

***Initial proposal 3-1-9 (Open):***

The following table is used to collect companies’ link level evaluation results for coverage performance.

* Each company can input multiple groups of evaluation results, and each group corresponds to one kind of key assumptions, e.g., coverage enhancement schemes for SBFD, traffic load, etc.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| PUSCH-FR1-Urban Macro/ PUSCH-FR2-Dense Urban Macro | | | | | | |
| Company name | TDD/SBFD | Required SNR | MCL | MIL | MPL | Key assumptions |
| Source 1 | TDD |  |  |  |  |  |
| SBFD |  |  |  |  |
| Gain |  |  |  |  |
| Source X | TDD |  |  |  |  |  |
| SBFD |  |  |  |  |
| Gain |  |  |  |  |
| … | TDD |  |  |  |  |  |
| SBFD |  |  |  |  |
| Gain |  |  |  |  |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Hope companies can be OK with this one. Anyway, regarding SBFD w/o and w/ enhancements, companies can describe in the “Key assumptions” part and one companies can provide more than one rows in this table. I think it will be easy to accommodate Huawei’s request. |
|  |  |
|  |  |

## Issue#3-2: Others

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Ericsson (R1-2302769) | Observation 10: A coverage metric based on the pathloss corresponding to a given bit rate is a good metric for system level simulations as it considers realistic beamforming and CLI (Option 2), unlike the MPL obtained from link budget analysis (Option 1 and Option 3).  Proposal 15: RAN1 to adopt the proposed methodology for calculating 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 in FR1 and 25 Mbps for DL and 5 Mbps for UL in FR2. This is called “10 Mbps coverage” for DL, “1 Mbps coverage” for UL, etc. (Option 2 in the proposal discussed in RAN1 #110)  Observation 1: It is not necessary to perform link level simulations using separate models for DPD and PA.  Proposal 2: Adopt a net effect model for link-level simulations that captures the essential behaviors of a realistic DPD and PA combination with compliance to the base station ACLR requirements. This requires input from RAN4.  Proposal 3: Adopt a simple crest factor processing model, e.g., hard clipping + bandpass filtering, that captures the essential behaviors of a BS design to increase transmit power. This requires input from RAN4.  Proposal 4: The self-interference channel should be modeled as a set of tapped delay lines directly from TX sub-array ports to RX sub-array ports.  Proposal 5: Self-interference channel coefficients should be based on realistic setups supported by real measurements or high-fidelity electromagnetic (EM) evaluations.  Proposal 6: For both system and link level assessment of SBFD, proper modelling of advanced antennas as well as modelling of beamforming impact on the BS TX to RX isolation should be considered.  Observation 2: For FR2, using a structure with RF chokes, 80dB of isolation is achievable over a reasonable bandwidth. Unlike FR1, the isolation does not vary with beam steering.  Proposal 7: For both system level and link level assessment of SBFD, proper modelling of advanced antennas as well as modelling of beamforming impact on the inter-sector TX to RX isolation needs be considered. For the simple exemplary site setup we have simulated for FR1, we see Tx-panel-to-Rx-port isolation values in the range of 67 to 87 dB depending on the azimuth and elevation beam steering directions and the frequency within the band. These values would most likely degrade if other realistic effects are included, e.g., electronics on the backside of the antenna, equipment and other metallic objects between sectors in a practical site, the presence of sub-arrays, and the presence of radomes.  Proposal 8: For both system level and link level assessment of SBFD, proper modelling of advanced antennas as well as modelling of beamforming impact on the inter-sector TX to RX isolation needs be considered. For the simple exemplary site setup we have simulated for FR2, we see isolation values in the range of 72 to 95 dB depending on the azimuth and elevation beam steering directions and the frequency within the band. These values would most likely degrade if other realistic effects are included, e.g., electronics on the backside of the antenna, equipment and other metallic objects between sectors in a practical site, the presence of sub-arrays, and the presence of radomes.  Observation 3: The gain from beam nulling increases when the TX beam is steered and the antenna isolation decreases. Thus, beam nulling can to some extent reduce the variation of the overall spatial isolation due to beam steering. It may also reduce the frequency variation. However, there is a const in terms of reduced DL beam gain.  Observation 4: The cost of beam nulling in downlink can be substantial; we have observed up to 5dB DL power loss. There may be further DL losses due to lower degrees of freedom for MIMO operation.  Observation 5: When deciding beam nulling gains, downlink impacts should be considered.  Proposal 9: Adopt a third order representation model in RAN1 studies to capture the essential behaviors of typical high-gain low noise amplifiers (LNA) in BS receiver chains.  Observation 6: The interference power caused by reciprocal mixing of phase noise in a 40-20-40 MHz SBFD carrier is around -60 to -70 dBc depending on BS implementation.  Proposal 10: Adopt phase noise modelling in RAN1 studies to capture the distortion introduced by high power leakage from the DL sub-bands into the UL sub-bands. The phase noise models in TR 38.803 or those provided by RAN4 during the Rel-17 phase can be adopted as baseline models.  Proposal 11: Adopt modelling of analog filtering, if present, in RAN1 link level studies to capture potential impacts to digital cancellation feasibility and performance.  Observation 7: Adopt explicit digital filtering models in RAN1 link level studies to capture potential impacts to digital cancellation feasibility and performance.  Observation 8: The complexity of digital self-interference cancellation scales with the product of (1) the number of TX chains, (2) the number of RX chains and (3) the effective length of the multi-tap response of the environment and the analog RX frontends.  Proposal 12: RAN1 further agrees that interested companies may perform link-level simulations (LLS) for the purposes of evaluating SBFD performance and feasibility in both FR1 and FR2 including evaluation of the following:   1. Self-interference suppression/cancellation accounting for realistic non-linearities in the gNB transmit and receive chains. 2. Transmit beam nulling accounting for realistic non-linearities in the gNB transmit chain. |
| Qualcomm (R1-2303588) | Proposal 4: RAN1 to perform LLS for the evaluation of inter-UE CLI and study the effect of minimum UE distance, guardband and filtering on DL performance  **Observation 1: There is no 3GPP model for clutter modelling.**  **Observation 2: Exact clutter modelling is complicated and may take long time and efforts for discussion.**  **Observation 3: A statistical clutter model based on statistics of clutter strength and AoA is simple model.**  **Proposal 5: For subband full duplex deployment scenario, simplified statistical clutter modelling can be considered based on statistics of cluster power and AoA.**   * **Clutter is modelled per each serving gNB model and shall have no impact on other gNBs and UEs in the network.** |
| CATT (R1-2302701) | **Proposal 1: LLS for other purpose besides coverage** **performance evaluation is up to companies’ interests.** |
| Intel (R1-2302794) | **Proposal 2: It should be left up to companies to provide LLS simulations for purposes other than coverage performance.** |
|  |  |

### Summary

For FFS on the purposes other than coverage performance evaluation,

* [Qualcomm] suggests to perform LLS for the evaluation of inter-UE CLI and study the effect of minimum UE distance, guardband and filtering on DL performance
* [CATT, Intel] suggest LLS for other purpose besides coverage performance evaluation to be left up to companies’ interests

From moderator’s perspective, LLS for other purposes besides coverage performance evaluation can be left up to companies’ interests.

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

* + 1. 1st Round Proposals (Closed)

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

LLS for other purpose besides coverage performance evaluation is left up to companies’ interests.

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| ZTE | OK |
| Huawei, HiSilicon | OK. |
| Spreadtrum | OK |
| Xiaomi | We are fine with the proposal. |
| Intel | OK. |
| Ericsson | OK |
| QC | Support |
| Moderator | Seems Stable |

# Issue#4: Initial SLS evaluation results

## Issue#4-1: Format of capturing companies’ evaluation results

* + 1. Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| CMCC (R1-2303232) | ***Proposal 2:*** Companies are encouraged to upload evaluation results to the FTP draft folder with the link ([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))   * In the excel sheets, companies are encouraged to provide both assumptions and evaluation results. Each company can input multiple columns, and each column corresponds to one kind of assumption and the corresponding result * Regarding the performance metrics, it is recommended to at least provide Average-UPT CDF related metrics and Packet-Latency CDF related metrics for drawing conclusions, and other metrics (e.g., Tail-UPT, Median-UPT, UE-Average-Latency) are up to companies. In addition, it is also recommended to at least provide relative gains of SBFD compared to legacy TDD for UPT and latency related metrics, and the absolute values are up to companies * For each excel file, every time when update the results, companies are recommended to add one new row in the sheet named “Revision comments” to briefly indicate what changes have been made at this time   ***Proposal 3:*** For duplex evolution evaluation, the evaluation results are categorized into *X* sub-cases (as shown in below table for example) based on the different key assumptions. Each sub-case is based on one combination of key assumptions.   * Note: How many sub-cases will be determined and which assumptions will be used for the categorization can be discussed based on the final evaluation results and assumptions submitted by companies.   **Table X: Sub-cases for Urban Macro in FR1 in SBFD Deployment Case 1.**   |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Key assumptions**  **Sub-cases** | **Interference modelling**  (e.g., Co-site: Spatial isolation + digital isolation) | | | | **SBFD slot configuration** | | **BS transmit power** | | **SBFD antenna configuration** | | **Packet Size** | | **Sources** | | **75dB** | **93dB** | **100dB** | **100+10 dB** | **Alt-2: {DDDSU} vs. {XXXXU}** | **Alt-4:**  **{DDDSU} vs. {XXXXX}** | **53dBm** | **49dBm** | **Twice area&same TxRUs** | **Same area&same TxRUs** | **DL: 4Kbytes, UL: 1Kbyte** | **DL: 0.5Mbytes, UL: 0.125Mbyte** | | SBFD#1\_UMa\_FR1\_Sub#1 |  |  |  | ○ | ○ |  | ○ |  | ○ |  |  |  | Source [X], … | | SBFD#1\_UMa\_FR1\_Sub#2 |  |  |  | ○ |  | ○ | ○ |  | ○ |  |  |  | Source [X], … | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |   ***Proposal 4:*** For each sub-case, the performance gains of SBFD over legacy TDD are summarized (as shown in below table for example). For each performance metric, the {mean, <min~max>} is used to represent the mean value and the value range from the sources.  **Table-Y: Summary of results for sub-case XX.**   |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | ***Simple description for the sub-case (e.g., 100dB co-site inter-sector co-channel inter-subband isolation, SBFD Alt2, 49dBm gNB Tx power, Twice area&same TxRUs, DL: 4Kbytes, UL: 1Kbyte, UE clustering,…)*** | | | | | | | | | | | |  | | **DL and UL arrival rate for baseline static TDD**  **(Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | | | **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | | | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | | **DL Average-UPT (Mbps)** | **Mean** | {mean, <min~max>} = {3%, <-10%~20%>} |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL Average-UPT (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **DL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **DL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  | | **Type-2** |  |  |  |  |  |  |  |  |  | | **UL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  | | **Type-2** |  |  |  |  |  |  |  |  |  | | Note:   * For Average-UPT / Packet-Latency / RU, the gain can be calculated as: Gain (%) = | | | | | | | | | | |   ***Proposal 5:*** The following table is used to capture companies’ evaluation results in the Annex of TR 38.858. Companies are encouraged to provide evaluation results in their submitted contribution with the following table.  **Table D.1.2: Evaluation results for Urban Macro in FR1 in SBFD Deployment Case 1**   |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Tdoc/Source** | **Reported Parameters** | | **SBFD Alt 2: {DDDSU} vs. {XXXXU}**  **(UL/DL resource percentage in a TDD period = {XX%, YY%} for TDD, {ZZ%, MM%} for SBFD)** | | | | | | | | | | **DL and UL arrival rate for baseline static TDD**  **(Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | | | **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | | | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | | **DL Average-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **DL Tail-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **DL Median-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL Average-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL Tail-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL Median-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **DL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **DL UE- Average-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL UE- Average-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **Type-1 RU (%)** | **DL** |  |  |  |  |  |  |  |  |  | | **UL** |  |  |  |  |  |  |  |  |  | | **Type-2 RU (%)** | **DL** |  |  |  |  |  |  |  |  |  | | **UL** |  |  |  |  |  |  |  |  |  | | **Unfinished/dropped Packet Rate (%)** | **DL** |  |  |  |  |  |  |  |  |  | | **UL** |  |  |  |  |  |  |  |  |  | | Additional comments: e.g.,  **Layout and UE distribution**   * **Macro Layer:** e.g., Hexagonal grid with 7 macro sites and 3 sectors per site with wrap around * **UE distribution**: e.g., UE clustering distribution with M=20, X=2   **Interference Modelling**   * gNB self-interference: e.g., based on 1 dB UL desense * Co-site inter-sector co-channel inter-subband CLI: e.g., 100dB (spatial isolation), 10dB digital isolation * UE-UE co-channel inter-subband CLI: e.g., 33 dBc   **SBFD subband and slot configuration**   * SBFD slot configuration: Alt 2 (higher priority): Legacy TDD: {DDDSU}; SBFD: {XXXXU} * SBFD Subband configuration: e.g., <ND, NU, NG >=<104, 55, 5> * Guard symbol number: * UL resource percentage per TDD period (%): * DL resource percentage per TDD period (%):   **BS transmit power & antenna configuration**   * BS transmit power for legacy TDD: e.g., 53dBm * BS transmit power for SBFD: e.g., Option-1: Power boosting is not assumed for SBFD symbols compared to DL-only symbols (as in legacy systems) * BS antenna configuration for legacy TDD: e.g., (M,N,P,Mg,Ng;Mp,Np) = (8,8,2,1,1;2,8) , (dH,dV) = (0.5, 0.8)λ, +45°/-45° polarization * BS antenna configuration for SBFD: e.g., Twice area&same TxRUs (higher priority): SBFD antenna configuration Option 2 * BS antenna radiation pattern: e.g., Table 9 in Report ITU-R M.2412 * UE antenna configuration: e.g., 2Tx: (M,N,P,Mg,Ng;Mp,Np) = (1,1,2,1,1;1,1), (dH,dV) = (N/A, N/A)λ, 0°,90° polarization; 4Rx: (M,N,P,Mg,Ng;Mp,Np) = (1,2,2,1,1;1,2), (dH,dV) = (0.5, N/A)λ, 0°,90° polarization   **Traffic Model**   * DL/UL traffic assignment for the same UE: e.g., Option 2: Each UE is assigned both UL traffic and DL traffic * DL/UL FTP packet size: 4Kbytes for DL and 1Kbyte for UL   **Channel model**   * gNB-gNB: e.g., Both Large scale fading and small scale fading * UE-UE: e.g., Large scale fading only * UE-UE details: e.g., TR 38.901   **Others**   * Open loop power control parameters: e.g., P0= -80 dBm, alpha = 0.8 * UE receiver: e.g., MMSE-IRC * Channel estimation: e.g., Ideal * Transmission scheme: e.g., SU-MIMO * Overhead: | | | | | | | | | | | | **Tdoc/Source** | **Reported Parameters** | | **SBFD Alt 4: {DDDSU} vs. {XXXXX}**  **(UL/DL resource percentage in a TDD period = {XX%, YY%} for TDD, {ZZ%, MM%} for SBFD)** | | | | | | | | | | **DL and UL arrival rate for baseline static TDD**  **(Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | | | **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | | | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | | **DL Average-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **DL Tail-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **DL Median-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL Average-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL Tail-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL Median-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **DL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **DL UE- Average-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **UL UE- Average-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **50%** |  |  |  |  |  |  |  |  |  | | **95%** |  |  |  |  |  |  |  |  |  | | **Type-1 RU (%)** | **DL** |  |  |  |  |  |  |  |  |  | | **UL** |  |  |  |  |  |  |  |  |  | | **Type-2 RU (%)** | **DL** |  |  |  |  |  |  |  |  |  | | **UL** |  |  |  |  |  |  |  |  |  | | **Unfinished/dropped Packet Rate (%)** | **DL** |  |  |  |  |  |  |  |  |  | | **UL** |  |  |  |  |  |  |  |  |  | | Additional comments: e.g.,  **Layout and UE distribution**   * **Macro Layer:** e.g., Hexagonal grid with 7 macro sites and 3 sectors per site with wrap around * **UE distribution**: e.g., UE clustering distribution with M=20, X=2   **Interference Modelling**   * gNB self-interference: e.g., based on 1 dB UL desense * Co-site inter-sector co-channel inter-subband CLI: e.g., 100dB (spatial isolation), 10dB digital isolation * UE-UE co-channel inter-subband CLI: e.g., 33 dBc   **SBFD subband and slot configuration**   * SBFD slot configuration: Alt 4: Legacy TDD: {DDDSU}; SBFD: {XXXXX} * SBFD Subband configuration: e.g., <ND, NU, NG >=<104, 55, 5> * Guard symbol number: * UL resource percentage per TDD period (%): * DL resource percentage per TDD period (%):   **BS transmit power & antenna configuration**   * BS transmit power for legacy TDD: e.g., 53dBm * BS transmit power for SBFD: e.g., Option-1: Power boosting is not assumed for SBFD symbols compared to DL-only symbols (as in legacy systems) * BS antenna configuration for legacy TDD: e.g., (M,N,P,Mg,Ng;Mp,Np) = (8,8,2,1,1;2,8) , (dH,dV) = (0.5, 0.8)λ, +45°/-45° polarization * BS antenna configuration for SBFD: e.g., Twice area&same TxRUs (higher priority): SBFD antenna configuration Option 2 * BS antenna radiation pattern: e.g., Table 9 in Report ITU-R M.2412 * UE antenna configuration: e.g., 2Tx: (M,N,P,Mg,Ng;Mp,Np) = (1,1,2,1,1;1,1), (dH,dV) = (N/A, N/A)λ, 0°,90° polarization; 4Rx: (M,N,P,Mg,Ng;Mp,Np) = (1,2,2,1,1;1,2), (dH,dV) = (0.5, N/A)λ, 0°,90° polarization   **Traffic Model**   * DL/UL traffic assignment for the same UE: e.g., Option 2: Each UE is assigned both UL traffic and DL traffic * DL/UL FTP packet size: 4Kbytes for DL and 1Kbyte for UL   **Channel model**   * gNB-gNB: e.g., Both Large scale fading and small scale fading * UE-UE: e.g., Large scale fading only * UE-UE details: e.g., TR 38.901   **Others**   * Open loop power control parameters: e.g., P0= -80 dBm, alpha = 0.8 * UE receiver: e.g., MMSE-IRC * Channel estimation: e.g., Ideal * Transmission scheme: e.g., SU-MIMO * Overhead: | | | | | | | | | | | |
|  |  |

* + 1. Summary

Before RAN1#112bis-e, an email discussion was kicked off to collect the duplex evaluation results. Companies are encouraged to upload evaluation results to the FTP draft folder with the link

([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))

* In the excel sheets, companies are encouraged to provide both assumptions and evaluation results. Each company can input multiple columns, and each column corresponds to one kind of assumption and the corresponding result
* Regarding the performance metrics, it is recommended to at least provide Average-UPT CDF related metrics and Packet-Latency CDF related metrics for drawing conclusions, and other metrics (e.g., Tail-UPT, Median-UPT, UE-Average-Latency) are up to companies. In addition, it is also recommended to at least provide relative gains of SBFD compared to legacy TDD for UPT and latency related metrics, and the absolute values are up to companies
* For each excel file, every time when update the results, companies are recommended to add one new row in the sheet named “Revision comments” to briefly indicate what changes have been made at this time

Based on the collected excel data, the evaluation results will be categorized into *X* sub-cases (as shown in below table for example) based on the different key assumptions. Each sub-case is based on one combination of key assumptions.

* Note: How many sub-cases will be determined and which assumptions will be used for the categorization can be discussed based on the final evaluation results and assumptions submitted by companies.

**Table X: Sub-cases for Urban Macro in FR1 in SBFD Deployment Case 1.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Key assumptions**  **Sub-cases** | **Interference modelling**  (e.g., Co-site: Spatial isolation + digital isolation) | | | | **SBFD slot configuration** | | **BS transmit power** | | **SBFD antenna configuration** | | **Packet Size** | | **Sources** |
| **75dB** | **93dB** | **100dB** | **100+10 dB** | **Alt-2: {DDDSU} vs. {XXXXU}** | **Alt-4:**  **{DDDSU} vs. {XXXXX}** | **53dBm** | **49dBm** | **Twice area&same TxRUs** | **Same area&same TxRUs** | **DL: 4Kbytes, UL: 1Kbyte** | **DL: 0.5Mbytes, UL: 0.125Mbyte** |
| SBFD#1\_UMa\_FR1\_Sub#1 |  |  |  | ○ | ○ |  | ○ |  | ○ |  |  |  | Source [X], … |
| SBFD#1\_UMa\_FR1\_Sub#2 |  |  |  | ○ |  | ○ | ○ |  | ○ |  |  |  | Source [X], … |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

For each sub-case, the performance gains of SBFD over legacy TDD are summarized in table-Y as an example.

**Table-Y: Summary of results for sub-case XX.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Simple description for the sub-case (e.g., 100dB inter-sector isolation, SBFD Alt2, Twice area&same TxRUs, DL: 4Kbytes, UL: 1Kbyte,…)*** | | | | | | | | | | |
|  | | **DL and UL arrival rate for baseline static TDD**  **(Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) |
| **DL Average-UPT (Mbps)** | **Mean** | Source1: xx  Source2: xx  Source3: xx | Source1: xx  Source2: xx  Source3: xx | Source1: xx%  Source2: xx%  Source3: xx% |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **UL Average-UPT (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **DL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **UL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **DL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  |
| **Type-2** |  |  |  |  |  |  |  |  |  |
| **UL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  |
| **Type-2** |  |  |  |  |  |  |  |  |  |
| Note:   * For Average-UPT / Packet-Latency / RU, the gain can be calculated as: Gain (%) = | | | | | | | | | | |

Furthermore, the following table can be used to capture companies’ evaluation results in the Annex of TR 38.858. Companies are encouraged to provide evaluation results in their submitted contribution with the following table.

**Table D.1.2: Evaluation results for Urban Macro in FR1 in SBFD Deployment Case 1**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tdoc/Source** | **Reported Parameters** | | **SBFD Alt 2: {DDDSU} vs. {XXXXU}**  **(UL/DL resource percentage in a TDD period = {XX%, YY%} for TDD, {ZZ%, MM%} for SBFD)** | | | | | | | | |
| **DL and UL arrival rate for baseline static TDD**  **(Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) |
| **DL Average-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **DL Tail-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **DL Median-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **UL Average-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **UL Tail-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **UL Median-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **DL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **DL UE- Average-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **UL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **UL UE- Average-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **Type-1 RU (%)** | **DL** |  |  |  |  |  |  |  |  |  |
| **UL** |  |  |  |  |  |  |  |  |  |
| **Type-2 RU (%)** | **DL** |  |  |  |  |  |  |  |  |  |
| **UL** |  |  |  |  |  |  |  |  |  |
| **Unfinished/dropped Packet Rate (%)** | **DL** |  |  |  |  |  |  |  |  |  |
| **UL** |  |  |  |  |  |  |  |  |  |
| Additional comments: e.g.,  **Layout and UE distribution**   * **Macro Layer:** e.g., Hexagonal grid with 7 macro sites and 3 sectors per site with wrap around * **UE distribution**: e.g., UE clustering distribution with M=20, X=2   **Interference Modelling**   * gNB self-interference: e.g., based on 1 dB UL desense * Co-site inter-sector co-channel inter-subband CLI: e.g., 100dB (spatial isolation), 10dB digital isolation * UE-UE co-channel inter-subband CLI: e.g., 33 dBc   **SBFD subband and slot configuration**   * SBFD slot configuration: Alt 2 (higher priority): Legacy TDD: {DDDSU}; SBFD: {XXXXU} * SBFD Subband configuration: e.g., <ND, NU, NG >=<104, 55, 5> * Guard symbol number: * UL resource percentage per TDD period (%): * DL resource percentage per TDD period (%):   **BS transmit power & antenna configuration**   * BS transmit power for legacy TDD: e.g., 53dBm * BS transmit power for SBFD: e.g., Option-1: Power boosting is not assumed for SBFD symbols compared to DL-only symbols (as in legacy systems) * BS antenna configuration for legacy TDD: e.g., (M,N,P,Mg,Ng;Mp,Np) = (8,8,2,1,1;2,8) , (dH,dV) = (0.5, 0.8)λ, +45°/-45° polarization * BS antenna configuration for SBFD: e.g., Twice area&same TxRUs (higher priority): SBFD antenna configuration Option 2 * BS antenna radiation pattern: e.g., Table 9 in Report ITU-R M.2412 * UE antenna configuration: e.g., 2Tx: (M,N,P,Mg,Ng;Mp,Np) = (1,1,2,1,1;1,1), (dH,dV) = (N/A, N/A)λ, 0°,90° polarization; 4Rx: (M,N,P,Mg,Ng;Mp,Np) = (1,2,2,1,1;1,2), (dH,dV) = (0.5, N/A)λ, 0°,90° polarization   **Traffic Model**   * DL/UL traffic assignment for the same UE: e.g., Option 2: Each UE is assigned both UL traffic and DL traffic * DL/UL FTP packet size: 4Kbytes for DL and 1Kbyte for UL   **Channel model**   * gNB-gNB: e.g., Both Large scale fading and small scale fading * UE-UE: e.g., Large scale fading only * UE-UE details: e.g., TR 38.901   **Others**   * Open loop power control parameters: e.g., P0= -80 dBm, alpha = 0.8 * UE receiver: e.g., MMSE-IRC * Channel estimation: e.g., Ideal * Transmission scheme: e.g., SU-MIMO * Overhead: | | | | | | | | | | |

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

* + 1. 1st Round Proposals (Closed)

***Initial proposal 4-1-1 (Suspended):***

The following table-Z (as an example) is used to capture companies’ detailed evaluation results in the Annex of TR 38.858. Companies are encouraged to provide evaluation results in their submitted contribution with the following table.

**Table-Z: Evaluation results for Urban Macro in FR1 in SBFD Deployment Case 1**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Tdoc/Source** | **Reported Parameters** | | **SBFD Alt 2: {DDDSU} vs. {XXXXU}**  **(UL/DL resource percentage in a TDD period = {XX%, YY%} for TDD, {ZZ%, MM%} for SBFD)** | | | | | | | | |
| **DL and UL arrival rate for baseline static TDD**  **(Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) |
| **DL Average-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **DL Tail-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **DL Median-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **UL Average-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **UL Tail-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **UL Median-UPT CDF (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **DL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **DL UE- Average-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **UL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **UL UE- Average-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **95%** |  |  |  |  |  |  |  |  |  |
| **Type-1 RU (%)** | **DL** |  |  |  |  |  |  |  |  |  |
| **UL** |  |  |  |  |  |  |  |  |  |
| **Type-2 RU (%)** | **DL** |  |  |  |  |  |  |  |  |  |
| **UL** |  |  |  |  |  |  |  |  |  |
| **Unfinished/dropped Packet Rate (%)** | **DL** |  |  |  |  |  |  |  |  |  |
| **UL** |  |  |  |  |  |  |  |  |  |
| Additional comments: e.g.,  **Layout and UE distribution**   * **Macro Layer:** e.g., Hexagonal grid with 7 macro sites and 3 sectors per site with wrap around * **UE distribution**: e.g., UE clustering distribution with M=20, X=2   **Interference Modelling**   * gNB self-interference: e.g., based on 1 dB UL desense * Co-site inter-sector co-channel inter-subband CLI: e.g., 100dB (spatial isolation), 10dB digital isolation * UE-UE co-channel inter-subband CLI: e.g., 33 dBc   **SBFD subband and slot configuration**   * SBFD slot configuration: Alt 2 (higher priority): Legacy TDD: {DDDSU}; SBFD: {XXXXU} * SBFD Subband configuration: e.g., <ND, NU, NG >=<104, 55, 5> * Guard symbol number: * UL resource percentage per TDD period (%): * DL resource percentage per TDD period (%):   **BS transmit power & antenna configuration**   * BS transmit power for legacy TDD: e.g., 53dBm * BS transmit power for SBFD: e.g., Option-1: Power boosting is not assumed for SBFD symbols compared to DL-only symbols (as in legacy systems) * BS antenna configuration for legacy TDD: e.g., (M,N,P,Mg,Ng;Mp,Np) = (8,8,2,1,1;2,8) , (dH,dV) = (0.5, 0.8)λ, +45°/-45° polarization * BS antenna configuration for SBFD: e.g., Twice area&same TxRUs (higher priority): SBFD antenna configuration Option 2 * BS antenna radiation pattern: e.g., Table 9 in Report ITU-R M.2412 * UE antenna configuration: e.g., 2Tx: (M,N,P,Mg,Ng;Mp,Np) = (1,1,2,1,1;1,1), (dH,dV) = (N/A, N/A)λ, 0°,90° polarization; 4Rx: (M,N,P,Mg,Ng;Mp,Np) = (1,2,2,1,1;1,2), (dH,dV) = (0.5, N/A)λ, 0°,90° polarization   **Traffic Model**   * DL/UL traffic assignment for the same UE: e.g., Option 2: Each UE is assigned both UL traffic and DL traffic * DL/UL FTP packet size: 4Kbytes for DL and 1Kbyte for UL   **Channel model**   * gNB-gNB: e.g., Both Large scale fading and small scale fading * UE-UE: e.g., Large scale fading only * UE-UE details: e.g., TR 38.901   **Others**   * Open loop power control parameters: e.g., P0= -80 dBm, alpha = 0.8 * UE receiver: e.g., MMSE-IRC * Channel estimation: e.g., Ideal * Transmission scheme: e.g., SU-MIMO * Overhead:   Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1 - For Latency, the gain can be calculated as: Gain (%) = SBFD latency / TDD latency - 1 - For RU, the gain can be calculated as: Gain (%) = SBFD RU (%) – TDD RU (%) | | | | | | | | | | |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We support the proposal. |
| Samsung | We are ok with the proposal except “**(UL/DL resource percentage in a TDD period = {XX%, YY%} for TDD, {ZZ%, MM%} for SBFD)**” See the comment on the proposal 2-2-2 |
| ZTE | One question for clarification. It seems the information in this table is duplicated with the info in the spreadsheet that rapporteur used to collect companies’ input. In the end, will both the above table and the spreadsheet be captured in the TR? If yes, then it seems these info is duplicated. |
| Huawei, HiSilicon | We are fine with the template.  The “addition comments” part are not clear to us. Some assumptions have been agreed in previous meetings, e.g., Layout and UE distribution, etc., and some other assumptions are reported by companies, e.g., BS antenna configuration, receiver, channel estimation, transmission scheme, etc. |
| Fujitsu | Support. |
| Spreadtrum | We are generally fine with this proposal. Does “UE-UE co-channel inter-subband CLI: e.g., 33 dBc” in “addition comments ” mean the value of ICSUE in UE-UE co-channel inter-subband CLI modelling not the value of UE-UE co-channel inter-subband CLI which should be obtained by CLI modelling in previous agreement. |
| Xiaomi | We are fine with the proposal. |
| Intel | We have couple comments:   * Suggest discussing whether we need to collect values in a table format. In our view, it may be more informative and insightful to provide the whole CDF, and then superimpose results from different sources. * The four metrics are quite coupled, for example, throughput is inversely proportional to delay since packet sizes are fixed, and also packet statistics vs UE average statistics is not fundamentally different. Capturing similar metrics complicates drawing conclusions. We suggest downselecting for example two metrics. |
| Ericsson | We propose to keep the table for summary of companies’ evaluations (Proposal 4.1-2) as the main table.  This table can be submitted in an excel sheet which can be attached to the TR. This keeps the TR short without any duplication of the tables. |
| Nokia/NSB | Fine with the way of collecting the results but agree with ZTE on potential duplication of information. |
| Sony | Support the proposal. |
| QC | Fine with the template |
| Moderator | My original intention is to capture each company’s submitted evaluation results in Annex of TR 38.858 using this table format, but indeed it is duplicated with the excel sheet used for collecting results. Considering companies will provide their evaluation results in the excel sheet which can be attached to the TR, we can leave this proposal. This keeps the TR short without any duplication of the tables. |

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

For summary of companies’ SLS evaluation results for SBFD in the TR, the evaluation results are categorized into *X* sub-cases (as shown in below table-X for example) based on the different key assumptions. Each sub-case is based on one combination of key assumptions.

* Note: How many sub-cases will be determined and which assumptions will be used for the categorization will be discussed and determined based on the final evaluation results and assumptions submitted by companies.

**Table X: Sub-cases for Urban Macro in FR1 in SBFD Deployment Case 1.**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Key assumptions**  **Sub-cases** | **Interference modelling**  (e.g., Co-site: Spatial isolation + digital isolation) | | | | **SBFD slot configuration** | | **BS transmit power** | | **SBFD antenna configuration** | | **Packet Size** | | **Sources** | |
| **75dB** | **93dB** | **100dB** | **100+10 dB** | **Alt-2: {DDDSU} vs. {XXXXU}** | **Alt-4:**  **{DDDSU} vs. {XXXXX}** | **53dBm** | **49dBm** | **Twice area&same TxRUs** | **Same area&same TxRUs** | **DL: 4Kbytes, UL: 1Kbyte** | **DL: 0.5Mbytes, UL: 0.125Mbyte** |  |
| SBFD#1\_UMa\_FR1\_Sub#1 |  |  |  | ○ | ○ |  | ○ |  | ○ |  |  |  | Source [X], … |
| SBFD#1\_UMa\_FR1\_Sub#2 |  |  |  | ○ |  | ○ | ○ |  | ○ |  |  |  | Source [X], … |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |

For each sub-case, the performance gains of SBFD over legacy TDD are summarized in table-Y as an example.

**Table-Y: Summary of results for sub-case XX.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Simple description for the sub-case (e.g., 100dB inter-sector isolation, SBFD Alt2, Twice area&same TxRUs, DL: 4Kbytes, UL: 1Kbyte,…)*** | | | | | | | | | | |
|  | | **DL and UL arrival rate for baseline static TDD**  **(Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) |
| **DL Average-UPT (Mbps)** | **Mean** | Source1: xx  Source2: xx  Source3: xx | Source1: xx  Source2: xx  Source3: xx | Source1: xx%  Source2: xx%  Source3: xx% |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **UL Average-UPT (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **DL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **UL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **DL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  |
| **Type-2** |  |  |  |  |  |  |  |  |  |
| **UL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  |
| **Type-2** |  |  |  |  |  |  |  |  |  |
| Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1 - For Latency, the gain can be calculated as: Gain (%) = SBFD latency / TDD latency - 1 - For RU, the gain can be calculated as: Gain (%) = SBFD RU (%) – TDD RU (%) | | | | | | | | | | |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We agree with this proposal, but we have one question. Both table Y and Z appear to be about evaluation results. However, what is the difference between the two? |
| Samsung | Basically ok with the proposal.  A few remarks are   * For latency, the derived value from the equation, “SBFD latency / TDD latency -1” is not gain actually. (For instance, when SBFD latency is double or TDD latency, we have 100% latency gain from the equation). The value is just difference between SBFD latency and TDD latency. * For RU, the higher RU is considered as gain, but we think that lower RU is good from system-perspective. * The table prioritizes mean and 5%-tile only. For 50% and 95%, we will not make a summary table, right? |
| ZTE | OK |
| Huawei, HiSilicon | We suggest to add some additional columns to Table-X as follows:   * “Antenna radiation pattern” with “3GPP antenna radiation pattern” and “Realistic antenna radiation pattern”. We have performed some evaluations and found that there is a significant difference between the simulations results with 3GPP antenna radiation pattern and realistic antenna radiation pattern. We would like to encourage companies to take a look at the impact of this as well. * “Channel estimation” with “Ideal channel estimation” and “Realistic channel estimation”. We found that the impact of the channel estimation is quite significant especially on SBFD UL performance. We would like to encourage companies to take a look at the impact of this as well. |
| Xiaomi | We are fine with the proposal. |
| Intel | See comments above. |
| Ericsson | We generally support this proposal.   We would like to add “Coverage gain from SLS” as an optional row in the table as we will provide Coverage metric using SLS and not LLS.   |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | ***Simple description for the sub-case (e.g., 100dB inter-sector isolation, SBFD Alt2, Twice area&same TxRUs, DL: 4Kbytes, UL: 1Kbyte,…)*** | | | | | | | | | | | |  | | **DL and UL arrival rate for baseline static TDD**  **(Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | | | **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | | | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | | **DL Average-UPT (Mbps)** | **Mean** | Source1: xx  Source2: xx  Source3: xx | Source1: xx  Source2: xx  Source3: xx | Source1: xx%  Source2: xx%  Source3: xx% |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **UL Average-UPT (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **DL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **UL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  | | **5%** |  |  |  |  |  |  |  |  |  | | **DL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  | | **Type-2** |  |  |  |  |  |  |  |  |  | | **UL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  | | **Type-2** |  |  |  |  |  |  |  |  |  | | **DL Coverage (optional)** | **10 Mbps(FR1)/25 Mbps (FR2)** |  |  |  |  |  |  |  |  |  | | **UL Coverage (optional)** | **1 Mbps (FR1)/5Mbps(FR2)** |  |  |  |  |  |  |  |  |  | | Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1 - For Latency, the gain can be calculated as: Gain (%) = SBFD latency / TDD latency - 1 - For RU, the gain can be calculated as: Gain (%) = SBFD RU (%) – TDD RU (%) | | | | | | | | | | | |
| Sony | Support the proposal. |
| QC | The median 50% UPT is missing in the table.  Also, agree with Ericsson comment to add at least UL coverage metric based on SLS. |

* + 1. 2nd Round Proposals (Closed)

***Updated proposal 4-1-2a (Closed):***

For summary of companies’ SLS evaluation results for SBFD in the TR, the evaluation results are categorized into *X* sub-cases (as shown in below table-X for example) based on the different key assumptions. Each sub-case is based on one combination of key assumptions.

* Note: How many sub-cases will be determined and which assumptions will be used for the categorization will be discussed and determined based on the final evaluation results and assumptions submitted by companies.

**Table X: Sub-cases for Urban Macro in FR1 in SBFD Deployment Case 1.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sub-cases**  **Key assumptions** | | **SBFD#1\_UMa\_FR1\_Sub#1** | **SBFD#1\_UMa\_FR1\_Sub#2** | **…** |  |
| **Co-site inter-sector**  **CLI modelling**  **(Spatial isolation + digital isolation)** | **75dB** |  |  |  |  |
| **93dB** |  |  |  |  |
| **100dB** | √ | √ |  |  |
| **…** |  |  |  |  |
| **SBFD slot configuration** | **Alt-2: {DDDSU} vs. {XXXXU}** | √ |  |  |  |
| **Alt-4:{DDDSU} vs. {XXXXX}** |  | √ |  |  |
| **…** |  |  |  |  |
| **BS transmit power** | **53dBm** |  |  |  |  |
| **49dBm** | √ | √ |  |  |
| **SBFD antenna configuration** | **Twice area&same TxRUs** | √ | √ |  |  |
| **Same area&same TxRUs** |  |  |  |  |
| **…** |  |  |  |  |
| **Packet Size** | **DL: 4Kbytes, UL: 1Kbyte** | √ | √ |  |  |
| **DL: 0.5Mbytes, UL: 0.125Mbyte** |  |  |  |  |
| **…** |  |  |  |  |
| **BS Antenna radiation pattern** | **3GPP antenna radiation pattern** | √ | √ |  |  |
| **Realistic antenna radiation pattern** |  |  |  |  |
| **…** | **…** |  |  |  |  |
| **…** |  |  |  |  |
| **Sources** | | Source [X], Source [Y]… | Source [X], Source [Y]… |  |  |

For each sub-case, the performance of SBFD and legacy TDD are summarized in table-Y as an example.

**Table-Y: Summary of results for sub-case XX.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Simple description for the sub-case (e.g., 100dB inter-sector isolation, SBFD Alt2, Twice area&same TxRUs, DL: 4Kbytes, UL: 1Kbyte,…)*** | | | | | | | | | | |
|  | | **DL and UL arrival rate for baseline static TDD**  **(Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase |
| **DL Average-UPT (Mbps)** | **Mean** | Source1: xx  Source2: xx  Source3: xx | Source1: xx  Source2: xx  Source3: xx | Source1: xx%  Source2: xx%  Source3: xx% |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **UL Average-UPT (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **DL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **UL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **DL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  |
| **Type-2** |  |  |  |  |  |  |  |  |  |
| **UL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  |
| **Type-2** |  |  |  |  |  |  |  |  |  |
| **DL Coverage based on SLS (optional)** | **MPL(dB)** |  |  |  |  |  |  |  |  |  |
| **UL Coverage based on SLS (optional)** | **MPL(dB)** |  |  |  |  |  |  |  |  |  |
| Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1  - For Latency, the increase can be calculated as: Increase (%) = SBFD latency / TDD latency - 1  - For RU, the increase can be calculated as: Increase (%) = SBFD RU (%) - TDD RU (%)  - For optional DL/UL Coverage based on SLS, Gain (dB)= SBFD MPL - TDD MPL | | | | | | | | | | |

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Moderator | Updated based on comments. Several explanations:   * The format of Table X is changed, which I think is easier for read and capture potential multiple sub-cases. * Table X is just for example, more rows may be added or some rows may be deleted based on companies’ results. As the note says, how many sub-cases will be determined and which assumptions will be used for the categorization will be discussed and determined based on the final evaluation results and assumptions submitted by companies.   @Samsung, yes, the table prioritizes mean and 5%-tile only. For 50% and 95%, my current plan is not to make a summary table, but they will be captured in the excel sheet. But we can further discuss if more companies think it is necessary to make summary for 50% and 95% based on companies’ submitted results. |
| ZTE | Issue#1:  Regarding the newly added row “3GPP antenna radiation pattern” and “Realistic antenna radiation pattern”, it is not clear what the detailed Realistic antenna radiation pattern” refers to at this stage. More clarification is needed.  Issue#2:  Regarding the newly added “DL Coverage based on SLS (optional)” and “UL Coverage based on SLS (optional)” in table Y, our previous understanding is that table Y is used to collect companies’ simulation results that are “mandatory” or interested by majority companies. However, “DL Coverage based on SLS (optional)” and “UL Coverage based on SLS (optional)” are clearly optional metrics which can be captured in the spreadsheet provided by moderator to collect companies simulation results, instead of capturing them in the table Y. |
| QC | We think that Table-X should reflect the down-selected parameters as agreed in RAN1 #112.   * Packet size (Small, large) * SBFD slot configuration (Alt 2, Alt 4) * Load: Low,Medium and high * Reported value of alpha and alpha\_cosite. * Tx Power (49 or 53dBm)   Regarding antenna configuration and radiation pattern, baseline to follow optio-2 and 3GPP radiation pattern. If companies used different configuration, a note can be added.  For Table-Y, we think that at least 50% should be added to the table. Looking at the reported values for UMa where CDFs plot has large tails, there are quite variance in the %gain of mean vs median. |
| Spreadtrum | We agree with ZTE and want more clarification about “Realistic antenna radiation pattern”. |
| Xiaomi | We have similar view with QC. |
| New H3C | The motivation of added “Realistic antenna radiation pattern” isn’t clear to us and need be clarified. |
| Huawei, HiSilicon | On ZTE’s question on releastic antenna radiation pattern, in addition to the SLS result using the agreed BS antenna radiation pattern, we use another BS antenna radition pattern close to one deployed in the field. |
| Samsung | We understand the table is basically capture the baseline results. The “realistic antenna radiation pattern” is not a baseline so that whether to capture it is up to # of samples provided by companies. At this stage, we suggest to remove “realistic antenna radiation”  Also, regarding two rows, DL Coverage based on SLS (optional) and UL Coverage based on SLS (optional), these are also optional results. All optional cases may be captured separately. So, we also suggest to remove two rows and revisit whether these rows are needed or not after collecting results.  Regarding 50%-tile, and 95%-tile, our view is to include these in the table, but we are okay to include mean and 5%-tile in the table only. |
| LG | We have similar view with ZTE. We want to exclude optional categories in fundamental frame of table. |
| Ericsson | We need clarification on the previous proposal in 4-1-1 and perhaps, we misunderstood the FL’s intention. There needs to be a way for companies’ results to be caputured in the TR. The excel sheet can be appended in the Annex but companies’ individual results for different alternatives may not be captured sufficieintly in the TR if the proposal 4-1-1 is discarded. Therefore, we think that both the proposals 4-1-1 and 4-1-2 are valid and must be discussed.  Perhaps, we can discuss it over an offline session dedicated for this? We think this is important to align before we capture the results in the TR. The excel sheet can still be used to submit results from companies but we need to capture those results in the TR in a readable form. |
| Intel | Many thanks for accommodating one of our early comments. However, we still have concerns in capturing the results in format of a table, since many informative and insightful information would be lost compared to providing a whole CDF.  Example 1: UE average vs Per packet delay  We illustrated that for example packet delay vs UE-average packer delay has very similar gain numbers.   * 5% Packet delay gain: 0.29 vs UE average packet delay gain: 0.06 * 50% Packet delay gain: -0.12 vs UE average packet dela gain: -0.08 * 95% Packet delay gain: -0.17 vs Ue average packet delay gain: -0.14     Example 2: Delay vs Throughput   * 5% Packet delay gain: 0.29 vs 95% Throughput gain: -0.23 * 50% Packet delay gain: -0.12 vs 50% Throughput gain: 0.14 * 95% Packet delay gain: -0.17 vs 5% Throughput gain: 0.20   Since the proposed Gain calculation formula is the same for all metrics, throughput gain may be matched with delay gain as 1/(Gain + 1)-1, i.e., 1/(-0.12+1)-1 ~= 0.14.    From the above examples, analysing UE-average vs per packet statistics may not be insightful, thus the group can prioritize one of the metrics. Also, packet delay gains are inversely proportional to throughput gains, which is also not giving additional info.  Further, some longer tails around >95% and <5% are invisible in the table format. The group may consider capturing some selected metrics directly in CDF format, e.g. one of throughput or delay. |
| Moderator | This proposal was agreed as working assumption as below. |

***Working Assumption***

For summary of companies’ SLS evaluation results for SBFD in the TR, the evaluation results are categorized into *X* sub-cases (as shown in below table-X for example) based on the different key assumptions. Each sub-case is based on one combination of key assumptions.

* Note: How many sub-cases will be determined and which assumptions will be used for the categorization will be discussed and determined based on the final evaluation results and assumptions submitted by companies.

**Table X: Sub-cases for Urban Macro in FR1 in SBFD Deployment Case 1.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Sub-cases**  **Key assumptions** | | **SBFD#1\_UMa\_FR1\_Sub#1** | **SBFD#1\_UMa\_FR1\_Sub#2** | **…** |  |
| **Co-site inter-sector**  **CLI modelling**  **(Spatial isolation + digital isolation)** | **75dB** |  |  |  |  |
| **93dB** |  |  |  |  |
| **100dB** | √ | √ |  |  |
| **…** |  |  |  |  |
| **SBFD slot configuration** | **Alt-2: {DDDSU} vs. {XXXXU}** | √ |  |  |  |
| **Alt-4:{DDDSU} vs. {XXXXX}** |  | √ |  |  |
| **…** |  |  |  |  |
| **BS transmit power** | **53dBm** |  |  |  |  |
| **49dBm** | √ | √ |  |  |
| **SBFD antenna configuration** | **Twice area&same TxRUs** | √ | √ |  |  |
| **Same area&same TxRUs** |  |  |  |  |
| **…** |  |  |  |  |
| **Packet Size** | **DL: 4Kbytes, UL: 1Kbyte** | √ | √ |  |  |
| **DL: 0.5Mbytes, UL: 0.125Mbyte** |  |  |  |  |
| **…** |  |  |  |  |
| **…** | **…** |  |  |  |  |
| **…** |  |  |  |  |
| **Sources** | | Source [X], Source [Y]… | Source [X], Source [Y]… |  |  |

For each sub-case, the performance of SBFD and legacy TDD are summarized in table-Y as an example.

**Table-Y: Summary of results for sub-case XX.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Simple description for the sub-case (e.g., 100dB inter-sector isolation, SBFD Alt2, Twice area&same TxRUs, DL: 4Kbytes, UL: 1Kbyte, …)*** | | | | | | | | | | |
|  | | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase |
| **DL Average-UPT (Mbps)** | **Mean** | Source1: xx  Source2: xx  Source3: xx | Source1: xx  Source2: xx  Source3: xx | Source1: xx%  Source2: xx%  Source3: xx% |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **UL Average-UPT (Mbps)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **DL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **UL Packet-Latency CDF (ms)** | **Mean** |  |  |  |  |  |  |  |  |  |
| **5%** |  |  |  |  |  |  |  |  |  |
| **50%** |  |  |  |  |  |  |  |  |  |
| **DL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  |
| **Type-2** |  |  |  |  |  |  |  |  |  |
| **UL RU (%)** | **Type-1** |  |  |  |  |  |  |  |  |  |
| **Type-2** |  |  |  |  |  |  |  |  |  |
| **~~DL Coverage based on SLS (optional)~~** | **~~MPL(dB)~~** |  |  |  |  |  |  |  |  |  |
| **~~UL Coverage based on SLS (optional)~~** | **~~MPL(dB)~~** |  |  |  |  |  |  |  |  |  |
| Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1  - For Latency, the increase can be calculated as: Increase (%) = SBFD latency / TDD latency - 1  - For RU, the increase can be calculated as: Increase (%) = SBFD RU (%) - TDD RU (%)  ~~- For optional DL/UL Coverage based on SLS, Gain (dB)= SBFD MPL - TDD MPL~~ | | | | | | | | | | |

* 1. Issue#4-2: SLS evaluation results for SBFD Deployment Case 1
     1. Submitted proposal

#### **(higher priority) InH (FR1)**

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| CMCC (R1-2303232) | ***Observation 8:*** For Indoor Office (FR1) in SBFD Deployment Case 1, assuming gNB self-interference isolation based on 1 dB UL desense, SBFD antenna configuration Option 2, 0.5Mbyte FTP packet size for DL and 0.125 Mbytes for UL,   * For SBFD slot configuration Alt 2: {DDDSU} vs. {XXXXU} with 2 guard symbols,   + For UL/DL resource percentage per TDD period     - The DL resource percentage per TDD period is decreased by around 23.8%     - The UL resource percentage per TDD period is increased by around 77.7%   + For {DL : UL} traffic load for legacy TDD = {Low : Low}     - DL performance of SBFD compared with legacy TDD       * The mean value of DL average-UPT CDF of SBFD is decreased by around 19.97%       * The 5% of DL average-UPT CDF of SBFD is decreased by around 20.91%       * The mean value of DL packet-latency CDF of SBFD is increased by around 22.92%       * The 5% of DL packet-latency CDF of SBFD is increased by around 23.53%       * The DL Type-1 RU of SBFD almost keeps unchanged       * The DL Type-2 RU of SBFD is increased by around 26.91%     - UL performance of SBFD compared with legacy TDD       * The mean value of UL average-UPT CDF of SBFD is increased by around 81.92%       * The 5% of UL average-UPT CDF of SBFD is increased by around 100.20%       * The mean value of UL packet-latency CDF of SBFD is decreased by around 47.27%       * The 5% of UL packet-latency CDF of SBFD is decreased by around 39.13%       * The UL Type-1 RU of SBFD is decreased by around 10.62%       * The UL Type-2 RU of SBFD is decreased by around 50.64%   + For {DL : UL} traffic load for legacy TDD = {Medium : Medium}     - DL performance of SBFD compared with legacy TDD       * The mean value of DL average-UPT CDF of SBFD is decreased by around 23.68%       * The 5% of DL average-UPT CDF of SBFD is decreased by around 24.13%       * The mean value of DL packet-latency CDF of SBFD is increased by around 33.07%       * The 5% of DL packet-latency CDF of SBFD is increased by around 23.53%       * The DL Type-1 RU of SBFDs increased by around 2.60%       * The DL Type-2 RU of SBFD is increased by around 29.74%     - UL performance of SBFD compared with legacy TDD       * The mean value of UL average-UPT CDF of SBFD is increased by around 88.35%       * The 5% of UL average-UPT CDF of SBFD is increased by around 113.82%       * The mean value of UL packet-latency CDF of SBFD is decreased by around 50.26%       * The 5% of UL packet-latency CDF of SBFD is decreased by around 39.13%       * The UL Type-1 RU of SBFD is decreased by around 11.03%       * The UL Type-2 RU of SBFD is decreased by around 50.71% * For SBFD slot configuration Alt 4: {DDDSU} vs. {XXXXX}   + For UL/DL resource percentage per TDD period     - The DL resource percentage per TDD period is decreased by around 1.2%     - The UL resource percentage per TDD period is increased by around 0.7%   + For {DL : UL} traffic load for legacy TDD = {Low : Low}     - DL performance of SBFD compared with legacy TDD       * The mean value of DL average-UPT CDF of SBFD is increased by around 0.91%       * The 5% of DL average-UPT CDF of SBFD is increased by around 0.65%       * The mean value of DL packet-latency CDF of SBFD is decreased by around 3.12%       * The 5% of DL packet-latency CDF of SBFD almost keeps unchanged       * The DL Type-1 RU of SBFD almost keeps unchanged       * The DL Type-2 RU of SBFD is increased by around 0.70%     - UL performance of SBFD compared with legacy TDD       * The mean value of UL average-UPT CDF of SBFD is increased by around 8.38%       * The 5% of UL average-UPT CDF of SBFD is increased by around 23.61%       * The mean value of UL packet-latency CDF of SBFD is decreased by around 13.33%       * The 5% of UL packet-latency CDF of SBFD is increased by around 13.04%       * The UL Type-1 RU of SBFD is decreased by around 16.81%       * The UL Type-2 RU of SBFD is decreased by around 18.28%   + For {DL : UL} traffic load for legacy TDD = {Medium : Medium}     - DL performance of SBFD compared with legacy TDD       * The mean value of DL average-UPT CDF of SBFD is increased by around 0.42%       * The 5% of DL average-UPT CDF of SBFD is increased by around 1.03%       * The mean value of DL packet-latency CDF of SBFD is decreased by around 2.69%       * The 5% of DL packet-latency CDF of SBFD almost keeps unchanged       * The DL Type-1 RU of SBFD is increased by around 0.21%       * The DL Type-2 RU of SBFD is increased by around 0.61%     - UL performance of SBFD compared with legacy TDD       * The mean value of UL average-UPT CDF of SBFD is increased by around 9.82%       * The 5% of UL average-UPT CDF of SBFD is increased by around 26.69%       * The mean value of UL packet-latency CDF of SBFD is decreased by around 15.34%       * The 5% of UL packet-latency CDF of SBFD is increased by around 13.04%       * The UL Type-1 RU of SBFD is decreased by around 16.91%       * The UL Type-2 RU of SBFD is decreased by around 18.31% |
| Huawei (R1-2302347) | ***Observation 1:*** *Under Indoor Office scenario, the following can be observed from UL evaluation results:*   * *SBFD has same UL signal powers as legacy TDD.* * *SBFD has lower legacy UL interferences than legacy TDD, especially for XXXXU and DXXXU.* * *The inter-site gNB-gNB co-channel inter-subband CLI (including leakage and selectivity) as well as the gNB self-interferences can be ignored compared with the legacy UL interferences.*   ***Observation 2:*** *Under Indoor Office scenario, the following can be observed from UL evaluation results:*   * *The MMSE-IRC receiver has similar UL Average-UPT to the performance upper limit (w/o CLI).* * *The UL Average-UPT gains for SBFD are achieved from two aspects:*   + *Aspect 1: Increased UL resources for SBFD.*   + *Aspect 2: Lower legacy UL interferences for SBFD.* * *The UL Average-UPT gains for SBFD increase from low RU to high RU, and 5% UL Average-UPT gains for SBFD are larger than mean UL Average-UPT gains, especially for medium RU and high RU.*   ***Proposal 7****: Capture the system level simulation results in Fig. 2 and Fig. 3 under Indoor Office scenario into TR 38.858.*  ***Observation 3:*** *Under Indoor Office scenario, the following can be observed from DL evaluation results:*   * *SBFD has same DL signal powers as legacy TDD.* * *SBFD has larger legacy DL interferences than legacy TDD, especially for XXXXU and DXXXU.* * *The UE-UE CLI (including leakage and selectivity) can be ignored compared with the legacy DL interferences.*   ***Observation 4:*** *Under Indoor Office scenario, the following can be observed from DL evaluation results:*   * *The MMSE-IRC receiver has similar DL Average-UPT to the performance upper limit (w/o CLI).* * *The DL Average-UPT lost for SBFD are caused by two aspects:*   + *Aspect 1: Reduced DL resources for SBFD.*   + *Aspect 2: Larger legacy DL interferences for SBFD.* * *The DL Average-UPT lost for SBFD increase from low RU to high RU, and 5% DL Average-UPT lost for SBFD are larger than mean UL Average-UPT lost, especially for high RU.*   ***Proposal 8****: Capture the system level simulation results in Fig. 4 and Fig. 5 under Indoor Office scenario into TR 38.858.*   * *DL Average-UPT will be further degraded for SBFD (besides DL resources lost) for high RU.* |
| ZTE (R1-2302756) | ***Observation 3****: Regarding SBFD deployment case1, FR1 Indoor office, SBFD Alt.2 subband pattern, Packet size 0.5Mbps/0.125Mbps*   * *The DL average UPT (mean) of SBFD is decreased by around 24% - 31% due to the decreased DL resource and UE-UE CLI. The higher traffic load, the higher loss of DL average UPT (mean) of SBFD due to the UE-UE CLI. The loss of DL average UPT (5%) SBFD is much higher than that of DL average UPT (mean) since UE with poor coverage (e.g., cell edge UE) experiences more serious UE-UE CLI.* * *The DL Packet-Latency (mean) of SBFD is increased by around 32%-69% due to the decreased DL resource and UE-UE CLI. The higher traffic load, the larger DL Packet-Latency (mean) of SBFD due to the UE-UE CLI.* * *The UL average UPT (mean) of SBFD is increased by around 33% - 48% due to the increased UL resource. The gain of UL average UPT (mean) of SBFD is increased as the increase of traffic load because the UL average UPT (mean) of baseline TDD is decreased as the increase of traffic load due to the limited UL resource in the baseline TDD.* * *The UL Packet-Latency (mean) of SBFD is decreased by around 16% - 54% due to the increased UL resource. The gain of UL Packet-Latency (mean) of SBFD is increased as the increase of traffic load because the UL Packet-Latency (mean) of baseline TDD is increased as the increase of traffic load due to the limited UL resource in the baseline TDD.*   ***Observation 4****: Regarding SBFD deployment case1, FR1 Indoor office, SBFD Alt.4 subband pattern,* *Packet size 0.5Mbps/0.125Mbps*   * *The DL average UPT (mean) of SBFD is decreased by around 4% - 10% due to the UE-UE CLI. The higher traffic load, the higher loss of DL average UPT (mean) of SBFD due to the UE-UE CLI. The loss of DL average UPT (5%) SBFD is much higher than that of DL average UPT (mean) since UE with poor coverage (e.g., cell edge UE) experiences more serious UE-UE CLI.* * *The DL Packet-Latency (mean) of SBFD is increased by around 4%-8% in case of low and medium traffic load due to UE-UE CLI. In case of high traffic load, the DL Packet-Latency (mean) of SBFD is increased by around 54% due to the much more serious UE-UE CLI.* * *The UL average UPT (mean) of SBFD is increased by around 9% - 15% due to the increased UL resource due to more transmission occasions in time domain.* * *The UL Packet-Latency (mean) of SBFD is decreased by around 11% - 17% in case of low and medium traffic load due to gNB CLI. In case of high traffic load, the UL Packet-Latency (mean) of SBFD is increased by around 45% due to the much more serious gNB CLI.*   ***Observation 3****: Regarding SBFD deployment case1, FR1 Indoor office, SBFD Alt.2 subband pattern, Packet size 0.5Mbps/0.125Mbps*   * *The DL average UPT (mean) of SBFD is decreased by around 24% - 31% due to the decreased DL resource and UE-UE CLI. The higher traffic load, the higher loss of DL average UPT (mean) of SBFD due to the UE-UE CLI. The loss of DL average UPT (5%) SBFD is much higher than that of DL average UPT (mean) since UE with poor coverage (e.g., cell edge UE) experiences more serious UE-UE CLI.* * *The DL Packet-Latency (mean) of SBFD is increased by around 32%-69% due to the decreased DL resource and UE-UE CLI. The higher traffic load, the larger DL Packet-Latency (mean) of SBFD due to the UE-UE CLI.* * *The UL average UPT (mean) of SBFD is increased by around 33% - 48% due to the increased UL resource. The gain of UL average UPT (mean) of SBFD is increased as the increase of traffic load because the UL average UPT (mean) of baseline TDD is decreased as the increase of traffic load due to the limited UL resource in the baseline TDD.* * *The UL Packet-Latency (mean) of SBFD is decreased by around 16% - 54% due to the increased UL resource. The gain of UL Packet-Latency (mean) of SBFD is increased as the increase of traffic load because the UL Packet-Latency (mean) of baseline TDD is increased as the increase of traffic load due to the limited UL resource in the baseline TDD.*   ***Observation 4****: Regarding SBFD deployment case1, FR1 Indoor office, SBFD Alt.4 subband pattern,* *Packet size 0.5Mbps/0.125Mbps*   * *The DL average UPT (mean) of SBFD is decreased by around 4% - 10% due to the UE-UE CLI. The higher traffic load, the higher loss of DL average UPT (mean) of SBFD due to the UE-UE CLI. The loss of DL average UPT (5%) SBFD is much higher than that of DL average UPT (mean) since UE with poor coverage (e.g., cell edge UE) experiences more serious UE-UE CLI.* * *The DL Packet-Latency (mean) of SBFD is increased by around 4%-8% in case of low and medium traffic load due to UE-UE CLI. In case of high traffic load, the DL Packet-Latency (mean) of SBFD is increased by around 54% due to the much more serious UE-UE CLI.* * *The UL average UPT (mean) of SBFD is increased by around 9% - 15% due to the increased UL resource due to more transmission occasions in time domain.* * *The UL Packet-Latency (mean) of SBFD is decreased by around 11% - 17% in case of low and medium traffic load due to gNB CLI. In case of high traffic load, the UL Packet-Latency (mean) of SBFD is increased by around 45% due to the much more serious gNB CLI.*   ***Observation 5****: Regarding SBFD deployment case1, FR1 Indoor office, SBFD Alt.2 subband pattern, Packet size 5Kbps/1Kbps*   * *The DL average UPT (mean) of SBFD is almost the same as baseline TDD.* * *The DL Packet-Latency (mean) of SBFD is almost the same as baseline TDD in case of low and medium traffic load. In case of high traffic load, the DL Packet-Latency (mean) of SBFD is increased by around 15% due to the UE-UE CLI.* * *The UL average UPT (mean) of SBFD is increased by around 43% - 52% due to the increased UL resource.* * *The UL Packet-Latency (mean) of SBFD is decreased by around 24% - 27% due to the increased UL resource.*   ***Observation 6****: Regarding SBFD deployment case1, FR1 Indoor office, SBFD Alt.4 subband pattern,* *Packet size 5Kbps/1Kbps*   * *The DL average UPT (mean) of SBFD is increased by around 11% - 13% due to increased transmission occasion in the last slot of each TDD period.* * *The DL Packet-Latency (mean) of SBFD is decreased by around 16%-17% due to increased transmission occasion in the last slot of each TDD period.* * *The UL average UPT (mean) of SBFD is increased by around 107% - 129% due to increased transmission occasion in the first four slots of each TDD period.* * *The UL Packet-Latency (mean) of SBFD is decreased by around 61% - 66% due to increased transmission occasion in the first four slots of each TDD period.*   ***Observation 7****: Regarding SBFD deployment case1, FR1 Indoor office,*   * *In case of larger packet size, obvious DL UPT loss is observed due to the reduced DL resource; in case of smaller packet size, small or no DL UPT loss is observed.* * *The UL UPT gain in case of smaller packet size is larger than that of larger packet size.* |
| Ericsson (R1-2302769) | Observation 19: FR1 Indoor simulation results show that   * For big packets: When part of DL resource is shifted to UL (compared to reference static TDD Alt.2), SBFD Alt. 2 and static TDD 2UL networks provide better user throughput and latency in the UL compared to the reference static TDD (Alt. 2) network, at the cost of decreased DL performances. When DL/UL resource splitting are similar (compared to reference static TDD Alt. 3,4), SBFD Alt. 3, 4 do not provide meaningful gains compared to static TDD in both UL and DL. Moreover, dynamic TDD offers quite good performance (i.e., similar or even better) compared to SBFD and static TDD for all Alternatives. * For small packets: SBFD (all Alternatives) offer some gains in term of throughput and latency compared to reference static TDDs. However, a simpler static TDD with 2 UL slots DUDDU would offer similar gains.   Observation 24: For isolated indoor deployments, system level simulations show that similar UL latency and cell-edge throughput improvements can be achieved by deploying an SBFD network as well as using simple schemes such as static TDD 2UL. However, there is a need to align and ensure the scenario assumed for Indoor is realistic by deploying, for example, an Urban Macro layer. |
| Qualcomm (R1-2303588) | **Observation 12: Indoor Hotspot downlink and uplink UPTs of SBFD Alt 4 exhibits gain in all loads as compared to TDD due to duty cycle improvement. The placement of Indoor TRPs on the ceiling has lowered the impact of cross-link interference between gNBs.**  **Observation 13: SBFD Alt 2 exhibits similar performance of TDD in DL UPT, and similar performance of SBFD Alt 4 in uplink UPT.**  **Observation 14: Under high load conditions SBFD Alt2 starts to show loss in downlink gains as compared to TDD as it has lower downlink resources as compared to TDD.**  **Observation 15: For InH with Large Packet, SBFD Alt2 exhibits large gain in UL UPT as compared to TDD due to more uplink resources than TDD and uplink duty cycle advantage.**  **Observation 16: For InH with Large Packet, SBFD Alt4 has exhibits some gains in UL UPT as compared to TDD.**  **Observation 17: For InH with Large Packet, SBFD Alt 2/4 has lower DL resources than TDD, resulting into lower DL UPT.** |
| CATT (R1-2302701) | **Observation 1: For indoor office, compared to legacy TDD, SBFD with Alt 2 achieves better UL user throughput at all three load conditions at the cost of decreased DL user throughput.**  **Observation 2: For indoor office, compared to legacy TDD, SBFD with Alt 2 can significantly reduce the UL latency at the cost of slightly increased DL latency.**  **Observation 3: For indoor office, compared to legacy TDD,** **compared to legacy TDD, SBFD with Alt 4 can improve the UL UPT at low/medium load conditions and DL UPT at all load conditions.**  **Observation 4: For indoor office, compared to legacy TDD, SBFD with Alt 4 can reduce DL latency slightly at all three low loads and reduce UL latency at low and median loads.**  **Observation 9: For indoor office, compared to legacy TDD, SBFD with Alt 2 with small packet shows comparable DL UPT and significant increased UL UPT performance.**  **Observation 10: For indoor office, compared to legacy TDD, SBFD Alt 2 with small packet has comparable DL latency performance and shows significant UL latency performance gain compared with legacy TDD.**  **Observation 11: For indoor office, compared to legacy TDD, SBFD with Alt 4 shows moderate DL UPT performance gain and shows significant UL UPT performance gain at all the three load conditions.**  **Observation 12: For indoor office, compared to legacy TDD, SBFD with Alt 4 shows significant DL latency performance gain mainly at 95% CDF and shows significant UL latency performance gain at most of the cases compared to legacy TDD.** |
| vivo (R1-2302483) | ***Observation 1: For FR 1 InH and asymmetric packet size with 4Kbytes for DL and 1Kbytes for UL,*** ***compared to legacy TDD with DDDSU (scheme 1-1)***   * ***Semi-static SBFD with XXXXX (Scheme 1-2) achieves 3.01% DL average-UPT gain with low load, but has 4.16% and 16.47% DL average-UPT degradation with medium and high load. The gain of DL average-UPT degradation with the increase of traffic load.*** * ***Semi-static SBFD with XXXXX (Scheme 1-2) achieves 65.28% ,65.79% and 56.44% UL average-UPT gain with low, medium, and high load. The gain of UL average-UPT degradation with the increase of traffic load.*** * ***Dynamic SBFD with XXXXX (Scheme 1-3) achieves 1.62% DL average-UPT gain with low load, but has 3.58% and 12.65% DL average-UPT degradation with medium and high load. The gain of DL average-UPT degradation with the increase of traffic load.*** * ***Dynamic SBFD with XXXXX (Scheme 1-3) achieves 53.80%, 55.13% and 33.01% UL average-UPT gain in low, medium, and high load. The gain of UL average-UPT decreases with the increase of traffic load.*** * ***Dynamic TDD with FFFFF (Scheme 1-4) achieves 18.09%, 17.17% and 11.13% DL average-UPT gain in low, medium and high load. The gain of DL average-UPT decreases with the increase of traffic load.*** * ***Dynamic TDD with FFFFF (Scheme 1-4) achieves 6.59% and 5.21% UL average-UPT gain in low and medium load, but has 3.96% UL average-UPT degradation with high load. The gain of DL average-UPT decreases with the increase of traffic load.***   ***Observation 2: For FR 1 InH and asymmetric packet size with 4Kbytes for DL and 1Kbytes for UL, compared to dynamic TDD (scheme 1-4), dynamic SBFD (scheme 1-3) can obtain a significant UL gain with low, medium and high load.***  ***Observation 3: For FR 1 InH and asymmetric packet size with 0.5Mbytes for DL and 0.125Mbytes for UL,*** ***compared to legacy TDD with DDDSU (scheme 1-1)***   * ***Semi-static SBFD with XXXXX (Scheme 1-2) achieves 0.83% and 4.46% DL average-UPT gain with low load, but has 2.33% DL average-UPT degradation with high load.*** * ***Semi-static SBFD with XXXXX (Scheme 1-2) has 12.57% ,13.40% and 20.66% UL average-UPT degradation with low, medium, and high load. The gain of UL average-UPT decreases with the increase of traffic load.*** * ***Dynamic SBFD with XXXXX (Scheme 1-3) achieves 11.23%, 16.76% and 8.57% DL average-UPT gain with low, medium, and high load.*** * ***Dynamic SBFD with XXXXX (Scheme 1-3) achieves 77.71%, 48.24% and 7.61% UL average-UPT gain in low, medium, and high load. The gain of UL average-UPT decreases with the increase of traffic load.*** * ***Dynamic TDD with FFFFF (Scheme 1-4) achieves 1.33%, 7.35% and 8.57% DL average-UPT gain in low, medium and high load. The gain of DL average-UPT increase with the increase of traffic load.*** * ***Dynamic TDD with FFFFF (Scheme 1-4) achieves 87.71% and 49.85% UL average-UPT gain in low and medium load, but has 1.68% UL average-UPT degradation with high load. The gain of UL average-UPT decreases with the increase of traffic load.***   ***Observation 4: For FR 1 InH and asymmetric packet size with 0.5Mbytes for DL and 0.125Mbytes for UL, compared to semi-static SBFD (scheme 1-2), dynamic SBFD (scheme 1-3) can achieve higher performance in both DL and UL, especially in UL significant gain can be obtained.***  ***Observation 5: For FR 1 InH and asymmetric packet size with 0.5Mbytes for DL and 0.125Mbytes for UL, compared to dynamic TDD (scheme 1-4),***   * ***Dynamic SBFD (scheme 1-3) can obtain a significant DL gain with low, medium and high load*** * ***Dynamic SBFD (scheme 1-3) can obtain similar UL UPT with low, medium load*** * ***Dynamic SBFD (scheme 1-3) can obtain UL gain with high load***   ***Observation 6: For FR 1 InH and asymmetric packet size with 4Kbytes for DL and 1Kbytes for UL,*** ***compared to legacy TDD with DDDSU (scheme 1-1)***   * ***Semi-static SBFD with XXXXU (Scheme 2-2) has 5.31%, 12,21% and 34.80% DL average-UPT degradation with low, medium and high load. The gain of DL average-UPT degradation with the increase of traffic load.*** * ***Semi-static SBFD with XXXXU (Scheme 2-2) achieves 52.86% ,53.55% and 39.62% UL average-UPT gain with low, medium, and high load. The gain of UL average-UPT degradation with the increase of traffic load.*** * ***Dynamic SBFD with XXXXU (Scheme 2-3) has 0.97%, 1.29% and 0.65% DL average-UPT degradation with low load.*** * ***Dynamic SBFD with XXXXU (Scheme 2-3) achieves 18.69%, 10.81% and 4.64% UL average-UPT gain in low, medium, and high load. The gain of UL average-UPT decreases with the increase of traffic load.*** * ***Dynamic TDD with FFFFU (Scheme 2-4) achieves 11.94%, 11.60% and 5.20% DL average-UPT gain in low, medium and high load. The gain of DL average-UPT decreases with the increase of traffic load.*** * ***Dynamic TDD with FFFFU (Scheme 2-4) achieves 18.44%, 20.39% and 19.55% UL average-UPT gain in low, medium and high load.***   ***Observation 7: For FR 1 InH and asymmetric packet size with 0.5Mbytes for DL and 0.125Mbytes for UL,*** ***compared to legacy TDD with DDDSU (scheme 1-1)***   * ***Semi-static SBFD with XXXXU (Scheme 2-2) has 20.66%, 23.20% and 39.96% DL average-UPT degradation with low, medium and high load. The gain of DL average-UPT decreases with the increase of traffic load.*** * ***Semi-static SBFD with XXXXU (Scheme 2-2) achieves 42.23% ,47.27% and 46.29% UL average-UPT gain with low, medium, and high load.*** * ***Dynamic SBFD with XXXXU (Scheme 2-3) has 4.49%, 6.25% and 15.48% DL average-UPT degradation with low, medium, and high load. The gain of DL average-UPT decreases with the increase of traffic load.*** * ***Dynamic SBFD with XXXXU (Scheme 2-3) achieves 95.02%, 59.65% and 25.69% UL average-UPT gain in low, medium, and high load. The gain of UL average-UPT decreases with the increase of traffic load.*** * ***Dynamic TDD with FFFFU (Scheme 2-4) has 17.97%, 17.46% and 30.20% DL average-UPT gain in low, medium and high load. The gain of DL average-UPT increase with the increase of traffic load.*** * ***Dynamic TDD with FFFFU (Scheme 2-4) achieves 93.32%, 63.03% and 38.13% UL average-UPT gain in low, medium and high load. The gain of UL average-UPT increase with the increase of traffic load.***   ***Observation 8: For FR 1 InH and asymmetric packet size with 0.5Mbytes for DL and 0.125Mbytes for UL, compared to semi-static SBFD (scheme 2-2), dynamic SBFD (scheme 2-3) can achieve higher performance in both DL and UL, except UL UPT with high load.***  ***Observation 9: For FR 1 InH and asymmetric packet size with 0.5Mbytes for DL and 0.125Mbytes for UL,*** ***as the adjustment periodicity decreases, the DL/UL average-UPT performance further improves for dynamic SBFD and dynamic TDD.*** |
| LG (R1-2303741) | ***Observation 1:*** Downlink throughput performance degradation of SBFD compared to TDD is observed.   * In Indoor Office case, the tendency of downlink throughput performance degradation of SBFD to TDD is reduced compared to Urban Macro case. * In small packet size case, the tendency of downlink throughput performance degradation of SBFD to TDD is reduced compared to large packet size case. * RU impacts the degradation tendency of downlink throughput performance from SBFD to TDD. A small packet size case shows less degradation as RU decreases, while a large packet size case shows less degradation as RU increases. * When using small packet size in Indoor Office deployment case with low RU, there is little or no difference in downlink performance between SBFD and TDD, despite the fact that SBFD has a characteristic of lacking downlink resources compared to TDD.   ***Observation 2:*** Uplink throughput performance improvement of SBFD compared to TDD is observed.   * Both Indoor Office and Urban Macro cases show performance gain of SBFD compared to TDD in terms of uplink throughput performance. The improvement in uplink throughput performance is more significant in the Indoor Office case than in the Urban Macro case. * The improvement of uplink throughput performance of SBFD to TDD in small packet size case outperforms that of large packet size case. * Uplink throughput performance improvement of SBFD to TDD with small packet size case in both deployment case, as lower the RU the more performance improvement could be observed. * When using small packet size in Indoor Office deployment case with low RU, there is over 200% improvement in uplink performance between SBFD and TDD, because of the fact that SBFD has a characteristic of having more uplink resources compared to TDD. |
| Nokia (R1-2303015) | ***Observation 9: For FR1 Indoor Office scenario with 0.125 Mbytes FTP3 payload size and assuming similar ratio of DL resources for SBFD and TDD (XXXXX vs DDDSU), SBFD results in a UL throughput degradation of around 5% compared to static TDD. The reason is that with TDD there are more resource blocks available simultaneously for the same link direction (either UL or DL) which allows to upload the 0.125 Mbytes payloads faster than in SBFD.***  ***Observation 10: For FR1 Indoor Office scenario, no UL performance degradation due to self-interference is observed even with relaxed assumption of RSI=100 dB. The reason of this is that the required receiver sensitivity in this local-area scenario is much lower than in wide-area deployments due to higher received power from the UEs.***  ***Observation 11: For FR1 Indoor Office scenario with small 1 kB FTP3 payload size and assuming similar ratio of DL resources for SBFD and TDD (XXXXX vs DDDSU), SBFD provides significant UL throughput and UL latency improvement as compared to static TDD. As compared to the case with large 125 kB payload, here the transmission of the entire 1 kB payload can generally fit a single radio slot, thus it is transmitted almost immediately in the case of SBFD, while there is generally some waiting time in the case of TDD.***  ***Observation 12: For Indoor Office, SBFD performance shall be compared with dynamic TDD or more UL-centric TDD radio frames rather than “DDDSU” static TDD. It is expected that such alternatives can provide similar gains as SBFD.***  ***Observation 13: For FR1 Indoor Office scenario with small 4 kB FTP3 payload size and assuming similar ratio of DL resources for SBFD and TDD (XXXXX vs DDDSU), SBFD provides gains in DL throughput and DL latency. The reason is the low impact on the UE-to-UE CLI and that fact that small DL payloads can be transmitted in a single radio slot.***  ***Observation 14: Given the interference conditions and the assumptions for an RSI to match 1 dB desense, the noise figure proposed by RAN4 has no impact for the indoor office scenario in FR1 (Deployment case 1).*** |
| Spreadtrum (R1-2302598) | ***Observation 1: For indoor office, compared to legacy TDD, SBFD with {XXXXU} achieves better UL UPT in all kinds of traffic loads at the cost of degradation of DL UPT.***  ***Observation 2: For indoor office, compared to legacy TDD, SBFD with {XXXXX} improve the UL UPT at 5%-UPT and 50%-UPT and has comparable DL UPT at all traffic loads.***  ***Observation 3: For indoor office, compared to legacy TDD, SBFD with {XXXXU} can significantly reduce the UL latency at the cost of increased DL latency especially in medium/high RU.***  ***Observation 4: For indoor office, compared to legacy TDD, SBFD with {XXXXX} can reduce 5% and 50% DL latency slightly and reduce UL latency at 50%-packet latency and 95%-packet latency at all traffic loads.*** |
| Apple (R1-2303481) | **Observation**: For indoor scenario with no CLI/SI at UE or gNB, UL throughput enhancement for cell-edge UEs is limited to 10%. |
| InterDigital (R1-2302521) | ***Observation 3.*** *Restricting DL subband transmissions on slots that correspond to UL slots in legacy TDD can improve uplink performance but negatively impacts downlink performance.*  ***Observation 4.*** *The static/fixed subband partitioning, e.g., [DUD] = [40 20 40] RB split all the time, results in worse performance for SBFD compared with legacy TDD in downlink, which is not reflecting a practical usefulness of SBFD.*  ***Proposal 4.*** *Evaluations on various downlink performance degradation aspects due to the SBFD operations compared with legacy TDD systems should also be an important part of the NR-Duplex study.*  ***Proposal 5.*** *To fairly reflect a practical usefulness of SBFD, the static/fixed subband partitioning assumption is not a proper assumption but is to be used as a baseline assumption for SBFD, where flexible/dynamic subband partitioning schemes should be further evaluated to overcome the degraded downlink performance for SBFD.*  ***Observation 5.*** *Inter-site gNB-gNB inter-subband interference is the dominating source of performance degradation in the UL.*  ***Observation 6.*** *UE-UE CLI severely impacts SBFD DL performance.* |
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#### **(higher priority) Urban Macro (FR1)**

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| **Company** | **Proposals** |
| Huawei (R1-2302347) | ***Observation 10:*** *Under Urban Macro scenario, the following can be observed from UL evaluation results:*   * *SBFD has higher UL signal powers than legacy TDD for coverage limited UEs; SBFD has same UL signal powers as legacy TDD for others.*   + *Compared with Dense Urban Macro layer scenario, Urban Macro scenario has much more UEs are under full transmit power.* * *SBFD has lower legacy UL interferences than legacy TDD,* *especially for XXXXU and DXXXU with low RU and medium RU.*   + *Except for XXXXX, which has higher UL legacy UL interferences than legacy TDD.*   + *Except for XXXXU and DXXXU, which have higher UL signal powers than legacy TDD in the case of high RU.* * *The inter-site gNB-gNB co-channel inter-subband CLI (leakage) dominates the UL interferences.* * *The inter-site gNB-gNB co-channel inter-subband CLI (selectivity), gNB self-interferences, and co-site inter-sector gNB-gNB co-channel inter-subband CLI are comparable to the legacy UL interferences.*   ***Observation 11:*** *Under Urban Macro scenario, the following can be observed from UL evaluation results:*   * *For performance upper limit (w/o CLI), a similar observation as Dense Urban Macro layer scenario can be obtained as well as following observations:*   + *The performance upper limit (w/o CLI) for Urban Macro scenario is generally lower than that for Dense Urban Macro scenario.*   + *The 5% UL Average-UPT gains for Urban Macro scenario are much lower than that for Dense Urban Macro scenario in the case of high RU.* * *For MMSE-IRC receiver, the UL Average-UPT gains will be lost compared with the performance upper limit (w/o CLI), caused by inter-site gNB-gNB CLI (leakage).* * *For E-MMSE-IRC receiver, it has a better UL Average-UPT than the MMSE-IRC receiver, and it is much c loser to the performance upper limit (w/o CLI), especially for 5% UL Average-UPT.*   ***Proposal 12****: Capture the system level simulation results in Fig. 11 and Fig. 12 under Urban Macro scenario and the following observations into TR 38.858:*   * *E-MMSE-IRC receiver to suppress the inter-site gNB-gNB co-channel inter-subband CLI (leakage) is beneficial for Urban Macro scenario.*   ***Observation 12:*** *Under Urban Macro scenario, the following can be observed from DL evaluation results:*   * *SBFD has similar DL signal powers as legacy TDD.* * *SBFD has larger legacy DL interferences than legacy TDD.* * *The UE-UE co-channel inter-subband CLI dominates the DL interferences.*   ***Observation 13:*** *Under Urban Macro scenario, the following can be observed from DL evaluation results:*   * *The DL Average-UPT lost for SBFD are caused by the same aspects in Dense Urban Macro layer.* * *For performance upper limit (w/o CLI), the DL Average-UPT lost for SBFD are mainly caused by Aspect 1 and Aspect 2. It has a similar observations as Dense Urban Macro layer scenario.* * *For MMSE-IRC receiver, the DL Average-UPT lost for SBFD will be additionally affected by Aspect 3 beside Aspect 1 and Aspect 2, due to MMSE-IRC receiver cannot suppress UE-UE CLI.*   ***Proposal 13****: Capture the system level simulation results in Fig. 13 and Fig. 14 under Urban Macro scenario and the following observations into TR 38.858:*   * *The DL performance lost caused by UE-UE co-channel inter-subband CLI should be further studied, e.g. coordinated scheduling.*   ***Observation 14:*** *Under Urban Macro scenario, the noise figure will be deteriorated at gNB sides for high RU.*   * *The average total power received by gNB exceeds -43dBm with 8%, 30%, and 60% probability for low RU, medium RU, and high RU, respectively.* * *The inter-sector gNB-gNB co-channel inter-subband CLI dominates the average total power received by gNB.*   ***Proposal 14****: Capture the system level simulation results in Fig. 15 under Urban Macro scenario and the following observations into TR 38.858:*   * *Potential solutions to suppress inter-site gNB-gNB co-channel inter-subband CLI at aggressor gNB sides should be considered, e.g., coordinated beamforming, etc.*   ***Observation 16:*** *Under Urban Macro scenario, the noise figure will be deteriorated severely at gNB sides for each RU, and the receiver will be blocked especially for middle RU and high RU.*   * *The average total power received by gNB exceeds -43dBm with 60%, 99.9%, and 100% probability for low RU, medium RU, and high RU, respectively.* * *The average total power received by gNB exceeds -25dBm with 0.1%, 10%, and 20% probability for low RU, medium RU, and high RU, respectively.* * *The inter-sector gNB-gNB co-channel inter-subband CLI dominates the average total power received by gNB.*   ***Proposal 16****: Capture the system level simulation results in Fig. 18 under Urban Macro scenario and the following observations into TR 38.858:*   * *Potential solutions to suppress inter-site gNB-gNB co-channel inter-subband CLI at aggressor gNB sides should be considered, e.g., coordinated beamforming, etc.* |
| ZTE (R1-2302756) | ***Observation 8****: Regarding SBFD deployment case1, FR1 Urban Macro, SBFD Alt.2 subband pattern, Packet size 0.5Mbps/0.125Mbps*   * *The DL average UPT (mean) of SBFD is decreased by around 19% - 29% due to the decreased DL resource and UE-UE CLI. The higher traffic load, the higher loss of DL average UPT (mean) of SBFD due to the UE-UE CLI. The loss of DL average UPT (5%) SBFD is much higher than that of DL average UPT (mean) since UE with poor coverage (e.g., cell edge UE) experiences more serious UE-UE CLI.* * *The DL Packet-Latency (mean) of SBFD is increased by around 29%-145% due to the decreased DL resource and UE-UE CLI. The higher traffic load, the larger DL Packet-Latency (mean) of SBFD due to the UE-UE CLI.* * *The UL average UPT (mean) of SBFD is increased by around 43% - 63% due to the increased UL resource. The gain is smaller in case of high traffic load due to the gNB CLI.* * *The UL Packet-Latency (mean) of SBFD is decreased by around 3% - 19% due to the increased UL resource. The gain is smaller in case of high traffic load due to the gNB CLI.*   ***Observation 9****: Regarding SBFD deployment case1, FR1 Urban Macro, SBFD Alt.2 subband pattern, Packet size 5Kbps/1Kbps*   * *The DL average UPT (mean) of SBFD is almost the same as baseline TDD.* * *The DL Packet-Latency (mean) of SBFD is almost the same as baseline TDD in case of low load. In case of medium and high traffic load, the DL Packet-Latency (mean) of SBFD is increased by around 114%-180% due to the UE-UE CLI.* * *The UL average UPT (mean) of SBFD is increased by around 43% - 70% due to the increased UL resource. The gain of UL average UPT (mean) of SBFD is increased as the increase of traffic load because the UL average UPT (mean) of baseline TDD is decreased as the increase of traffic load due to the limited UL resource in the baseline TDD.* * *The UL Packet-Latency (mean) of SBFD is decreased by around 8% - 62% due to the increased UL resource.* |
| Ericsson (R1-2302769) | Observation 15: For single operator Urban Macro scenario in FR1, UL performance gains of SBFD network in terms of coverage, latency and cell-edge user throughputs decrease as the load in the network increases.  Observation 16: For single operator Urban Macro scenario in FR1, the proposed DTDD network provides comparable performance as an SBFD network in terms of coverage, latency, and cell-edge user throughput in both DL and UL without having to deal with the hardware-complexity of SBFD network.  Observation 17: For single operator Urban Macro scenario in FR1, the UL performance gains for an SBFD network with all SBFD slots (XXXXX) in cell-edge user throughput is on par with SBFD with XXXXU at low loads but the performance drops considerably at medium and high loads due to significant interference limitations in all the SBFD slots. Further, even with optimistic assumptions for self-interference and inter-sector suppression, there is no noteworthy improvement in UL performance of an SBFD XXXXX network.  Observation 20: For FR1 single operator urban macro scenario, UL coverage is the key metric for potential improvement. The simulated alternatives (Alt2, Alt4, Alt3) show that SBFD only offers marginal UL coverage gains (~3 dB) when compared with the corresponding static TDD schemes at low load. The 5% UL average-UPT results across the three alternatives also indicate similar performance gains.  Observation 23: For higher power BS class in Urban Macro scenario, system level simulations have shown that there is little to no improvement in UL coverage or cell-edge throughput performance by deploying an SBFD network as opposed to using a simple scheme such as static TDD 2UL or a semi-static DTDD in both single and multi-operator scenario. |
| Qualcomm (R1-2303588) | **Observation 4: ­SBFD Alt 4 with small packets exhibits higher downlink UPT gain as compared to TDD and SBFD Alt 2. The gain is due to duty cycle improvement in SBFD slot format Alt 4. Cell edge UEs with SBFD Alt 2/4 are affected due to UE-UE CLI.**  **Observation 5: The median Uplink UPT of SBFD Alt 2/4 exhibits gain as compared to TDD even in the presence of gNB-gNB cross link interference.**  **Observation 6: Increase in Uplink resource in Alt2 (XXXXU) did not results in proportionate UPT improvement in any load condition.**  **Observation 7: Tail performance of downlink transfer time in SBFD is affected because of UE-UE cross link interference. Longer transfer time projects the network’s the ability to handle the load without dropping the packet but subjecting to cross link interference.**  **Observation 8: SBFD exhibits improved uplink coverage as compared to TDD under all load conditions and with gNB-gNB Cross Link Interference. Downlink coverage is comparable to TDD and reduced in some cases due to increased UE-UE Cross Link Interference**  **Observation 9: The UPT observed for DL and UP in Large Packet size experiment aligns with the available resources in uplink and downlink.**  **Observation 10: The uplink median UPT of Alt2 (XXXXU) is higher compared to TDD due to increase in uplink resource in the specific slot format.**  **Observation 11: For UMa with large packet size, SBFD Alt 2/4 provides higher uplink coverage as compared to TDD as TDD is limited by uplink UEs Tx power over the U slots.**  **Observation 18: For UMa scenario with low load (mean load of all the gNBs is <10%), some of the gNB have high loading (>60%) due to serving UEs with very high Coupling Loss that consume many downlink resources.**  **Proposal 10: RAN1 to further discuss admission control for serving UEs with high coupling loss. For example, a maximum coupling loss could be defined as threshold for serving a UE.**  **Observation 19: For FR1 UMa scenario, the open loop power control parameters result into high UL interference (UE-gNB) that is comparable with inter-gNB interference. Even in low load scenario, more than 50% of the UEs are operating at Maximum transmit power.**  **Proposal 11: RAN1 to further discuss whether the P0 value can be lowered to reduce the UL interference for UMa (e.g. P0= -95 dBm).** |
| CATT (R1-2302701) | **Observation 5: For urban macro, compared to legacy TDD, SBFD with Alt 2 achieves better UL user throughput at all three load conditions at the cost of slightly decreased DL user throughput.**  **Observation 6: For urban macro, compared to legacy TDD, SBFD with Alt 2 can significantly reduce the UL latency at all three load conditions with the cost of slightly increased DL latency.**  **Observation 7: For urban macro, compared to legacy TDD, SBFD with Alt 4 can reduce the DL latency at all three load conditions for urban macro and UL latency at low/medium load condition.**  **Observation 8: For urban macro,** **compared to legacy TDD, SBFD with Alt 4 can significantly improve the DL UPT at all the three load conditions and improve UL UPT at low/medium load conditions for urban macro while there is a decrease for the 95%-CDF of UL UPT at high load condition.**  **Observation 13: For urban macro,** **compared to legacy TDD, SBFD with Alt 2 with small packet shows comparable DL UPT except that it shows significant performance gain at 5%-CDF of DL UPT at high load condition and shows significant UL UPT performance gain at all three load conditions.**  **Observation 14: For urban macro, compared to legacy TDD, SBFD with Alt 2 with small packet shows comparable DL latency with legacy TDD except that it shows significant performance gain at 95%-CDF of DL latency at high load condition and shows significant UL latency performance gain at all three load conditions.**  **Observation 15: For urban macro, compared to legacy TDD, SBFD with Alt 4 with small packet achieves significant UPT gain at all three load conditions and moderate DL UPT performance gain.**  **Observation 16: For urban macro, compared to legacy TDD, SBFD with Alt 4 with small packet shows significant UL latency gain and moderate DL latency performance gain.** |
| LG (R1-2303741) | ***Observation 2:*** Uplink throughput performance improvement of SBFD compared to TDD is observed.   * Both Indoor Office and Urban Macro cases show performance gain of SBFD compared to TDD in terms of uplink throughput performance. The improvement in uplink throughput performance is more significant in the Indoor Office case than in the Urban Macro case. * The improvement of uplink throughput performance of SBFD to TDD in small packet size case outperforms that of large packet size case. * Uplink throughput performance improvement of SBFD to TDD with small packet size case in both deployment case, as lower the RU the more performance improvement could be observed. * When using small packet size in Indoor Office deployment case with low RU, there is over 200% improvement in uplink performance between SBFD and TDD, because of the fact that SBFD has a characteristic of having more uplink resources compared to TDD. |
| Nokia (R1-2303015) | ***Observation 3: With clustered UE distribution in UMa Scenario, there is significant degradation of UE DL throughput due to UE-UE CLI even at low load. This mainly occurs when one or more coverage-limited UEs transmit over a few, e.g. 4, RBs with full 23 dBm UL transmit power which generates large amount of UL leakage interference to other UEs receiving in DL.***  ***Observation 4: The RAN4 proposed noise figure further degrades the UL performance of SBFD in the UMa FR1 scenario and it is especially impactful for cases with modest self-interference and inter-sector interference mitigation capabilities.***  ***Observation 5: For static TDD with low UL duty cycle (e.g. DDDSU), some UEs may have the capability for up to 26 dBm maximum UL transmit power. Comparing SBFD with 23 dBm UL max transmit power vs static TDD DDDSU with 26 dBm max UL transmit power, static TDD performs as good or better in terms of UL average throughput performance, with only 20%-30% lower 5%-ile user UL throughput.***  **Proposal 3: When evaluating the benefits of SBFD, the performance evaluation needs to be done under realistic assumptions of inter-sector isolation and self-interference suppression levels as well as the proposed noise figure model by RAN4. The performance evaluation should also include possible alternatives already allowed by the current NR standard, e.g.: TDD with power class 2 UE (max 26 dBm output transmit power).** |
| MediaTek (R1-2302735) | ***Observation 1:*** *错误!未找到引用源。****The resource gain/loss in UL and DL, as well as the spectral efficiency gain/loss in UL and DL for SBFD over the legacy TDD, are closely aligned.***  ***Observation 2: Inter-UE CLI has significant impact to the DL performance in clustered UE scenario.***  ***Observation 3: Intra-site gNB CLI has significant impact to the UL performance.***  ***Observation 4: Intra-site isolation has a major influence on UL performance, and it is observed that 75 dB of isolation is insufficient, and 100 dB is preferred in addition to the frequency isolation.***  ***Observation 5: RSIC of 102 dB in addition to the frequency isolation is required to mitigate the gNB self-interference.***  ***Observation 6: DL UPT of SBFD suffers (~43% loss in mean UPT of medium RU) when compared to TDD due to DL resource loss and inter-UE CLI.***  ***Observation 7: UL UPT of SBFD is gained (~69% gain in mean UPT of medium RU) when compared to TDD due to UL resource gain and with the best RSIC and RCIC capabilities at gNB.***  ***Observation 8: Good scope of studying the solutions for the inter-site gNB CLI management with minimal or no impact to the UE.***  ***Observation 9: DL latency of SBFD suffers (~124% loss in mean packet latency of medium RU) when compared to TDD due to DL resource loss and inter-UE CLI.***  ***Observation 10: UL latency of SBFD is gained (~43% loss in mean packet latency of medium RU) when compared to TDD due to UL resource gain and with the best RSIC and RCIC capabilities at gNB.*** |
| Samsung (R1-2303126) | Observation 6 *For all traffic load points, a SBFD network provides better UL UPT performance than a static TDD network*  Observation 7 *For high traffic load, UL UPT gain can be affected by the increased co-site inter-sector CLI and inter-gNB CLI, but the benefits of SBFD system are still significant.*  Observation 8 *Regarding the suppression capabilty comparison of co-site inter-sector CLI, SBFD #2 (93 dB spatial isolation) is not significantly different from SBFD #1 (100 dB spatial isolation + 10 dB digital isolation). Dominant degradation factor for SBFD UL performance is other interference source, not co-site inter-sector CLI.*  Observation 9 *Effect of legacy UE-gNB interference or inter-site gNB-gNB CLI is domiant over co-site inter-sector CLI. It confirms that there is a performance degradation by higher inter-sector CLI suppression capability, but it is not a dominant factor for SBFD UL performance*  Observation 10 *For low and medium traffic load, DL UPT is reduced since reduced DL frequency resource is dominant rather than UE-UE CLI impact. However, for high traffic load, it is observed that the DL UPT is slightly degraded due to strong UE-UE CLI.*  Observation 11 *If the advanced scheduler is applied, DL performance can be further improved* |

#### **(higher priority) InH (FR2-1)**

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| **Company** | **Proposals** |
| Nokia (R1-2303015) | ***Observation 15: For the large payload size, SBFD shows UL UPT gains for 5%-ile of the users in the Indoor office FR2-1 scenario. As compared with static TDD, UEs can spread their transmissions over time in SBFD which helps especially to the power limited UEs.***  ***Observation 16: For the large payload size, SBFD shows no gain or even degradation in performance in terms of DL UPT and latency in the Indoor office FR2-1 scenario. This is especially noticeable at high loads where the co-channel inter-subband UE-to-UE CLI plays an important role.***  ***Observation 17: For the small payload size, SBFD shows significant gains in both the UL UPT and the UL packet latency in the Indoor office FR2-1 scenario. The reason for this is a combination of the following: good link budget that results in high SINR, sufficient self-interference isolation, 100% availability of UL resources at any SBFD slot, and UL packets mostly fitting into 1 radio slot.***  ***Observation 18: For the small payload size, SBFD shows no gain or even degradation in performance in terms of DL UPT and latency in the Indoor office FR2-1 scenario. This is especially noticeable at high loads where the co-channel inter-subband UE-to-UE CLI plays an important role.*** |

#### **(higher priority) Dense Urban Macro layer (FR2-1)**

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| **Company** | **Proposals** |
| Ericsson (R1-2302769) | Observation 25: For FR2 single operator Dense Macro scenario, there are UL performance gains in terms of cell-edge, median and 95%ile throughput and latency for SBFD network at low loads, and slightly lower gains at medium and high loads when compared to a reference static TDD network. However, it is not possible to make any meaningful conclusions as the scenario does not seem to be coverage limited. |
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#### **Dense Urban Macro layer (FR1)**

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| **Company** | **Proposals** |
| Huawei (R1-2302347) | ***Observation 5:*** *Under Dense Urban Macro layer scenario, the following can be observed from UL evaluation results:*   * *SBFD has higher UL signal powers than legacy TDD for coverage limited UEs; SBFD has same UL signal powers as legacy TDD for others.* * *SBFD has lower legacy UL interferences than legacy TDD, especially for XXXXU and DXXXU.*   + *Except XXXXX for high RU, which has larger legacy UL interferences than legacy TDD.* * *The inter-site gNB-gNB co-channel inter-subband CLI (leakage) is comparable to the legacy UL interferences.* * *The inter-site gNB-gNB co-channel inter-subband CLI (selectivity), gNB self-interferences, and co-site inter-sector gNB-gNB CLI can be ignored compared with the inter-site gNB-gNB co-channel inter-subband CLI (leakage) and legacy UL interferences.*   ***Observation 6:*** *Under Dense Urban Macro layer scenario, the following can be observed from UL evaluation results:*   * *For performance upper limit (w/o CLI), the UL Average-UPT gains for SBFD are achieved from three aspects:*   + *Aspect 1: Increased UL resources.*   + *Aspect 2: Lower legacy UL interferences, expect for XXXXX in the case of medium RU and high RU.*   + *Aspect 3: Increased UL transmission chances for coverage limited UEs, which mainly improves 5% UL Average-UPT for SBFD.* * *For MMSE-IRC receiver, the UL Average-UPT gains will be lost compared with the performance upper limit (w/o CLI), caused by inter-site gNB-gNB co-channel inter-subband CLI (leakage).*   + *The MMSE-IRC receiver cannot achieve the basic gains from the increased UL resources for SBFD due to the inter-site gNB-gNB co-channel inter-subband CLI (leakage).* * *For E-MMSE-IRC receiver, it has a better UL Average-UPT than the MMSE-IRC receiver, and it is much closer to the performance upper limit (w/o CLI), especially for 5% UL Average-UPT.*   + *The E-MMSE-IRC receiver can achieve the basic gains from the increased UL resources for SBFD even if affected by inter-site gNB-gNB co-channel inter-subband CLI (leakage).*   ***Proposal 9****: Capture the system level simulation results in Fig. 6 and Fig. 7 under Dense Urban Macro layer scenario and the following observations into TR 38.858:*   * *E-MMSE-IRC receiver to suppress the inter-site gNB-gNB co-channel inter-subband CLI (leakage) is beneficial for Dense Urban Macro layer scenario.*   ***Observation 7:*** *Under Dense Urban Macro layer scenario, the following can be observed from DL evaluation results:*   * *SBFD has same DL signal powers as legacy TDD.* * *SBFD has larger legacy DL interferences than legacy TDD, especially for XXXXU and DXXXU.*   + *Except XXXXX, which has similar legacy DL interferences as legacy TDD.* * *The UE-UE co-channel inter-subband CLI impacts on the total DL interferences, especially for the coverage limited UEs.*   ***Observation 8:*** *Under Dense Urban Macro layer scenario, the following can be observed from DL evaluation results:*   * *The DL Average-UPT lost for SBFD are caused by three aspects:*   + *Aspect 1: Reduced DL resources.*   + *Aspect 2: Larger legacy DL interferences.*   + *Aspect 3: UE-UE co-channel inter-subband CLI.* * *For performance upper limit (w/o CLI), the DL Average-UPT lost for SBFD are mainly caused by Aspect 1 and Aspect 2, except for XXXXX.* * *For MMSE-IRC receiver, the DL Average-UPT lost for SBFD will be additionally affected by Aspect 3 beside Aspect 1 and Aspect 2, due to MMSE-IRC receiver cannot suppress UE-UE co-channel inter-subband CLI, especially for 5% DL Average-UPT.*   ***Proposal 10****: Capture the system level simulation results in Fig. 8 and Fig. 9 under Dense Urban Macro layer scenario and the following observations into TR 38.858.*   * *Several potential solutions to handle UE-UE co-channel inter-subband CLI should be considered, e.g., coordinated scheduling, etc.*   ***Observation 9:*** *Under Dense Urban Macro layer scenario, the noise figure will be deteriorated severely at gNB sides for medium RU and high RU.*   * *The average total power received by gNB exceeds -43dBm with 17%, 63%, and 90% probability for low RU, medium RU, and high RU, respectively.* * *The inter-sector gNB-gNB co-channel inter-subband CLI dominates the average total power received by gNB.*   ***Proposal 11****: Capture the system level simulation results in Fig. 10 under Dense Urban Macro layer scenario and the following observations into TR 38.858:*   * *Potential solutions to suppress inter-site gNB-gNB co-channel inter-subband CLI at aggressor gNB sides should be considered, e.g., coordinated beamforming, etc.* |
| ZTE (R1-2302756) | ***Observation 10****: Regarding SBFD deployment case1, FR1 Dense Urban Macro, SBFD Alt.2 subband pattern, Packet size 0.5Mbps/0.125Mbps, for medium and high traffic load*   * *The DL average UPT (mean) of SBFD is decreased by around 18% - 28% due to the decreased DL resource and UE-UE CLI.* * *The DL Packet-Latency (mean) of SBFD is increased by around 26%-81% due to the decreased DL resource and UE-UE CLI.* * *The UL average UPT (mean) of SBFD is increased by around 24% due to the increased UL resource.* * *The UL Packet-Latency (mean) of SBFD is decreased by around 7% - 10% due to the increased UL resource.*   ***Observation 11****: Regarding SBFD deployment case1, FR1 Urban Macro, SBFD Alt.2 subband pattern, Packet size 5Kbps/1Kbps, medium and high traffic load*   * *The DL average UPT (mean) of SBFD is almost the same as baseline TDD.* * *The DL Packet-Latency (mean) of SBFD is almost the same as baseline TDD in case of medium load. In case of high traffic load, the DL Packet-Latency (mean) of SBFD is increased by around 12% due to the UE-UE CLI.* * *The UL average UPT (mean) of SBFD is increased by around 24% - 27% due to the increased UL resource.* * *The UL Packet-Latency (mean) of SBFD is decreased by around 14% - 15% due to the increased UL resource.* |
| Nokia (R1-2303015) | ***Observation 6: In the Dense Urban FR1 scenario, SBFD brings benefits to the UL performance specially for the cell-edge users (5%-ile of the throuhgput).. Due to the lower transmit power at the gNBs, the benefits of SBFD in UL are larger than the observed in Urban Macro FR1 scenario.***  **Observation 7: *With clustered UE distribution in Dense Urban FR1 scenario, there is significant degradation of UE DL throughput due to UE-UE CLI. This mainly occurs when one or more coverage-limited UEs transmit over a few, e.g. 4, RBs with full 23 dBm UL transmit power which generates large amount of UL leakage interference to other UEs receiving in DL.***  ***Observation 8: In the Dense Urban FR1 scenario, the importance of good inter-sector isolation is increased when the RAN4 piece-wise noise figure model is adopted.*** |
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#### **Dense Urban with 2-layer (FR1)**

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| **Company** | **Proposals** |
| ZTE (R1-2302756) | ***Observation 12****: Regarding SBFD deployment case1, FR1 Dense Urban (2-layer scenario), SBFD Alt.2 subband pattern, Packet size 0.5Mbps/0.125Mbps*   * *For both Macro layer and Micro layer, the DL average UPT (mean) of SBFD is decreased by around 30% - 39% due to the decreased DL resource and UE-UE CLI. The higher traffic load, the higher loss of DL average UPT (mean) of SBFD due to the UE-UE CLI.* * *For Macro layer, the DL Packet-Latency (mean) of SBFD is increased by around 48%-127% due to the decreased DL resource and UE-UE CLI; for Micro layer, the DL Packet-Latency (mean) of SBFD is increased by around 57%-93% due to the decreased DL resource and UE-UE CLI.* * *For Macro layer, the UL average UPT (mean) of SBFD is increased by around 10% due to the increased UL resource; for Micro layer, the UL average UPT (mean) of SBFD is increased by around 14% due to the increased UL resource.* * *For Macro layer, the UL Packet-Latency (mean) of SBFD is decreased by around 16% - 43% due to the increased UL resource; for Micro layer, the UL Packet-Latency (mean) of SBFD is decreased by around 14% - 32% due to the increased UL resource. The gain is smaller in case of high traffic load due to the gNB CLI.* |
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#### **Scenario agnostic proposals**

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| **Company** | **Proposals** |
| OPPO (R1-2302546) | ***Observation 1: The setup of UL subband over DL symbols would not have big impact to the average cell throughput under the assumed traffic loads.***  ***Observation 2: The setup of UL subband over DL symbols improves the UL UPT per UE.***  ***Observation 3: With the assumed D/U resource ratio in “X” slot, if the packet size is small (4Kbytes for DL and 1Kbytes for UL) and the traffic load is low-to-medium, {XXXXX, XXXXU, DXXXU} offer better DL/UL UPT than DDDSU in Indoor office, which is however just partially observed in the other two evaluated scenarios.***  ***Proposal 1: RAN1 examines the comparability of evaluation results corresponding to the two agreed UE distribution options (i.e., M DL-only UEs and M UL-only UEs vs. M dual-direction UEs) and, if necessary, summarizes the evaluation results corresponding to these two options separately.*** |
| xiaomi (R1-2302981) | Observation 2: When UL subband is introduced in DL slot, UL user throughput is improved significantly:   * ***Degradation of DL user throughput is also observed, which depends on the UL subband configuration.*** * ***In ratio, improvement of UL performance is much more than the degradation of DL performance.***   Observation 3: When UL subband is introduced in DL slot, UL latency can be reduced:   * ***Increasement of DL latency is also observed, magnitudes of degradation for DL performance are close to improvement for UL performance.***   Observation 4: When UL subband is introduced in DL slot, UL resource utilization can be reduced. Increasement of DL RU is also observed. |
| LG (R1-2303741) | ***Observation 3:*** SBFD operation is beneficial compared to TDD operation. Specifically, considering factors such as deployment scenarios, packet size, and resource utilization, the following environments are more suitable for SBFD operation compared to TDD.   * Environments where the improvement of uplink performance compared to the degradation of downlink performance is required * Environments with relatively low traffic load (operating with small packet sizes and low packet arrival rates) * Environments with limited interference (compared to Urban Macro, Indoor Office environments are more suitable) |
| Nokia (R1-2303015) | ***Observation 1: In low load conditions, SBFD improves the UL throughput performance at the 5%-ile for cell-edge UEs, thanks to the presence of UL resources in each SBFD slot. The UL throughput gains diminishes as the load increases since self-interference, inter-sector interference and inter-gNB interference starts to play a role.***  ***Observation 2: For the same RSI capabilities, the SBFD UL performance is quite dependent on the inter-sector isolation. SBFD reported larger gains when 93 dB of spatial isolation for the co-site inter-sector interference is assumed.*** |
| Intel (R1-2302794) | **Observation 2: From the interference components analysis, for the considered scenarios and traffic loads it can be observed:**   * + **FR2 operation is insensitive to new interference components from SBFD up to higher loading in FTP traffic.**   + **FR1 operation is sensitive to new interference components from SBFD:**     - **In Macro scenario, UE-UE interference is severe and causes degradation to SINR/RU.**     - **In Indoor scenario, UE-UE interference is also noticeable, but does not cause major degradation to system performance.**   **Observation 3: From the UE-average packet delay analysis, for the considered scenarios and traffic loads it can be observed:**   * + **FR2 scenarios experience noticeable packet delay gains in low to medium traffic loading conditions, and the gains are still observed in high loading conditions from SBFD.**   + **FR1 Indoor scenario experiences noticeable packet delay gains from SBFD, without observing impact from new interference types of SBFD.**   + **FR1 Macro scenario experiences noticeable degradation when new SBFD interference type is enabled, no positive gains are observed in DL and UL.** |
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* + 1. Summary

#### **(higher priority) InH (FR1)**

[CMCC, Huawei, ZTE, Ericsson, Qualcomm, CATT, vivo, OPPO, Xiaomi, LG, Nokia, SPRD, Intel, New H3C] provide initial SLS evaluation results for InH (FR1) for SBFD Deployment Case 1, wherein, [CMCC, vivo, SPRD, CATT, ZTE, Sony, Mediatek, LG, Qualcomm, Samsung, OPPO, Nokia] upload evaluation results to the following draft FTP folder.

([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))

Based on the collected excel data in “SBFD-Case1-v015\_OPPO\_Nokia.xlsx”, the evaluation results are categorized into 6 sub-cases based on the different key assumptions. Each sub-case is based on one combination of key assumptions.

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| **Sub-cases  Key assumptions** | | **SBFD#1\_InH\_FR1\_Sub#1** | **SBFD#1\_InH\_FR1\_Sub#2** | **SBFD#1\_InH\_FR1\_Sub#3** | **SBFD#1\_InH\_FR1\_Sub#4** | **SBFD#1\_InH\_FR1\_Sub#5** | **SBFD#1\_InH\_FR1\_Sub#6** |
| **SBFD slot configuration** | **Alt-2: {DDDSU} vs. {XXXXU}** | √ | √ |  |  | √ | √ |
| **Alt-4: {DDDSU} vs. {XXXXX}** |  |  | √ | √ | √ |  |
| **Alt-1: {DDDSU} vs. {DXXXX}** |  |  |  |  |  |  |
| **Alt-3: {DDSUU} vs. {XXXXU}** |  |  |  |  |  |  |
| **SBFD antenna configuration** | **Twice area&same TxRUs (Option 2)** | √ | √ | √ | √ | √ | √ |
| **Same area&same TxRUs (Option 1)** |  |  |  |  |  |  |
| **Same area&half TxRUs (Option 3)** |  |  |  |  |  |  |
| **Packet Size** | **DL: 0.5Mbytes, UL: 0.125Mbyte** | √ |  | √ |  | √ | √ |
| **DL: 4Kbytes, UL: 1Kbyte** |  | √ |  | √ | √ | √ |
| **Others** | |  |  |  |  | Legacy TDD vs. Dynamic SBFD | RSI=122.5dB |
| **Sources** | | CMCC, vivo, SPRD, CATT, ZTE, New H3C, Sony, Mediatek, Qualcomm, Samsung | vivo, CATT, ZTE, Qualcomm, OPPO | CMCC, vivo, SPRD, CATT, ZTE, New H3C, Sony, Qualcomm, Nokia | vivo, CATT, ZTE, Qualcomm, OPPO, Nokia | vivo | LG |

Only the first 4 subcases are summarized in the following considering more inputs for them.

*SBFD#1\_InH\_FR1\_Sub#1*

Table ‑**: Key assumption for SBFD#1\_InH\_FR1\_Sub#1.**

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| **Sub-cases  Key assumptions** | | **SBFD#1\_InH\_FR1\_Sub#1** |
| **SBFD slot configuration** | **Alt-2: {DDDSU} vs. {XXXXU}** | √ |
| **Alt-4: {DDDSU} vs. {XXXXX}** |  |
| **Alt-1: {DDDSU} vs. {DXXXX}** |  |
| **Alt-3: {DDSUU} vs. {XXXXU}** |  |
| **SBFD antenna configuration** | **Twice area&same TxRUs (Option 2)** | √ |
| **Same area&same TxRUs (Option 1)** |  |
| **Same area&half TxRUs (Option 3)** |  |
| **Packet Size** | **DL: 0.5Mbytes, UL: 0.125Mbyte** | √ |
| **DL: 4Kbytes, UL: 1Kbyte** |  |
| **Others** | |  |
| **Sources** | | CMCC, vivo, SPRD, CATT, ZTE, New H3C, Sony, Mediatek, Qualcomm, Samsung |

Table ‑**: Summary of results for SBFD#1\_InH\_FR1\_Sub#1.**

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| ***Simple description for the sub-case (RSI based on 1dB desense, SBFD Alt-2, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte)*** | | | | | | | | | | |
|  | | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase |
| **DL Average-UPT (Mbps)** | **Mean** | CMCC: 225.72,  vivo: 684.54,  SPRD: 400.52,  CATT: 336.84,  ZTE: 459.83,  Sony: 380.53,  Mediatek: 630.50,  Qualcomm: 35.10,  Samsung: 726.00, | CMCC: 180.64,  vivo: 543.09,  SPRD: 333.10,  CATT: 279.85,  ZTE: 349.44,  Sony: 300.00,  Mediatek: 488.30,  Qualcomm: 424.42,  Samsung: 720.00, | CMCC: -19.97%,  vivo: -20.66%,  SPRD: -16.83%,  CATT: -16.92%,  ZTE: -24.01%,  Sony: -21.16%,  Mediatek: -22.55%,  Qualcomm: -28.36%,  Samsung: -0.83%, | CMCC: 194.29,  vivo: 512.53,  SPRD: 281.77,  CATT: 225.83,  ZTE: 410.65,  Sony: 300.23,  Mediatek: 492.60,  Qualcomm: 19.76,  Samsung: 460.00, | CMCC: 148.29,  vivo: 393.63,  SPRD: 220.41,  CATT: 179.82,  ZTE: 301.54,  Sony: 222.11,  Mediatek: 343.60,  Qualcomm: 310.57,  Samsung: 444.00, | CMCC: -23.68%,  vivo: -23.20%,  SPRD: -21.78%,  CATT: -20.37%,  ZTE: -26.57%,  Sony: -26.02%,  Mediatek: -30.25%,  Qualcomm: -30.13%,  Samsung: -3.48%, | vivo: 346.01,  SPRD: 188.70,  CATT: 89.79,  ZTE: 368.92,  Sony: 200.09,  Mediatek: 357.40,  Qualcomm: 8.02,  Samsung: 321.00, | vivo: 207.73,  SPRD: 121.50,  CATT: 71.03,  ZTE: 252.89,  Sony: 144.05,  Mediatek: 249.20,  Qualcomm: 190.08,  Samsung: 228.00, | vivo: -39.96%,  SPRD: -35.61%,  CATT: -20.89%,  ZTE: -31.45%,  Sony: -28.01%,  Mediatek: -30.27%,  Qualcomm: -32.88%,  Samsung: -28.97%, |
| **5%** | CMCC: 212.57,  vivo: 523.64,  SPRD: 160.23,  CATT: 245.65,  ZTE: 166.69,  Sony: 180.35,  Mediatek: 264.50,  Qualcomm: 12.66,  Samsung: 396.00, | CMCC: 168.12,  vivo: 459.14,  SPRD: 127.20,  CATT: 192.71,  ZTE: 123.72,  Sony: 127.20,  Mediatek: 127.40,  Qualcomm: 260.04,  Samsung: 339.00, | CMCC: -20.91%,  vivo: -12.32%,  SPRD: -20.61%,  CATT: -21.55%,  ZTE: -25.78%,  Sony: -29.47%,  Mediatek: -51.83%,  Qualcomm: -26.91%,  Samsung: -14.39%, | CMCC: 165.76,  vivo: 291.85,  SPRD: 119.57,  CATT: 162.63,  ZTE: 127.78,  Sony: 120.30,  Mediatek: 72.50,  Qualcomm: 6.79,  Samsung: 242.00, | CMCC: 125.76,  vivo: 237.44,  SPRD: 87.74,  CATT: 121.44,  ZTE: 89.82,  Sony: 100.06,  Mediatek: 21.70,  Qualcomm: 177.50,  Samsung: 204.00, | CMCC: -24.13%,  vivo: -18.64%,  SPRD: -26.62%,  CATT: -25.32%,  ZTE: -29.71%,  Sony: -16.82%,  Mediatek: -70.07%,  Qualcomm: -31.87%,  Samsung: -15.70%, | vivo: 132.71,  SPRD: 48.80,  CATT: 73.87,  ZTE: 64.03,  Sony: 45.70,  Mediatek: 10.80,  Qualcomm: 2.00,  Samsung: 149.00, | vivo: 20.18,  SPRD: 17.90,  CATT: 52.97,  ZTE: 10.82,  Sony: 40.27,  Mediatek: 1.20,  Qualcomm: 86.99,  Samsung: 85.40, | vivo: -84.79%,  SPRD: -63.32%,  CATT: -28.30%,  ZTE: -83.10%,  Sony: -11.88%,  Mediatek: -88.89%,  Qualcomm: -38.54%,  Samsung: -42.68%, |
| **50%** | CMCC: 226.88,  vivo: 709.43,  SPRD: 366.93,  CATT: 327.14,  ZTE: 563.97,  Sony: 450.19,  Mediatek: 679.60,  Qualcomm: 33.55,  Samsung: 684.00, | CMCC: 182.07,  vivo: 551.30,  SPRD: 306.70,  CATT: 291.86,  ZTE: 420.84,  Sony: 318.90,  Mediatek: 530.90,  Qualcomm: 416.94,  Samsung: 678.00, | CMCC: -19.75%,  vivo: -22.29%,  SPRD: -16.41%,  CATT: -10.78%,  ZTE: -25.38%,  Sony: -29.16%,  Mediatek: -21.88%,  Qualcomm: -28.01%,  Samsung: -0.88%, | CMCC: 194.66,  vivo: 507.99,  SPRD: 261.27,  CATT: 224.90,  ZTE: 487.60,  Sony: 300.12,  Mediatek: 537.70,  Qualcomm: 18.97,  Samsung: 463.00, | CMCC: 148.92,  vivo: 389.26,  SPRD: 192.64,  CATT: 185.76,  ZTE: 349.48,  Sony: 210.19,  Mediatek: 374.80,  Qualcomm: 288.63,  Samsung: 447.00, | CMCC: -23.50%,  vivo: -23.37%,  SPRD: -26.27%,  CATT: -17.40%,  ZTE: -28.33%,  Sony: -29.96%,  Mediatek: -30.30%,  Qualcomm: -33.73%,  Samsung: -3.46%, | vivo: 322.75,  SPRD: 154.80,  CATT: 89.54,  ZTE: 421.94,  Sony: 120.91,  Mediatek: 374.00,  Qualcomm: 6.86,  Samsung: 307.00, | vivo: 182.59,  SPRD: 82.20,  CATT: 71.63,  ZTE: 269.54,  Sony: 101.88,  Mediatek: 263.90,  Qualcomm: 172.18,  Samsung: 198.00, | vivo: -43.43%,  SPRD: -46.90%,  CATT: -20.00%,  ZTE: -36.12%,  Sony: -15.74%,  Mediatek: -29.44%,  Qualcomm: -34.26%,  Samsung: -35.50%, |
| **UL Average-UPT (Mbps)** | **Mean** | CMCC: 37.11,  vivo: 204.43,  SPRD: 48.33,  CATT: 131.50,  ZTE: 143.85,  Sony: 120.65,  Mediatek: 137.50,  Qualcomm: 0.92,  Samsung: 79.90, | CMCC: 67.51,  vivo: 290.76,  SPRD: 93.80,  CATT: 193.87,  ZTE: 191.48,  Sony: 164.33,  Mediatek: 217.00,  Qualcomm: 174.67,  Samsung: 125.00, | CMCC: 81.92%,  vivo: 42.23%,  SPRD: 94.08%,  CATT: 47.43%,  ZTE: 33.11%,  Sony: 36.20%,  Mediatek: 57.82%,  Qualcomm: 82.58%,  Samsung: 56.45%, | CMCC: 34.43,  vivo: 186.08,  SPRD: 46.22,  CATT: 79.45,  ZTE: 130.01,  Sony: 75.28,  Mediatek: 128.60,  Qualcomm: 0.42,  Samsung: 68.80, | CMCC: 64.85,  vivo: 274.05,  SPRD: 91.10,  CATT: 109.25,  ZTE: 182.97,  Sony: 103.64,  Mediatek: 199.60,  Qualcomm: 142.97,  Samsung: 110.00, | CMCC: 88.35%,  vivo: 47.27%,  SPRD: 97.10%,  CATT: 37.51%,  ZTE: 40.74%,  Sony: 37.67%,  Mediatek: 55.21%,  Qualcomm: 121.39%,  Samsung: 59.88%, | vivo: 152.01,  SPRD: 39.10,  CATT: 27.26,  ZTE: 114.77,  Sony: 50.01,  Mediatek: 111.20,  Qualcomm: 0.15,  Samsung: 45.50, | vivo: 222.37,  SPRD: 84.10,  CATT: 36.62,  ZTE: 170.18,  Sony: 77.76,  Mediatek: 171.10,  Qualcomm: 109.66,  Samsung: 82.70, | vivo: 46.29%,  SPRD: 115.09%,  CATT: 34.34%,  ZTE: 48.28%,  Sony: 55.49%,  Mediatek: 53.87%,  Qualcomm: 186.94%,  Samsung: 81.76%, |
| **5%** | CMCC: 29.94,  vivo: 193.90,  SPRD: 18.21,  CATT: 74.10,  ZTE: 98.69,  Sony: 68.33,  Mediatek: 76.10,  Qualcomm: 0.42,  Samsung: 15.40, | CMCC: 59.94,  vivo: 280.32,  SPRD: 46.74,  CATT: 135.73,  ZTE: 104.51,  Sony: 90.25,  Mediatek: 170.00,  Qualcomm: 132.47,  Samsung: 18.50, | CMCC: 100.20%,  vivo: 44.57%,  SPRD: 156.67%,  CATT: 83.17%,  ZTE: 5.90%,  Sony: 32.08%,  Mediatek: 123.39%,  Qualcomm: 103.51%,  Samsung: 20.13%, | CMCC: 26.41,  vivo: 171.15,  SPRD: 17.13,  CATT: 53.01,  ZTE: 100.14,  Sony: 50.20,  Mediatek: 76.50,  Qualcomm: 0.09,  Samsung: 18.90, | CMCC: 56.47,  vivo: 258.96,  SPRD: 42.06,  CATT: 82.72,  ZTE: 120.81,  Sony: 75.51,  Mediatek: 106.40,  Qualcomm: 88.16,  Samsung: 22.00, | CMCC: 113.82%,  vivo: 51.31%,  SPRD: 145.53%,  CATT: 56.05%,  ZTE: 20.64%,  Sony: 50.42%,  Mediatek: 39.08%,  Qualcomm: 199.48%,  Samsung: 16.40%, | vivo: 121.33,  SPRD: 11.70,  CATT: 16.80,  ZTE: 51.43,  Sony: 31.45,  Mediatek: 58.70,  Qualcomm: 0.02,  Samsung: 4.40, | vivo: 156.00,  SPRD: 39.20,  CATT: 25.53,  ZTE: 91.93,  Sony: 60.48,  Mediatek: 5.20,  Qualcomm: 53.81,  Samsung: 7.10, | vivo: 28.57%,  SPRD: 235.04%,  CATT: 51.98%,  ZTE: 78.75%,  Sony: 92.31%,  Mediatek: -91.14%,  Qualcomm: 338.36%,  Samsung: 61.36%, |
| **50%** | CMCC: 37.99,  vivo: 204.07,  SPRD: 42.21,  CATT: 130.48,  ZTE: 148.95,  Sony: 120.65,  Mediatek: 137.80,  Qualcomm: 1.00,  Samsung: 89.50, | CMCC: 68.28,  vivo: 291.05,  SPRD: 91.04,  CATT: 191.90,  ZTE: 155.66,  Sony: 180.07,  Mediatek: 227.30,  Qualcomm: 179.32,  Samsung: 144.00, | CMCC: 79.73%,  vivo: 42.63%,  SPRD: 115.68%,  CATT: 47.07%,  ZTE: 4.50%,  Sony: 49.25%,  Mediatek: 64.95%,  Qualcomm: 78.95%,  Samsung: 60.89%, | CMCC: 34.91,  vivo: 187.05,  SPRD: 42.23,  CATT: 82.37,  ZTE: 132.75,  Sony: 79.34,  Mediatek: 130.30,  Qualcomm: 0.40,  Samsung: 73.60, | CMCC: 65.51,  vivo: 275.05,  SPRD: 86.26,  CATT: 107.48,  ZTE: 144.84,  Sony: 90.22,  Mediatek: 215.20,  Qualcomm: 145.13,  Samsung: 120.00, | CMCC: 87.65%,  vivo: 47.04%,  SPRD: 104.26%,  CATT: 30.48%,  ZTE: 9.11%,  Sony: 13.71%,  Mediatek: 65.16%,  Qualcomm: 128.58%,  Samsung: 63.04%, | vivo: 153.22,  SPRD: 35.00,  CATT: 26.90,  ZTE: 119.33,  Sony: 56.85,  Mediatek: 111.40,  Qualcomm: 0.12,  Samsung: 46.80, | vivo: 230.10,  SPRD: 79.60,  CATT: 36.19,  ZTE: 139.83,  Sony: 78.90,  Mediatek: 183.50,  Qualcomm: 108.59,  Samsung: 90.20, | vivo: 50.18%,  SPRD: 127.43%,  CATT: 34.55%,  ZTE: 17.18%,  Sony: 38.79%,  Mediatek: 64.72%,  Qualcomm: 214.33%,  Samsung: 92.74%, |
| **DL Packet-Latency CDF (ms)** | **Mean** | CMCC: 9.60,  vivo: 6.35,  SPRD: 12.83,  CATT: 11.80,  ZTE: 12.08,   Mediatek: 17.50,  Qualcomm: 7.70,  Samsung: 7.27, | CMCC: 11.80,  vivo: 7.98,  SPRD: 16.05,  CATT: 14.15,  ZTE: 16.06,   Mediatek: 17.70,  Qualcomm: 10.55,  Samsung: 7.31, | CMCC: 22.92%,  vivo: -25.65%,  SPRD: 25.10%,  CATT: 19.88%,  ZTE: 32.95%,  Sony: 0.00%,  Mediatek: 1.14%,  Qualcomm: -37.04%,  Samsung: 0.55%, | CMCC: 12.70,  vivo: 10.09,  SPRD: 19.54,  CATT: 17.48,  ZTE: 16.32,   Mediatek: 23.10,  Qualcomm: 10.50,  Samsung: 13.20, | CMCC: 16.90,  vivo: 13.42,  SPRD: 26.08,  CATT: 21.01,  ZTE: 25.50,   Mediatek: 35.60,  Qualcomm: 14.84,  Samsung: 13.90, | CMCC: 33.07%,  vivo: -32.98%,  SPRD: 33.47%,  CATT: 20.23%,  ZTE: 56.25%,  Sony: 0.00%,  Mediatek: 54.11%,  Qualcomm: -41.43%,  Samsung: 5.30%, | vivo: 23.65,  SPRD: 40.36,  CATT: 46.23,  ZTE: 32.67,   Mediatek: 46.90,  Qualcomm: 18.31,  Samsung: 45.90, | vivo: 150.97,  SPRD: 85.10,  CATT: 56.09,  ZTE: 55.27,   Mediatek: 39.80,  Qualcomm: 28.45,  Samsung: 70.70, | vivo: -538.29%,  SPRD: 110.85%,  CATT: 21.33%,  ZTE: 69.18%,  Sony: 0.00%,  Mediatek: -15.14%,  Qualcomm: -55.42%,  Samsung: 54.03%, |
| **5%** | CMCC: 8.50,  vivo: 4.63,  SPRD: 4.92,  CATT: 6.97,  ZTE: 6.02,   Mediatek: 6.50,  Qualcomm: 4.00,  Samsung: 3.10, | CMCC: 10.50,  vivo: 6.07,  SPRD: 6.55,  CATT: 10.55,  ZTE: 8.02,   Mediatek: 8.30,  Qualcomm: 5.50,  Samsung: 2.90, | CMCC: 23.53%,  vivo: -31.04%,  SPRD: 33.13%,  CATT: 51.29%,  ZTE: 33.22%,  Sony: 0.00%,  Mediatek: 27.69%,  Qualcomm: -37.39%,  Samsung: -6.45%, | CMCC: 8.50,  vivo: 4.97,  SPRD: 7.41,  CATT: 12.04,  ZTE: 6.02,   Mediatek: 6.50,  Qualcomm: 4.99,  Samsung: 4.70, | CMCC: 10.50,  vivo: 6.21,  SPRD: 8.71,  CATT: 15.72,  ZTE: 8.04,   Mediatek: 7.90,  Qualcomm: 6.61,  Samsung: 4.60, | CMCC: 23.53%,  vivo: -24.86%,  SPRD: 17.54%,  CATT: 30.63%,  ZTE: 33.55%,  Sony: 0.00%,  Mediatek: 21.54%,  Qualcomm: -32.64%,  Samsung: -2.13%, | vivo: 5.23,  SPRD: 7.78,  CATT: 33.91,  ZTE: 6.05,   Mediatek: 6.50,  Qualcomm: 6.89,  Samsung: 6.20, | vivo: 6.75,  SPRD: 8.78,  CATT: 41.79,  ZTE: 8.09,   Mediatek: 7.90,  Qualcomm: 9.83,  Samsung: 7.40, | vivo: -29.02%,  SPRD: 12.85%,  CATT: 23.24%,  ZTE: 33.72%,  Sony: 0.00%,  Mediatek: 21.54%,  Qualcomm: -42.70%,  Samsung: 19.35%, |
| **50%** | CMCC: 8.50,  vivo: 5.36,  SPRD: 11.69,  CATT: 11.40,  ZTE: 6.88,   Mediatek: 6.50,  Qualcomm: 6.77,  Samsung: 5.90, | CMCC: 10.50,  vivo: 6.73,  SPRD: 14.50,  CATT: 13.58,  ZTE: 8.91,   Mediatek: 9.30,  Qualcomm: 9.29,  Samsung: 5.90, | CMCC: 23.53%,  vivo: -25.51%,  SPRD: 24.04%,  CATT: 19.10%,  ZTE: 29.51%,  Sony: 0.00%,  Mediatek: 43.08%,  Qualcomm: -37.20%,  Samsung: 0.00%, | CMCC: 9.00,  vivo: 7.81,  SPRD: 15.43,  CATT: 16.47,  ZTE: 10.27,   Mediatek: 8.50,  Qualcomm: 9.05,  Samsung: 9.70, | CMCC: 12.50,  vivo: 10.17,  SPRD: 19.84,  CATT: 19.90,  ZTE: 15.02,   Mediatek: 12.90,  Qualcomm: 12.83,  Samsung: 10.50, | CMCC: 38.89%,  vivo: -30.25%,  SPRD: 28.58%,  CATT: 20.84%,  ZTE: 46.25%,  Sony: 0.00%,  Mediatek: 51.76%,  Qualcomm: -41.66%,  Samsung: 8.25%, | vivo: 13.06,  SPRD: 24.62,  CATT: 44.94,  ZTE: 12.41,   Mediatek: 12.00,  Qualcomm: 14.84,  Samsung: 35.10, | vivo: 26.25,  SPRD: 44.04,  CATT: 54.54,  ZTE: 17.48,   Mediatek: 17.90,  Qualcomm: 22.48,  Samsung: 45.80, | vivo: -101.07%,  SPRD: 78.88%,  CATT: 21.36%,  ZTE: 40.85%,  Sony: 0.00%,  Mediatek: 49.17%,  Qualcomm: -51.47%,  Samsung: 30.48%, |
| **UL Packet-Latency CDF (ms)** | **Mean** | CMCC: 16.50,  vivo: 5.24,  SPRD: 29.11,  CATT: 7.21,  ZTE: 9.44,   Mediatek: 11.80,  Qualcomm: 10.12,  Samsung: 27.50, | CMCC: 8.70,  vivo: 3.52,  SPRD: 12.66,  CATT: 4.91,  ZTE: 7.93,   Mediatek: 13.90,  Qualcomm: 6.01,  Samsung: 19.40, | CMCC: -47.27%,  vivo: 32.84%,  SPRD: -56.51%,  CATT: -31.88%,  ZTE: -16.00%,  Sony: 0.00%,  Mediatek: 17.80%,  Qualcomm: 40.60%,  Samsung: -29.45%, | CMCC: 18.90,  vivo: 6.20,  SPRD: 31.44,  CATT: 12.47,  ZTE: 9.82,   Mediatek: 19.90,  Qualcomm: 18.58,  Samsung: 35.20, | CMCC: 9.40,  vivo: 3.87,  SPRD: 13.66,  CATT: 8.72,  ZTE: 6.75,   Mediatek: 27.50,  Qualcomm: 7.87,  Samsung: 29.90, | CMCC: -50.26%,  vivo: 37.66%,  SPRD: -56.55%,  CATT: -30.09%,  ZTE: -31.26%,  Sony: 0.00%,  Mediatek: 38.19%,  Qualcomm: 57.62%,  Samsung: -15.06%, | vivo: 9.72,  SPRD: 49.05,  CATT: 37.37,  ZTE: 18.85,   Mediatek: 23.50,  Qualcomm: 43.42,  Samsung: 124.00, | vivo: 5.48,  SPRD: 15.87,  CATT: 26.89,  ZTE: 8.63,   Mediatek: 54.70,  Qualcomm: 11.38,  Samsung: 85.50, | vivo: 43.65%,  SPRD: -67.65%,  CATT: -28.05%,  ZTE: -54.22%,  Sony: 0.00%,  Mediatek: 132.77%,  Qualcomm: 73.78%,  Samsung: -31.05%, |
| **5%** | CMCC: 11.50,  vivo: 3.64,  SPRD: 11.15,  CATT: 4.79,  ZTE: 5.59,   Mediatek: 5.20,  Qualcomm: 6.82,  Samsung: 10.10, | CMCC: 7.00,  vivo: 3.03,  SPRD: 6.70,  CATT: 2.89,  ZTE: 3.27,   Mediatek: 4.60,  Qualcomm: 4.29,  Samsung: 5.60, | CMCC: -39.13%,  vivo: 16.74%,  SPRD: -39.91%,  CATT: -39.79%,  ZTE: -41.50%,  Sony: 0.00%,  Mediatek: -11.54%,  Qualcomm: 37.13%,  Samsung: -44.55%, | CMCC: 11.50,  vivo: 3.68,  SPRD: 10.66,  CATT: 8.09,  ZTE: 5.63,   Mediatek: 5.70,  Qualcomm: 7.59,  Samsung: 10.10, | CMCC: 7.00,  vivo: 3.04,  SPRD: 6.07,  CATT: 5.47,  ZTE: 3.38,   Mediatek: 4.60,  Qualcomm: 4.58,  Samsung: 5.60, | CMCC: -39.13%,  vivo: 17.31%,  SPRD: -43.06%,  CATT: -32.36%,  ZTE: -39.96%,  Sony: 0.00%,  Mediatek: -19.30%,  Qualcomm: 39.71%,  Samsung: -44.55%, | vivo: 3.76,  SPRD: 11.50,  CATT: 20.76,  ZTE: 5.63,   Mediatek: 5.70,  Qualcomm: 10.51,  Samsung: 10.60, | vivo: 3.08,  SPRD: 6.58,  CATT: 18.52,  ZTE: 3.41,   Mediatek: 4.60,  Qualcomm: 5.22,  Samsung: 5.90, | vivo: 18.19%,  SPRD: -42.78%,  CATT: -10.81%,  ZTE: -39.43%,  Sony: 0.00%,  Mediatek: -19.30%,  Qualcomm: 50.36%,  Samsung: -44.34%, |
| **50%** | CMCC: 14.00,  vivo: 4.91,  SPRD: 23.97,  CATT: 6.21,  ZTE: 6.77,   Mediatek: 9.20,  Qualcomm: 8.82,  Samsung: 11.60, | CMCC: 8.00,  vivo: 3.34,  SPRD: 11.50,  CATT: 4.63,  ZTE: 5.95,   Mediatek: 5.60,  Qualcomm: 5.38,  Samsung: 7.20, | CMCC: -42.86%,  vivo: 31.91%,  SPRD: -52.02%,  CATT: -25.40%,  ZTE: -12.11%,  Sony: 0.00%,  Mediatek: -39.13%,  Qualcomm: 38.97%,  Samsung: -37.93%, | CMCC: 15.50,  vivo: 5.24,  SPRD: 25.35,  CATT: 11.33,  ZTE: 7.20,   Mediatek: 10.20,  Qualcomm: 14.92,  Samsung: 12.30, | CMCC: 8.00,  vivo: 3.42,  SPRD: 11.75,  CATT: 8.44,  ZTE: 6.23,   Mediatek: 6.10,  Qualcomm: 6.81,  Samsung: 10.00, | CMCC: -48.39%,  vivo: 34.80%,  SPRD: -53.65%,  CATT: -25.47%,  ZTE: -13.47%,  Sony: 0.00%,  Mediatek: -40.20%,  Qualcomm: 54.38%,  Samsung: -18.70%, | vivo: 6.21,  SPRD: 31.11,  CATT: 35.27,  ZTE: 7.63,   Mediatek: 12.20,  Qualcomm: 27.07,  Samsung: 46.50, | vivo: 4.12,  SPRD: 13.35,  CATT: 26.22,  ZTE: 6.55,   Mediatek: 6.60,  Qualcomm: 9.33,  Samsung: 24.10, | vivo: 33.68%,  SPRD: -57.09%,  CATT: -25.65%,  ZTE: -14.15%,  Sony: 0.00%,  Mediatek: -45.90%,  Qualcomm: 65.54%,  Samsung: -48.17%, |
| **DL RU (%)** | **Type-1** | CMCC: 3.43%,  vivo: 7.37%,  SPRD: 2.80%,  CATT: 6.02%,  ZTE: 6.01%,  Sony: 5.13%,  Mediatek: 7.40%,  Qualcomm: 7.02%,  Samsung: 6.20%, | CMCC: 3.43%,  vivo: 7.35%,  SPRD: 2.94%,  CATT: 5.16%,  ZTE: 5.79%,  Sony: 6.16%,  Mediatek: 10.30%,  Qualcomm: 9.20%,  Samsung: 7.40%, | CMCC: 0.00%,  vivo: -0.02%,  SPRD: 0.14%,  CATT: -0.86%,  ZTE: -0.22%,  Sony: 1.03%,  Mediatek: 2.90%,  Qualcomm: 2.18%,  Samsung: 1.20%, | CMCC: 14.23%,  vivo: 22.18%,  SPRD: 25.36%,  CATT: 19.89%,  ZTE: 20.51%,  Sony: 21.20%,  Mediatek: 27.10%,  Qualcomm: 17.29%,  Samsung: 18.60%, | CMCC: 14.60%,  vivo: 22.20%,  SPRD: 27.20%,  CATT: 16.52%,  ZTE: 19.96%,  Sony: 15.22%,  Mediatek: 34.30%,  Qualcomm: 22.48%,  Samsung: 21.50%, | CMCC: 0.37%,  vivo: 0.02%,  SPRD: 1.84%,  CATT: -3.37%,  ZTE: -0.55%,  Sony: -5.98%,  Mediatek: 7.20%,  Qualcomm: 5.18%,  Samsung: 2.90%, | vivo: 52.22%,  SPRD: 40.96%,  CATT: 40.94%,  ZTE: 33.82%,  Sony: 43.55%,  Mediatek: 44.50%,  Qualcomm: 43.49%,  Samsung: 53.60%, | vivo: 56.30%,  SPRD: 39.87%,  CATT: 32.98%,  ZTE: 31.73%,  Sony: 30.44%,  Mediatek: 49.70%,  Qualcomm: 51.97%,  Samsung: 62.20%, | vivo: 4.08%,  SPRD: -1.09%,  CATT: -7.96%,  ZTE: -2.09%,  Sony: -13.11%,  Mediatek: 5.20%,  Qualcomm: 8.49%,  Samsung: 8.60%, |
| **Type-2** | CMCC: 4.31%,  vivo: 9.55%,  SPRD: 3.50%,  CATT: 7.52%,  ZTE: 7.52%,  Sony: 8.54%,  Mediatek: 9.50%,  Qualcomm: 8.77%,  Samsung: 7.70%, | CMCC: 5.47%,  vivo: 11.72%,  SPRD: 4.60%,  CATT: 8.06%,  ZTE: 9.53%,  Sony: 10.33%,  Mediatek: 12.50%,  Qualcomm: 12.27%,  Samsung: 7.80%, | CMCC: 1.16%,  vivo: 2.17%,  SPRD: 1.10%,  CATT: 0.54%,  ZTE: 2.01%,  Sony: 1.79%,  Mediatek: 3.00%,  Qualcomm: 3.50%,  Samsung: 0.10%, | CMCC: 17.92%,  vivo: 28.75%,  SPRD: 31.70%,  CATT: 24.86%,  ZTE: 25.63%,  Sony: 26.55%,  Mediatek: 31.10%,  Qualcomm: 21.62%,  Samsung: 23.20%, | CMCC: 23.25%,  vivo: 35.41%,  SPRD: 42.50%,  CATT: 25.82%,  ZTE: 32.87%,  Sony: 29.06%,  Mediatek: 41.60%,  Qualcomm: 29.98%,  Samsung: 24.00%, | CMCC: 5.33%,  vivo: 6.65%,  SPRD: 10.80%,  CATT: 0.96%,  ZTE: 7.24%,  Sony: 2.51%,  Mediatek: 10.50%,  Qualcomm: 8.36%,  Samsung: 0.80%, | vivo: 67.69%,  SPRD: 51.20%,  CATT: 51.18%,  ZTE: 42.27%,  Sony: 46.38%,  Mediatek: 54.90%,  Qualcomm: 54.36%,  Samsung: 67.10%, | vivo: 89.77%,  SPRD: 62.30%,  CATT: 51.54%,  ZTE: 52.25%,  Sony: 41.54%,  Mediatek: 60.30%,  Qualcomm: 69.33%,  Samsung: 70.30%, | vivo: 22.08%,  SPRD: 11.10%,  CATT: 0.36%,  ZTE: 9.98%,  Sony: -4.84%,  Mediatek: 5.40%,  Qualcomm: 14.98%,  Samsung: 3.20%, |
| **UL RU (%)** | **Type-1** | CMCC: 1.13%,  vivo: 2.03%,  SPRD: 1.26%,  CATT: 1.53%,  ZTE: 2.39%,  Sony: 0.95%,  Mediatek: 7.20%,  Qualcomm: 1.68%,  Samsung: 1.88%, | CMCC: 1.01%,  vivo: 1.99%,  SPRD: 0.97%,  CATT: 2.45%,  ZTE: 2.45%,  Sony: 2.45%,  Mediatek: 2.50%,  Qualcomm: 1.55%,  Samsung: 2.06%, | CMCC: -0.12%,  vivo: -0.04%,  SPRD: -0.29%,  CATT: 0.92%,  ZTE: 0.06%,  Sony: 1.50%,  Mediatek: -4.70%,  Qualcomm: -0.12%,  Samsung: 0.18%, | CMCC: 4.08%,  vivo: 5.04%,  SPRD: 4.72%,  CATT: 5.74%,  ZTE: 6.23%,  Sony: 7.00%,  Mediatek: 22.80%,  Qualcomm: 5.59%,  Samsung: 4.70%, | CMCC: 3.63%,  vivo: 4.91%,  SPRD: 3.74%,  CATT: 8.05%,  ZTE: 6.07%,  Sony: 10.13%,  Mediatek: 5.80%,  Qualcomm: 4.31%,  Samsung: 5.07%, | CMCC: -0.45%,  vivo: -0.13%,  SPRD: -0.98%,  CATT: 2.31%,  ZTE: -0.16%,  Sony: 3.13%,  Mediatek: -17.00%,  Qualcomm: -1.28%,  Samsung: 0.37%, | vivo: 11.41%,  SPRD: 10.42%,  CATT: 10.52%,  ZTE: 10.32%,  Sony: 10.28%,  Mediatek: 33.60%,  Qualcomm: 13.04%,  Samsung: 10.90%, | vivo: 10.78%,  SPRD: 8.13%,  CATT: 18.48%,  ZTE: 10.41%,  Sony: 18.48%,  Mediatek: 10.10%,  Qualcomm: 9.97%,  Samsung: 12.00%, | vivo: -0.64%,  SPRD: -2.29%,  CATT: 7.96%,  ZTE: 0.09%,  Sony: 8.20%,  Mediatek: -23.50%,  Qualcomm: -3.07%,  Samsung: 1.10%, |
| **Type-2** | CMCC: 5.47%,  vivo: 10.14%,  SPRD: 6.30%,  CATT: 7.66%,  ZTE: 11.93%,  Sony: 6.66%,  Mediatek: 11.10%,  Qualcomm: 8.38%,  Samsung: 9.40%, | CMCC: 2.70%,  vivo: 5.56%,  SPRD: 2.70%,  CATT: 6.81%,  ZTE: 6.81%,  Sony: 6.81%,  Mediatek: 7.60%,  Qualcomm: 4.26%,  Samsung: 5.90%, | CMCC: -2.77%,  vivo: -4.58%,  SPRD: -3.60%,  CATT: -0.85%,  ZTE: -5.12%,  Sony: 0.15%,  Mediatek: -3.50%,  Qualcomm: -4.12%,  Samsung: -3.50%, | CMCC: 19.82%,  vivo: 25.20%,  SPRD: 23.60%,  CATT: 28.69%,  ZTE: 31.16%,  Sony: 35.07%,  Mediatek: 30.30%,  Qualcomm: 27.95%,  Samsung: 23.60%, | CMCC: 9.77%,  vivo: 13.71%,  SPRD: 10.40%,  CATT: 22.36%,  ZTE: 16.82%,  Sony: 26.72%,  Mediatek: 22.30%,  Qualcomm: 11.82%,  Samsung: 14.50%, | CMCC: -10.05%,  vivo: -11.48%,  SPRD: -13.20%,  CATT: -6.33%,  ZTE: -14.34%,  Sony: -8.35%,  Mediatek: -8.00%,  Qualcomm: -16.12%,  Samsung: -9.10%, | vivo: 57.06%,  SPRD: 52.10%,  CATT: 52.61%,  ZTE: 51.61%,  Sony: 40.06%,  Mediatek: 50.90%,  Qualcomm: 65.19%,  Samsung: 54.80%, | vivo: 30.08%,  SPRD: 22.60%,  CATT: 51.34%,  ZTE: 28.87%,  Sony: 44.60%,  Mediatek: 41.90%,  Qualcomm: 27.35%,  Samsung: 34.50%, | vivo: -26.99%,  SPRD: -29.50%,  CATT: -1.27%,  ZTE: -22.74%,  Sony: 4.54%,  Mediatek: -9.00%,  Qualcomm: -37.85%,  Samsung: -20.30%, |
| Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1 - For Latency, the increase can be calculated as: Increase (%) = SBFD latency / TDD latency - 1 - For RU, the increase can be calculated as: Increase (%) = SBFD RU (%) - TDD RU (%) | | | | | | | | | | |

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| ***Simple description for the sub-case (RSI based on 1dB desense, SBFD Alt-2, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte)*** | | | |
|  | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | |
| **DL: Low, UL: Low** | **DL: Medium, UL: Medium** | **DL: High, UL: High** |
| **Gain of DL resource (%)** | CMCC: -23.78%,  vivo: -18.71%,  SPRD: -20.93%,  CATT: -20.99%,  ZTE: -26.63%,  Sony: -20.93%,  Mediatek: -3.70%,  Qualcomm: -35.19%,  Samsung: -20.93%, | CMCC: -23.78%,  vivo: -18.71%,  SPRD: -20.93%,  CATT: -20.99%,  ZTE: -26.63%,  Sony: -20.93%,  Mediatek: -3.70%,  Qualcomm: -35.19%,  Samsung: -20.93%, | vivo: -18.71%,  SPRD: -20.93%,  CATT: -20.99%,  ZTE: -26.63%,  Sony: -20.93%,  Mediatek: -3.70%,  Qualcomm: -35.19%,  Samsung: -20.93%, |
| **Net gain of mean value of DL average-UPT (%)** | CMCC: 3.81%,  vivo: -1.95%,  SPRD: 4.09%,  CATT: 4.07%,  ZTE: 2.62%,  Sony: -0.24%,  Mediatek: -18.86%,  Qualcomm: 6.83%,  Samsung: 20.10%, | CMCC: 0.10%,  vivo: -4.49%,  SPRD: -0.85%,  CATT: 0.62%,  ZTE: 0.06%,  Sony: -5.09%,  Mediatek: -26.55%,  Qualcomm: 5.06%,  Samsung: 17.45%, | vivo: -21.25%,  SPRD: -14.69%,  CATT: 0.10%,  ZTE: -4.82%,  Sony: -7.08%,  Mediatek: -26.58%,  Qualcomm: 2.30%,  Samsung: -8.05%, |
| **Net gain of 5% value of DL average-UPT (%)** | CMCC: 2.87%,  vivo: 6.39%,  SPRD: 0.31%,  CATT: -0.56%,  ZTE: 0.85%,  Sony: -8.54%,  Mediatek: -48.14%,  Qualcomm: 8.28%,  Samsung: 6.53%, | CMCC: -0.35%,  vivo: 0.06%,  SPRD: -5.69%,  CATT: -4.33%,  ZTE: -3.08%,  Sony: 4.10%,  Mediatek: -66.37%,  Qualcomm: 3.31%,  Samsung: 5.22%, | vivo: -66.08%,  SPRD: -42.39%,  CATT: -7.31%,  ZTE: -56.47%,  Sony: 9.04%,  Mediatek: -85.19%,  Qualcomm: -3.35%,  Samsung: -21.76%, |
| **Net gain of 50% value of DL average-UPT (%)** | CMCC: 4.03%,  vivo: -3.58%,  SPRD: 4.51%,  CATT: 10.21%,  ZTE: 1.25%,  Sony: -8.24%,  Mediatek: -18.18%,  Qualcomm: 7.17%,  Samsung: 20.05%, | CMCC: 0.28%,  vivo: -4.66%,  SPRD: -5.34%,  CATT: 3.59%,  ZTE: -1.70%,  Sony: -9.04%,  Mediatek: -26.60%,  Qualcomm: 1.45%,  Samsung: 17.47%, | vivo: -24.72%,  SPRD: -25.97%,  CATT: 0.99%,  ZTE: -9.49%,  Sony: 5.19%,  Mediatek: -25.74%,  Qualcomm: 0.93%,  Samsung: -14.58%, |
| **Gain of UL resource (%)** | CMCC: 77.50%,  vivo: 79.10%,  SPRD: 80.50%,  CATT: 80.60%,  ZTE: 74.85%,  Sony: 80.50%,  Mediatek: 0.00%,  Qualcomm: 87.50%,  Samsung: 80.00%, | CMCC: 77.50%,  vivo: 79.10%,  SPRD: 80.50%,  CATT: 80.60%,  ZTE: 74.85%,  Sony: 80.50%,  Mediatek: 0.00%,  Qualcomm: 87.50%,  Samsung: 80.00%, | vivo: 79.10%,  SPRD: 80.50%,  CATT: 80.60%,  ZTE: 74.85%,  Sony: 80.50%,  Mediatek: 0.00%,  Qualcomm: 87.50%,  Samsung: 80.00%, |
| **Net gain of mean value of UL average-UPT (%)** | CMCC: 4.42%,  vivo: -36.87%,  SPRD: 13.58%,  CATT: -33.17%,  ZTE: -41.74%,  Sony: -44.30%,  Mediatek: 57.82%,  Qualcomm: -4.92%,  Samsung: -23.55%, | CMCC: 10.85%,  vivo: -31.83%,  SPRD: 16.60%,  CATT: -43.09%,  ZTE: -34.11%,  Sony: -42.83%,  Mediatek: 55.21%,  Qualcomm: 33.89%,  Samsung: -20.12%, | vivo: -32.81%,  SPRD: 34.59%,  CATT: -46.26%,  ZTE: -26.57%,  Sony: -25.01%,  Mediatek: 53.87%,  Qualcomm: 99.44%,  Samsung: 1.76%, |
| **Net gain of 5% value of UL average-UPT (%)** | CMCC: 22.70%,  vivo: -34.53%,  SPRD: 76.17%,  CATT: 2.57%,  ZTE: -68.95%,  Sony: -48.42%,  Mediatek: 123.39%,  Qualcomm: 16.01%,  Samsung: -59.87%, | CMCC: 36.32%,  vivo: -27.79%,  SPRD: 65.03%,  CATT: -24.55%,  ZTE: -54.21%,  Sony: -30.08%,  Mediatek: 39.08%,  Qualcomm: 111.98%,  Samsung: -63.60%, | vivo: -50.53%,  SPRD: 154.54%,  CATT: -28.62%,  ZTE: 3.90%,  Sony: 11.81%,  Mediatek: -91.14%,  Qualcomm: 250.86%,  Samsung: -18.64%, |
| **Net gain of 50% value of UL average-UPT (%)** | CMCC: 2.23%,  vivo: -36.47%,  SPRD: 35.18%,  CATT: -33.53%,  ZTE: -70.35%,  Sony: -31.25%,  Mediatek: 64.95%,  Qualcomm: -8.55%,  Samsung: -19.11%, | CMCC: 10.15%,  vivo: -32.06%,  SPRD: 23.76%,  CATT: -50.12%,  ZTE: -65.74%,  Sony: -66.79%,  Mediatek: 65.16%,  Qualcomm: 41.08%,  Samsung: -16.96%, | vivo: -28.92%,  SPRD: 46.93%,  CATT: -46.05%,  ZTE: -57.67%,  Sony: -41.71%,  Mediatek: 64.72%,  Qualcomm: 126.83%,  Samsung: 12.74%, |
| Note: - Gain of resource (%) = SBFD resource percentage / TDD resource percentage - 1, wherein, for legacy TDD, DL resource percentage per TDD period is 77.1%, and UL resource percentage per TDD period is 20%.  - Net gain of UPT (%) = Gain of UPT - Gain of UL/DL resource | | | |

For subcase SBFD#1\_InH\_FR1\_Sub#1, assuming RSI based on 1dB desense, SBFD Alt-2, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte, key findings are summarized below.

* Traffic load with {DL,UL} = {Low,Low},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 9 sources reported a degradation in the range of {-0.83%~-28.36%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 9 sources reported a degradation in the range of {-12.32%~-51.83%} for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 9 sources reported a degradation in the range of {-0.88%~-29.16%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 6 sources reported an increase in the range of {0.55%~32.95%} for SBFD, and 2 sources reported a decrease in the range of {-25.65%~-37.04%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 5 sources reported an increase in the range of {23.53%~51.29%} for SBFD, and 3 sources reported a decrease in the range of {-6.45%~-37.39%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 5 sources reported an increase in the range of {19.10%~43.08%} for SBFD, and 2 sources reported a decrease in the range of {-25.51%~-37.20%} for SBFD, and 2 sources reported no change for SBFD
    - Regarding DL Type-1 RU CDF, 5 sources reported an increase in the range of {0.14%~2.90%} for SBFD, and 3 sources reported a decrease in the range of {-0.02%~-0.86%} for SBFD, and 1 source reported no change for SBFD
    - Regarding DL Type-2 RU CDF, 9 sources reported an increase in the range of {0.10%~3.50%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 6 sources reported an improvement in the range of {2.62%~20.10%} for SBFD, and 3 sources reported a degradation in the range of {-0.24%~-18.86%} for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 6 sources reported an improvement in the range of {0.31%~8.28%} for SBFD, and 3 sources reported a degradation in the range of {-0.56%~-48.14%} for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 6 sources reported an improvement in the range of {1.25%~20.05%} for SBFD, and 3 sources reported a degradation in the range of {-3.58%~-18.18%} for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 9 sources reported an improvement in the range of {33.11%~94.08%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 9 sources reported an improvement in the range of {5.90%~156.67%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 9 sources reported an improvement in the range of {4.50%~115.68%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 3 sources reported an increase in the range of {17.80%~40.60%} for SBFD, and 5 sources reported a decrease in the range of {-16.00%~-56.51%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {16.74%~37.13%} for SBFD, and 6 sources reported a decrease in the range of {-11.54%~-44.55%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {31.91%~38.97%} for SBFD, and 6 sources reported a decrease in the range of {-12.11%~-52.02%} for SBFD, and 1 source reported no change for SBFD
    - Regarding UL Type-1 RU CDF, 4 sources reported an increase in the range of {0.06%~1.50%} for SBFD, and 5 sources reported a decrease in the range of {-0.04%~-4.70%} for SBFD
    - Regarding UL Type-2 RU CDF, 1 source reported an increase of 0.15% for SBFD, and 8 sources reported a decrease in the range of {-0.85%~-5.12%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 3 sources reported an improvement in the range of {4.42%~57.82%} for SBFD, and 6 sources reported a degradation in the range of {-4.92%~-44.30%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {2.57%~123.39%} for SBFD, and 4 sources reported a degradation in the range of {-34.53%~-68.95%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 3 sources reported an improvement in the range of {2.23%~64.95%} for SBFD, and 6 sources reported a degradation in the range of {-8.55%~-70.35%} for SBFD
* Traffic load with {DL,UL} = {Medium, Medium},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 9 sources reported a degradation in the range of {-3.48%~-30.25%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 9 sources reported a degradation in the range of {-15.70%~-70.07%} for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 9 sources reported a degradation in the range of {-3.46%~-33.73%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 6 sources reported an increase in the range of {5.30%~56.25%} for SBFD, and 2 sources reported a decrease in the range of {-32.98%~-41.43%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 5 sources reported an increase in the range of {17.54%~33.55%} for SBFD, and 3 sources reported a decrease in the range of {-2.13%~-32.64%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 6 sources reported an increase in the range of {8.25%~51.76%} for SBFD, and 2 sources reported a decrease in the range of {-30.25%~-41.66%} for SBFD, and 1 source reported no change for SBFD
    - Regarding DL Type-1 RU CDF, 6 sources reported an increase in the range of {0.02%~7.20%} for SBFD, and 3 sources reported a decrease in the range of {-0.55%~-5.98%} for SBFD
    - Regarding DL Type-2 RU CDF, 9 sources reported an increase in the range of {0.80%~10.80%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 5 sources reported an improvement in the range of {0.06%~17.45%} for SBFD, and 4 sources reported a degradation in the range of {-0.85%~-26.55%} for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {0.06%~5.22%} for SBFD, and 5 sources reported a degradation in the range of {-0.35%~-66.37%} for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {0.28%~17.47%} for SBFD, and 5 sources reported a degradation in the range of {-1.70%~-26.60%} for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 9 sources reported an improvement in the range of {37.51%~121.39%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 9 sources reported an improvement in the range of {16.40%~199.48%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 9 sources reported an improvement in the range of {9.11%~128.58%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 3 sources reported an increase in the range of {37.66%~57.62%} for SBFD, and 5 sources reported a decrease in the range of {-15.06%~-56.55%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {17.31%~39.71%} for SBFD, and 6 sources reported a decrease in the range of {-19.30%~-44.55%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {34.80%~54.38%} for SBFD, and 6 sources reported a decrease in the range of {-13.47%~-53.65%} for SBFD, and 1 source reported no change for SBFD
    - Regarding UL Type-1 RU CDF, 3 sources reported an increase in the range of {0.37%~3.13%} for SBFD, and 6 sources reported a decrease in the range of {-0.13%~-17.00%} for SBFD
    - Regarding UL Type-2 RU CDF, 9 sources reported a decrease in the range of {-6.33%~-16.12%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 4 sources reported an improvement in the range of {10.85%~55.21%} for SBFD, and 5 sources reported a degradation in the range of {-20.12%~-43.09%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 4 sources reported an improvement in the range of {36.32%~111.98%} for SBFD, and 5 sources reported a degradation in the range of {-24.55%~-63.60%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 4 sources reported an improvement in the range of {10.15%~65.16%} for SBFD, and 5 sources reported a degradation in the range of {-16.96%~-66.79%} for SBFD
* Traffic load with {DL,UL} = {High, High},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 8 sources reported a degradation in the range of {-20.89%~-39.96%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 8 sources reported a degradation in the range of {-11.88%~-88.89%} for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 8 sources reported a degradation in the range of {-15.74%~-46.90%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 4 sources reported an increase in the range of {21.33%~110.85%} for SBFD, and 3 sources reported a decrease in the range of {-15.14%~-538.29%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 5 sources reported an increase in the range of {12.85%~33.72%} for SBFD, and 2 sources reported a decrease in the range of {-29.02%~-42.70%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 5 sources reported an increase in the range of {21.36%~78.88%} for SBFD, and 2 sources reported a decrease in the range of {-51.47%~-101.07%} for SBFD, and 1 source reported no change for SBFD
    - Regarding DL Type-1 RU CDF, 4 sources reported an increase in the range of {4.08%~8.60%} for SBFD, and 4 sources reported a decrease in the range of {-1.09%~-13.11%} for SBFD
    - Regarding DL Type-2 RU CDF, 7 sources reported an increase in the range of {0.36%~22.08%} for SBFD, and 1 source reported a decrease of -4.84% for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 2 sources reported an improvement in the range of {0.10%~2.30%} for SBFD, and 6 sources reported a degradation in the range of {-4.82%~-26.58%} for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 1 source reported an improvement of 9.04% for SBFD, and 7 sources reported a degradation in the range of {-3.35%~-85.19%} for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 3 sources reported an improvement in the range of {0.93%~5.19%} for SBFD, and 5 sources reported a degradation in the range of {-9.49%~-25.97%} for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 8 sources reported an improvement in the range of {34.34%~186.94%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 7 sources reported an improvement in the range of {28.57%~338.36%} for SBFD, and 1 source reported a degradation of -91.14% for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 8 sources reported an improvement in the range of {17.18%~214.33%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 3 sources reported an increase in the range of {43.65%~132.77%} for SBFD, and 4 sources reported a decrease in the range of {-28.05%~-67.65%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {18.19%~50.36%} for SBFD, and 5 sources reported a decrease in the range of {-10.81%~-44.34%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {33.68%~65.54%} for SBFD, and 5 sources reported a decrease in the range of {-14.15%~-57.09%} for SBFD, and 1 source reported no change for SBFD
    - Regarding UL Type-1 RU CDF, 4 sources reported an increase in the range of {0.09%~8.20%} for SBFD, and 4 sources reported a decrease in the range of {-0.64%~-23.50%} for SBFD
    - Regarding UL Type-2 RU CDF, 1 source reported an increase of 4.54% for SBFD, and 7 sources reported a decrease in the range of {-1.27%~-37.85%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 4 sources reported an improvement in the range of {1.76%~99.44%} for SBFD, and 4 sources reported a degradation in the range of {-25.01%~-46.26%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 4 sources reported an improvement in the range of {3.90%~250.86%} for SBFD, and 4 sources reported a degradation in the range of {-18.64%~-91.14%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 4 sources reported an improvement in the range of {12.74%~126.83%} for SBFD, and 4 sources reported a degradation in the range of {-28.92%~-57.67%} for SBFD

*SBFD#1\_InH\_FR1\_Sub#2*

Table ‑**: Key assumption for SBFD#1\_InH\_FR1\_Sub#2.**

|  |  |  |
| --- | --- | --- |
| **Sub-cases  Key assumptions** | | **SBFD#1\_InH\_FR1\_Sub#2** |
| **SBFD slot configuration** | **Alt-2: {DDDSU} vs. {XXXXU}** | √ |
| **Alt-4: {DDDSU} vs. {XXXXX}** |  |
| **Alt-1: {DDDSU} vs. {DXXXX}** |  |
| **Alt-3: {DDSUU} vs. {XXXXU}** |  |
| **SBFD antenna configuration** | **Twice area&same TxRUs (Option 2)** | √ |
| **Same area&same TxRUs (Option 1)** |  |
| **Same area&half TxRUs (Option 3)** |  |
| **Packet Size** | **DL: 0.5Mbytes, UL: 0.125Mbyte** |  |
| **DL: 4Kbytes, UL: 1Kbyte** | √ |
| **Others** | |  |
| **Sources** | | vivo, CATT, ZTE, Qualcomm, OPPO |

Table ‑**: Summary of results for SBFD#1\_InH\_FR1\_Sub#2.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Simple description for the sub-case (RSI based on 1dB desense, SBFD Alt-2, Twice area&same TxRUs (Option 2), DL: 4kbytes, UL: 1kbyte)*** | | | | | | | | | | |
|  | | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase |
| **DL Average-UPT (Mbps)** | **Mean** | vivo: 39.59,  CATT: 37.70,  ZTE: 43.62,  Qualcomm: 0.15,  OPPO: 25.39, | vivo: 37.49,  CATT: 37.50,  ZTE: 43.90,  Qualcomm: 38.94,  OPPO: 28.17, | vivo: -5.31%,  CATT: -0.52%,  ZTE: 0.64%,  Qualcomm: -0.38%,  OPPO: 10.94%, | vivo: 38.48,  CATT: 37.62,  ZTE: 42.87,  Qualcomm: 0.15,  OPPO: 25.35, | vivo: 33.78,  CATT: 37.49,  ZTE: 43.02,  Qualcomm: 38.06,  OPPO: 25.52, | vivo: -12.21%,  CATT: -0.35%,  ZTE: 0.35%,  Qualcomm: -1.41%,  OPPO: 0.69%, | vivo: 36.10,  CATT: 37.26,  ZTE: 40.80,  Qualcomm: 0.15, | vivo: 23.54,  CATT: 35.30,  ZTE: 39.88,  Qualcomm: 35.49, | vivo: -34.80%,  CATT: -5.25%,  ZTE: -2.25%,  Qualcomm: -6.80%, |
| **5%** | vivo: 37.97,  CATT: 35.30,  ZTE: 42.29,  Qualcomm: 0.14,  OPPO: 23.66, | vivo: 36.17,  CATT: 35.67,  ZTE: 42.43,  Qualcomm: 37.54,  OPPO: 26.85, | vivo: -4.73%,  CATT: 1.05%,  ZTE: 0.33%,  Qualcomm: -0.29%,  OPPO: 13.46%, | vivo: 37.00,  CATT: 35.26,  ZTE: 40.54,  Qualcomm: 0.14,  OPPO: 24.72, | vivo: 32.02,  CATT: 35.67,  ZTE: 40.36,  Qualcomm: 36.54,  OPPO: 24.09, | vivo: -13.44%,  CATT: 1.18%,  ZTE: -0.44%,  Qualcomm: -2.22%,  OPPO: -2.56%, | vivo: 30.13,  CATT: 34.61,  ZTE: 36.72,  Qualcomm: 0.13, | vivo: 0.41,  CATT: 29.03,  ZTE: 28.02,  Qualcomm: 29.36, | vivo: -98.65%,  CATT: -16.12%,  ZTE: -23.69%,  Qualcomm: -19.37%, |
| **50%** | vivo: 39.29,  CATT: 37.76,  ZTE: 43.75,  Qualcomm: 0.15,  OPPO: 25.35, | vivo: 37.25,  CATT: 37.51,  ZTE: 44.04,  Qualcomm: 38.86,  OPPO: 28.05, | vivo: -5.21%,  CATT: -0.66%,  ZTE: 0.66%,  Qualcomm: -0.43%,  OPPO: 10.65%, | vivo: 38.00,  CATT: 37.72,  ZTE: 43.05,  Qualcomm: 0.15,  OPPO: 25.24, | vivo: 33.61,  CATT: 37.51,  ZTE: 43.33,  Qualcomm: 38.10,  OPPO: 25.48, | vivo: -11.56%,  CATT: -0.54%,  ZTE: 0.65%,  Qualcomm: -1.14%,  OPPO: 0.96%, | vivo: 36.57,  CATT: 37.62,  ZTE: 41.36,  Qualcomm: 0.15, | vivo: 26.71,  CATT: 35.78,  ZTE: 41.55,  Qualcomm: 36.49, | vivo: -26.95%,  CATT: -4.89%,  ZTE: 0.46%,  Qualcomm: -4.33%, |
| **UL Average-UPT (Mbps)** | **Mean** | vivo: 3.87,  CATT: 4.55,  ZTE: 5.76,  Qualcomm: 0.00,  OPPO: 4.07, | vivo: 5.91,  CATT: 10.64,  ZTE: 8.25,  Qualcomm: 4.27,  OPPO: 7.62, | vivo: 52.86%,  CATT: 134.09%,  ZTE: 43.23%,  Qualcomm: 59.79%,  OPPO: 87.01%, | vivo: 3.76,  CATT: 4.55,  ZTE: 5.36,  Qualcomm: 0.00,  OPPO: 4.14, | vivo: 5.78,  CATT: 10.64,  ZTE: 7.88,  Qualcomm: 4.27,  OPPO: 7.65, | vivo: 53.55%,  CATT: 133.87%,  ZTE: 47.01%,  Qualcomm: 60.58%,  OPPO: 84.99%, | vivo: 3.69,  CATT: 4.54,  ZTE: 4.80,  Qualcomm: 0.00, | vivo: 5.15,  CATT: 10.65,  ZTE: 7.31,  Qualcomm: 4.19, | vivo: 39.62%,  CATT: 134.46%,  ZTE: 52.29%,  Qualcomm: 66.27%, |
| **5%** | vivo: 3.66,  CATT: 3.97,  ZTE: 5.38,  Qualcomm: 0.00,  OPPO: 3.74, | vivo: 5.58,  CATT: 10.35,  ZTE: 5.40,  Qualcomm: 4.20,  OPPO: 7.37, | vivo: 52.56%,  CATT: 160.91%,  ZTE: 0.37%,  Qualcomm: 63.93%,  OPPO: 96.99%, | vivo: 3.54,  CATT: 3.99,  ZTE: 5.08,  Qualcomm: 0.00,  OPPO: 4.02, | vivo: 5.43,  CATT: 10.35,  ZTE: 5.10,  Qualcomm: 4.19,  OPPO: 7.57, | vivo: 53.46%,  CATT: 159.66%,  ZTE: 0.39%,  Qualcomm: 64.23%,  OPPO: 88.19%, | vivo: 3.42,  CATT: 3.99,  ZTE: 4.50,  Qualcomm: 0.00, | vivo: 4.08,  CATT: 10.38,  ZTE: 4.57,  Qualcomm: 3.93, | vivo: 19.46%,  CATT: 159.90%,  ZTE: 1.56%,  Qualcomm: 73.29%, |
| **50%** | vivo: 3.86,  CATT: 4.49,  ZTE: 5.75,  Qualcomm: 0.00,  OPPO: 4.05, | vivo: 5.95,  CATT: 10.63,  ZTE: 6.03,  Qualcomm: 4.27,  OPPO: 7.59, | vivo: 53.96%,  CATT: 136.77%,  ZTE: 4.87%,  Qualcomm: 59.56%,  OPPO: 87.26%, | vivo: 3.73,  CATT: 4.54,  ZTE: 5.35,  Qualcomm: 0.00,  OPPO: 4.14, | vivo: 5.78,  CATT: 10.63,  ZTE: 5.52,  Qualcomm: 4.27,  OPPO: 7.66, | vivo: 54.91%,  CATT: 134.10%,  ZTE: 3.18%,  Qualcomm: 60.87%,  OPPO: 85.09%, | vivo: 3.63,  CATT: 4.50,  ZTE: 4.78,  Qualcomm: 0.00, | vivo: 5.19,  CATT: 10.62,  ZTE: 5.03,  Qualcomm: 4.23, | vivo: 42.95%,  CATT: 135.90%,  ZTE: 5.23%,  Qualcomm: 66.45%, |
| **DL Packet-Latency CDF (ms)** | **Mean** | vivo: 1.02,  CATT: 0.87,  ZTE: 0.84,  Qualcomm: 1.14,  OPPO: 1.36, | vivo: 0.99,  CATT: 0.86,  ZTE: 0.82,  Qualcomm: 1.52,  OPPO: 1.19, | vivo: 2.64%,  CATT: -1.07%,  ZTE: -2.38%,  Qualcomm: -34.27%,  OPPO: -12.79%, | vivo: 1.10,  CATT: 0.87,  ZTE: 0.86,  Qualcomm: 1.18,  OPPO: 1.39, | vivo: 1.15,  CATT: 0.86,  ZTE: 0.85,  Qualcomm: 1.54,  OPPO: 1.43, | vivo: -5.09%,  CATT: -1.77%,  ZTE: -1.16%,  Qualcomm: -30.77%,  OPPO: 3.34%, | vivo: 1.32,  CATT: 0.90,  ZTE: 0.93,  Qualcomm: 1.21, | vivo: 12.78,  CATT: 0.93,  ZTE: 1.07,  Qualcomm: 1.76, | vivo: -869.09%,  CATT: 3.23%,  ZTE: 15.05%,  Qualcomm: -46.03%, |
| **5%** | vivo: 0.52,  CATT: 0.52,  ZTE: 0.45,  Qualcomm: 0.55,  OPPO: 1.00, | vivo: 0.54,  CATT: 0.52,  ZTE: 0.45,  Qualcomm: 0.55,  OPPO: 1.00, | vivo: -4.27%,  CATT: 0.17%,  ZTE: 0.00%,  Qualcomm: -0.98%,  OPPO: 0.00%, | vivo: 0.52,  CATT: 0.52,  ZTE: 0.45,  Qualcomm: 0.55,  OPPO: 1.00, | vivo: 0.55,  CATT: 0.52,  ZTE: 0.48,  Qualcomm: 0.55,  OPPO: 1.00, | vivo: -6.41%,  CATT: 0.38%,  ZTE: 6.67%,  Qualcomm: -0.98%,  OPPO: 0.00%, | vivo: 0.52,  CATT: 0.52,  ZTE: 0.48,  Qualcomm: 0.54, | vivo: 0.59,  CATT: 0.53,  ZTE: 0.48,  Qualcomm: 0.61, | vivo: -14.26%,  CATT: 0.44%,  ZTE: 0.00%,  Qualcomm: -11.48%, |
| **50%** | vivo: 0.82,  CATT: 0.81,  ZTE: 0.77,  Qualcomm: 0.86,  OPPO: 1.00, | vivo: 0.87,  CATT: 0.81,  ZTE: 0.77,  Qualcomm: 0.93,  OPPO: 1.00, | vivo: -6.50%,  CATT: -0.04%,  ZTE: 0.00%,  Qualcomm: -8.33%,  OPPO: 0.00%, | vivo: 0.83,  CATT: 0.80,  ZTE: 0.77,  Qualcomm: 0.86,  OPPO: 1.00, | vivo: 0.97,  CATT: 0.81,  ZTE: 0.77,  Qualcomm: 0.98,  OPPO: 1.00, | vivo: -17.49%,  CATT: 0.71%,  ZTE: 0.00%,  Qualcomm: -14.58%,  OPPO: 0.00%, | vivo: 0.87,  CATT: 0.82,  ZTE: 0.80,  Qualcomm: 0.88, | vivo: 1.47,  CATT: 0.86,  ZTE: 0.84,  Qualcomm: 1.05, | vivo: -67.62%,  CATT: 5.18%,  ZTE: 5.00%,  Qualcomm: -19.19%, |
| **UL Packet-Latency CDF (ms)** | **Mean** | vivo: 2.41,  CATT: 1.78,  ZTE: 1.86,  Qualcomm: 3.24,  OPPO: 2.52, | vivo: 1.43,  CATT: 0.76,  ZTE: 1.40,  Qualcomm: 2.41,  OPPO: 1.06, | vivo: 40.71%,  CATT: -57.15%,  ZTE: -24.73%,  Qualcomm: 25.68%,  OPPO: -58.13%, | vivo: 2.52,  CATT: 1.76,  ZTE: 2.09,  Qualcomm: 3.28,  OPPO: 2.47, | vivo: 1.48,  CATT: 0.76,  ZTE: 1.56,  Qualcomm: 2.31,  OPPO: 1.07, | vivo: 41.31%,  CATT: -56.67%,  ZTE: -25.36%,  Qualcomm: 29.48%,  OPPO: -56.65%, | vivo: 2.61,  CATT: 1.78,  ZTE: 2.48,  Qualcomm: 3.65, | vivo: 1.78,  CATT: 0.76,  ZTE: 1.81,  Qualcomm: 2.20, | vivo: 32.11%,  CATT: -57.22%,  ZTE: -27.02%,  Qualcomm: 39.57%, |
| **5%** | vivo: 1.13,  CATT: 0.60,  ZTE: 0.59,  Qualcomm: 1.76,  OPPO: 1.00, | vivo: 1.03,  CATT: 0.52,  ZTE: 0.48,  Qualcomm: 1.61,  OPPO: 1.00, | vivo: 8.66%,  CATT: -13.66%,  ZTE: -18.64%,  Qualcomm: 8.81%,  OPPO: 0.00%, | vivo: 1.14,  CATT: 0.59,  ZTE: 0.59,  Qualcomm: 1.76,  OPPO: 1.00, | vivo: 1.04,  CATT: 0.52,  ZTE: 0.48,  Qualcomm: 1.61,  OPPO: 1.00, | vivo: 9.28%,  CATT: -11.94%,  ZTE: -18.64%,  Qualcomm: 8.81%,  OPPO: 0.00%, | vivo: 1.15,  CATT: 0.60,  ZTE: 0.63,  Qualcomm: 1.76, | vivo: 1.05,  CATT: 0.52,  ZTE: 0.48,  Qualcomm: 1.64, | vivo: 8.46%,  CATT: -13.66%,  ZTE: -23.81%,  Qualcomm: 6.60%, |
| **50%** | vivo: 2.33,  CATT: 1.77,  ZTE: 1.80,  Qualcomm: 3.06,  OPPO: 2.50, | vivo: 1.34,  CATT: 0.75,  ZTE: 1.02,  Qualcomm: 1.91,  OPPO: 1.00, | vivo: 42.73%,  CATT: -57.90%,  ZTE: -43.33%,  Qualcomm: 37.61%,  OPPO: -60.00%, | vivo: 2.40,  CATT: 1.74,  ZTE: 1.98,  Qualcomm: 3.03,  OPPO: 2.50, | vivo: 1.36,  CATT: 0.75,  ZTE: 1.13,  Qualcomm: 1.96,  OPPO: 1.00, | vivo: 43.38%,  CATT: -57.20%,  ZTE: -42.93%,  Qualcomm: 35.10%,  OPPO: -60.00%, | vivo: 2.45,  CATT: 1.77,  ZTE: 2.20,  Qualcomm: 3.20, | vivo: 1.49,  CATT: 0.75,  ZTE: 1.27,  Qualcomm: 1.95, | vivo: 39.06%,  CATT: -57.90%,  ZTE: -42.27%,  Qualcomm: 39.11%, |
| **DL RU (%)** | **Type-1** | vivo: 6.35%,  CATT: 6.12%,  ZTE: 8.21%,  Qualcomm: 7.56%,  OPPO: 1.34%, | vivo: 6.47%,  CATT: 5.21%,  ZTE: 8.04%,  Qualcomm: 9.30%,  OPPO: 1.39%, | vivo: 0.12%,  CATT: -0.91%,  ZTE: -0.17%,  Qualcomm: 1.75%,  OPPO: 0.05%, | vivo: 20.98%,  CATT: 19.87%,  ZTE: 14.33%,  Qualcomm: 21.71%,  OPPO: 21.42%, | vivo: 23.50%,  CATT: 16.37%,  ZTE: 14.01%,  Qualcomm: 27.68%,  OPPO: 22.17%, | vivo: 2.52%,  CATT: -3.50%,  ZTE: -0.32%,  Qualcomm: 5.97%,  OPPO: 0.75%, | vivo: 53.63%,  CATT: 41.34%,  ZTE: 26.48%,  Qualcomm: 36.60%, | vivo: 56.00%,  CATT: 33.22%,  ZTE: 25.82%,  Qualcomm: 54.35%, | vivo: 2.37%,  CATT: -8.12%,  ZTE: -0.66%,  Qualcomm: 17.75%, |
| **Type-2** | vivo: 8.23%,  CATT: 7.65%,  ZTE: 10.27%,  Qualcomm: 9.45%,  OPPO: 1.68%, | vivo: 10.32%,  CATT: 8.15%,  ZTE: 13.24%,  Qualcomm: 12.41%,  OPPO: 2.29%, | vivo: 2.08%,  CATT: 0.50%,  ZTE: 2.97%,  Qualcomm: 2.96%,  OPPO: 0.61%, | vivo: 27.19%,  CATT: 24.84%,  ZTE: 17.92%,  Qualcomm: 27.13%,  OPPO: 26.78%, | vivo: 37.47%,  CATT: 25.58%,  ZTE: 23.06%,  Qualcomm: 36.92%,  OPPO: 36.37%, | vivo: 10.28%,  CATT: 0.74%,  ZTE: 5.14%,  Qualcomm: 9.79%,  OPPO: 9.59%, | vivo: 69.53%,  CATT: 51.67%,  ZTE: 33.10%,  Qualcomm: 45.75%, | vivo: 89.30%,  CATT: 51.91%,  ZTE: 42.51%,  Qualcomm: 72.50%, | vivo: 19.78%,  CATT: 0.24%,  ZTE: 9.41%,  Qualcomm: 26.75%, |
| **UL RU (%)** | **Type-1** | vivo: 2.00%,  CATT: 1.51%,  ZTE: 1.56%,  Qualcomm: 1.96%,  OPPO: 0.54%, | vivo: 2.22%,  CATT: 2.81%,  ZTE: 1.53%,  Qualcomm: 1.51%,  OPPO: 0.83%, | vivo: 0.22%,  CATT: 1.30%,  ZTE: -0.03%,  Qualcomm: -0.45%,  OPPO: 0.29%, | vivo: 5.28%,  CATT: 5.68%,  ZTE: 3.03%,  Qualcomm: 5.35%,  OPPO: 6.85%, | vivo: 7.13%,  CATT: 7.96%,  ZTE: 3.01%,  Qualcomm: 4.95%,  OPPO: 6.90%, | vivo: 1.85%,  CATT: 2.28%,  ZTE: -0.02%,  Qualcomm: -0.40%,  OPPO: 0.05%, | vivo: 11.15%,  CATT: 10.35%,  ZTE: 4.77%,  Qualcomm: 11.51%, | vivo: 14.52%,  CATT: 18.44%,  ZTE: 4.76%,  Qualcomm: 12.40%, | vivo: 3.36%,  CATT: 8.09%,  ZTE: -0.01%,  Qualcomm: 0.89%, |
| **Type-2** | vivo: 10.00%,  CATT: 7.57%,  ZTE: 7.78%,  Qualcomm: 9.80%,  OPPO: 2.70%, | vivo: 6.19%,  CATT: 7.81%,  ZTE: 4.25%,  Qualcomm: 4.13%,  OPPO: 1.37%, | vivo: -3.81%,  CATT: 0.24%,  ZTE: -3.53%,  Qualcomm: -5.67%,  OPPO: -1.33%, | vivo: 26.38%,  CATT: 28.40%,  ZTE: 15.13%,  Qualcomm: 26.77%,  OPPO: 34.27%, | vivo: 19.89%,  CATT: 22.12%,  ZTE: 8.34%,  Qualcomm: 13.59%,  OPPO: 11.33%, | vivo: -6.49%,  CATT: -6.28%,  ZTE: -6.79%,  Qualcomm: -13.18%,  OPPO: -22.94%, | vivo: 55.77%,  CATT: 51.75%,  ZTE: 23.87%,  Qualcomm: 57.55%, | vivo: 40.52%,  CATT: 51.24%,  ZTE: 13.20%,  Qualcomm: 34.02%, | vivo: -15.25%,  CATT: -0.51%,  ZTE: -10.67%,  Qualcomm: -23.54%, |
| Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1 - For Latency, the increase can be calculated as: Increase (%) = SBFD latency / TDD latency - 1 - For RU, the increase can be calculated as: Increase (%) = SBFD RU (%) - TDD RU (%) | | | | | | | | | | |

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| ***Simple description for the sub-case (RSI based on 1dB desense, SBFD Alt-2, Twice area&same TxRUs (Option 2), DL: 4kbytes, UL: 1kbyte)*** | | | |
|  | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | |
| **DL: Low, UL: Low** | **DL: Medium, UL: Medium** | **DL: High, UL: High** |
| **Gain of DL resource (%)** | vivo: -18.71%,  CATT: -20.99%,  ZTE: -26.63%,  Qualcomm: -35.19%,  OPPO: -20.99%, | vivo: -18.71%,  CATT: -20.99%,  ZTE: -26.63%,  Qualcomm: -35.19%,  OPPO: -20.99%, | vivo: -18.71%,  CATT: -20.99%,  ZTE: -26.63%,  Qualcomm: -35.19%, |
| **Net gain of mean value of DL average-UPT (%)** | vivo: 13.40%,  CATT: 20.47%,  ZTE: 27.27%,  Qualcomm: 34.80%,  OPPO: 31.93%, | vivo: 6.50%,  CATT: 20.65%,  ZTE: 26.98%,  Qualcomm: 33.77%,  OPPO: 21.68%, | vivo: -16.09%,  CATT: 15.74%,  ZTE: 24.38%,  Qualcomm: 28.39%, |
| **Net gain of 5% value of DL average-UPT (%)** | vivo: 13.98%,  CATT: 22.04%,  ZTE: 26.96%,  Qualcomm: 34.89%,  OPPO: 34.45%, | vivo: 5.27%,  CATT: 22.17%,  ZTE: 26.19%,  Qualcomm: 32.97%,  OPPO: 18.43%, | vivo: -79.94%,  CATT: 4.87%,  ZTE: 2.94%,  Qualcomm: 15.81%, |
| **Net gain of 50% value of DL average-UPT (%)** | vivo: 13.49%,  CATT: 20.33%,  ZTE: 27.29%,  Qualcomm: 34.76%,  OPPO: 31.64%, | vivo: 7.15%,  CATT: 20.45%,  ZTE: 27.28%,  Qualcomm: 34.04%,  OPPO: 21.95%, | vivo: -8.24%,  CATT: 16.10%,  ZTE: 27.09%,  Qualcomm: 30.86%, |
| **Gain of UL resource (%)** | vivo: 79.10%,  CATT: 80.60%,  ZTE: 74.85%,  Qualcomm: 87.50%,  OPPO: 80.59%, | vivo: 79.10%,  CATT: 80.60%,  ZTE: 74.85%,  Qualcomm: 87.50%,  OPPO: 80.59%, | vivo: 79.10%,  CATT: 80.60%,  ZTE: 74.85%,  Qualcomm: 87.50%, |
| **Net gain of mean value of UL average-UPT (%)** | vivo: -26.24%,  CATT: 53.49%,  ZTE: -31.62%,  Qualcomm: -27.71%,  OPPO: 6.42%, | vivo: -25.55%,  CATT: 53.27%,  ZTE: -27.84%,  Qualcomm: -26.92%,  OPPO: 4.41%, | vivo: -39.48%,  CATT: 53.86%,  ZTE: -22.56%,  Qualcomm: -21.23%, |
| **Net gain of 5% value of UL average-UPT (%)** | vivo: -26.54%,  CATT: 80.31%,  ZTE: -74.48%,  Qualcomm: -23.57%,  OPPO: 16.41%, | vivo: -25.64%,  CATT: 79.06%,  ZTE: -74.46%,  Qualcomm: -23.27%,  OPPO: 7.61%, | vivo: -59.64%,  CATT: 79.30%,  ZTE: -73.29%,  Qualcomm: -14.21%, |
| **Net gain of 50% value of UL average-UPT (%)** | vivo: -25.14%,  CATT: 56.17%,  ZTE: -69.98%,  Qualcomm: -27.94%,  OPPO: 6.67%, | vivo: -24.19%,  CATT: 53.50%,  ZTE: -71.67%,  Qualcomm: -26.63%,  OPPO: 4.51%, | vivo: -36.15%,  CATT: 55.30%,  ZTE: -69.62%,  Qualcomm: -21.05%, |
| Note: - Gain of resource (%) = SBFD resource percentage / TDD resource percentage - 1, wherein, for legacy TDD, DL resource percentage per TDD period is 77.1%, and UL resource percentage per TDD period is 20%.  - Net gain of UPT (%) = Gain of UPT - Gain of UL/DL resource | | | |

For subcase SBFD#1\_InH\_FR1\_Sub#2, assuming RSI based on 1dB desense, SBFD Alt-2, Twice area&same TxRUs (Option 2), DL: 4kbytes, UL: 1kbyte, key findings are summarized below.

* Traffic load with {DL,UL} = {Low,Low},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 2 sources reported an improvement in the range of {0.64%~10.94%} for SBFD, and 3 sources reported a degradation in the range of {-0.38%~-5.31%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 3 sources reported an improvement in the range of {0.33%~13.46%} for SBFD, and 2 sources reported a degradation in the range of {-0.29%~-4.73%} for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 2 sources reported an improvement in the range of {0.66%~10.65%} for SBFD, and 3 sources reported a degradation in the range of {-0.43%~-5.21%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 1 source reported an increase of 2.64% for SBFD, and 4 sources reported a decrease in the range of {-1.07%~-34.27%} for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 1 source reported an increase of 0.17% for SBFD, and 2 sources reported a decrease in the range of {-0.98%~-4.27%} for SBFD, and 2 sources reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 3 sources reported a decrease in the range of {-0.04%~-8.33%} for SBFD, and 2 sources reported no change for SBFD
    - Regarding DL Type-1 RU CDF, 3 sources reported an increase in the range of {0.05%~1.75%} for SBFD, and 2 sources reported a decrease in the range of {-0.17%~-0.91%} for SBFD
    - Regarding DL Type-2 RU CDF, 5 sources reported an increase in the range of {0.50%~2.97%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 5 sources reported an improvement in the range of {13.40%~34.80%} for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 5 sources reported an improvement in the range of {13.98%~34.89%} for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 5 sources reported an improvement in the range of {13.49%~34.76%} for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 5 sources reported an improvement in the range of {43.23%~134.09%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {0.37%~160.91%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {4.87%~136.77%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 2 sources reported an increase in the range of {25.68%~40.71%} for SBFD, and 3 sources reported a decrease in the range of {-24.73%~-58.13%} for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {8.66%~8.81%} for SBFD, and 2 sources reported a decrease in the range of {-13.66%~-18.64%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {37.61%~42.73%} for SBFD, and 3 sources reported a decrease in the range of {-43.33%~-60.00%} for SBFD
    - Regarding UL Type-1 RU CDF, 3 sources reported an increase in the range of {0.22%~1.30%} for SBFD, and 2 sources reported a decrease in the range of {-0.03%~-0.45%} for SBFD
    - Regarding UL Type-2 RU CDF, 1 source reported an increase of 0.24% for SBFD, and 4 sources reported a decrease in the range of {-1.33%~-5.67%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 2 sources reported an improvement in the range of {6.42%~53.49%} for SBFD, and 3 sources reported a degradation in the range of {-26.24%~-31.62%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 2 sources reported an improvement in the range of {16.41%~80.31%} for SBFD, and 3 sources reported a degradation in the range of {-23.57%~-74.48%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 2 sources reported an improvement in the range of {6.67%~56.17%} for SBFD, and 3 sources reported a degradation in the range of {-25.14%~-69.98%} for SBFD
* Traffic load with {DL,UL} = {Medium, Medium},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 2 sources reported an improvement in the range of {0.35%~0.69%} for SBFD, and 3 sources reported a degradation in the range of {-0.35%~-12.21%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 1 source reported an improvement of 1.18% for SBFD, and 4 sources reported a degradation in the range of {-0.44%~-13.44%} for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 2 sources reported an improvement in the range of {0.65%~0.96%} for SBFD, and 3 sources reported a degradation in the range of {-0.54%~-11.56%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 1 source reported an increase of 3.34% for SBFD, and 4 sources reported a decrease in the range of {-1.16%~-30.77%} for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 2 sources reported an increase in the range of {0.38%~6.67%} for SBFD, and 2 sources reported a decrease in the range of {-0.98%~-6.41%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 1 source reported an increase of 0.71% for SBFD, and 2 sources reported a decrease in the range of {-14.58%~-17.49%} for SBFD, and 2 sources reported no change for SBFD
    - Regarding DL Type-1 RU CDF, 3 sources reported an increase in the range of {0.75%~5.97%} for SBFD, and 2 sources reported a decrease in the range of {-0.32%~-3.50%} for SBFD
    - Regarding DL Type-2 RU CDF, 5 sources reported an increase in the range of {0.74%~10.28%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 5 sources reported an improvement in the range of {6.50%~33.77%} for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 5 sources reported an improvement in the range of {5.27%~32.97%} for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 5 sources reported an improvement in the range of {7.15%~34.04%} for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 5 sources reported an improvement in the range of {47.01%~133.87%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {0.39%~159.66%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {3.18%~134.10%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 2 sources reported an increase in the range of {29.48%~41.31%} for SBFD, and 3 sources reported a decrease in the range of {-25.36%~-56.67%} for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {8.81%~9.28%} for SBFD, and 2 sources reported a decrease in the range of {-11.94%~-18.64%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {35.10%~43.38%} for SBFD, and 3 sources reported a decrease in the range of {-42.93%~-60.00%} for SBFD
    - Regarding UL Type-1 RU CDF, 3 sources reported an increase in the range of {0.05%~2.28%} for SBFD, and 2 sources reported a decrease in the range of {-0.02%~-0.40%} for SBFD
    - Regarding UL Type-2 RU CDF, 5 sources reported a decrease in the range of {-6.28%~-22.94%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 2 sources reported an improvement in the range of {4.41%~53.27%} for SBFD, and 3 sources reported a degradation in the range of {-25.55%~-27.84%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 2 sources reported an improvement in the range of {7.61%~79.06%} for SBFD, and 3 sources reported a degradation in the range of {-23.27%~-74.46%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 2 sources reported an improvement in the range of {4.51%~53.50%} for SBFD, and 3 sources reported a degradation in the range of {-24.19%~-71.67%} for SBFD
* Traffic load with {DL,UL} = {High, High},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 4 sources reported a degradation in the range of {-2.25%~-34.80%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 4 sources reported a degradation in the range of {-16.12%~-98.65%} for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 1 source reported an improvement of 0.46% for SBFD, and 3 sources reported a degradation in the range of {-4.33%~-26.95%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 2 sources reported an increase in the range of {3.23%~15.05%} for SBFD, and 2 sources reported a decrease in the range of {-46.03%~-869.09%} for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 1 source reported an increase of 0.44% for SBFD, and 2 sources reported a decrease in the range of {-11.48%~-14.26%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 2 sources reported an increase in the range of {5.00%~5.18%} for SBFD, and 2 sources reported a decrease in the range of {-19.19%~-67.62%} for SBFD
    - Regarding DL Type-1 RU CDF, 2 sources reported an increase in the range of {2.37%~17.75%} for SBFD, and 2 sources reported a decrease in the range of {-0.66%~-8.12%} for SBFD
    - Regarding DL Type-2 RU CDF, 4 sources reported an increase in the range of {0.24%~26.75%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 3 sources reported an improvement in the range of {15.74%~28.39%} for SBFD, and 1 source reported a degradation of -16.09% for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 3 sources reported an improvement in the range of {2.94%~15.81%} for SBFD, and 1 source reported a degradation of -79.94% for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 3 sources reported an improvement in the range of {16.10%~30.86%} for SBFD, and 1 source reported a degradation of -8.24% for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 4 sources reported an improvement in the range of {39.62%~134.46%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 4 sources reported an improvement in the range of {1.56%~159.90%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 4 sources reported an improvement in the range of {5.23%~135.90%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 2 sources reported an increase in the range of {32.11%~39.57%} for SBFD, and 2 sources reported a decrease in the range of {-27.02%~-57.22%} for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {6.60%~8.46%} for SBFD, and 2 sources reported a decrease in the range of {-13.66%~-23.81%} for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {39.06%~39.11%} for SBFD, and 2 sources reported a decrease in the range of {-42.27%~-57.90%} for SBFD
    - Regarding UL Type-1 RU CDF, 3 sources reported an increase in the range of {0.89%~8.09%} for SBFD, and 1 source reported a decrease of -0.01% for SBFD
    - Regarding UL Type-2 RU CDF, 4 sources reported a decrease in the range of {-0.51%~-23.54%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 1 source reported an improvement of 53.86% for SBFD, and 3 sources reported a degradation in the range of {-21.23%~-39.48%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 1 source reported an improvement of 79.30% for SBFD, and 3 sources reported a degradation in the range of {-14.21%~-73.29%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 1 source reported an improvement of 55.30% for SBFD, and 3 sources reported a degradation in the range of {-21.05%~-69.62%} for SBFD

*SBFD#1\_InH\_FR1\_Sub#3*

Table ‑**: Key assumption for SBFD#1\_InH\_FR1\_Sub#3.**

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| --- | --- | --- |
| **Sub-cases  Key assumptions** | | **SBFD#1\_InH\_FR1\_Sub#3** |
| **SBFD slot configuration** | **Alt-2: {DDDSU} vs. {XXXXU}** |  |
| **Alt-4: {DDDSU} vs. {XXXXX}** | √ |
| **Alt-1: {DDDSU} vs. {DXXXX}** |  |
| **Alt-3: {DDSUU} vs. {XXXXU}** |  |
| **SBFD antenna configuration** | **Twice area&same TxRUs (Option 2)** | √ |
| **Same area&same TxRUs (Option 1)** |  |
| **Same area&half TxRUs (Option 3)** |  |
| **Packet Size** | **DL: 0.5Mbytes, UL: 0.125Mbyte** | √ |
| **DL: 4Kbytes, UL: 1Kbyte** |  |
| **Others** | |  |
| **Sources** | | CMCC, vivo, SPRD, CATT, ZTE, New H3C, Sony, Qualcomm, Nokia |

Table ‑**: Summary of results for SBFD#1\_InH\_FR1\_Sub#3.**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Simple description for the sub-case (RSI based on 1dB desense, SBFD Alt-4, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte)*** | | | | | | | | | | |
|  | | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase |
| **DL Average-UPT (Mbps)** | **Mean** | CMCC: 225.72,  vivo: 684.54,  SPRD: 400.52,  CATT: 336.84,  ZTE: 459.83,  Sony: 380.53,  Qualcomm: 35.10,  Nokia: 602.88, | CMCC: 227.77,  vivo: 690.24,  SPRD: 410.78,  CATT: 392.24,  ZTE: 438.63,  Sony: 311.39,  Qualcomm: 555.89,  Nokia: 610.93, | CMCC: 0.91%,  vivo: 0.83%,  SPRD: 2.56%,  CATT: 16.44%,  ZTE: -4.61%,  Sony: -18.17%,  Qualcomm: -6.17%,  Nokia: 1.34%, | CMCC: 194.29,  vivo: 512.53,  SPRD: 281.77,  CATT: 225.83,  ZTE: 410.65,  Sony: 300.23,  Qualcomm: 19.76,  Nokia: 436.80, | CMCC: 195.10,  vivo: 535.37,  SPRD: 297.95,  CATT: 242.57,  ZTE: 386.33,  Sony: 248.43,  Qualcomm: 418.24,  Nokia: 452.10, | CMCC: 0.42%,  vivo: 4.46%,  SPRD: 5.74%,  CATT: 7.41%,  ZTE: -5.92%,  Sony: -17.25%,  Qualcomm: -5.91%,  Nokia: 3.50%, | vivo: 346.01,  SPRD: 188.70,  CATT: 89.79,  ZTE: 368.92,  Sony: 200.09,  Qualcomm: 8.02,  Nokia: 325.00, | vivo: 337.93,  SPRD: 201.30,  CATT: 93.95,  ZTE: 328.67,  Sony: 183.37,  Qualcomm: 268.81,  Nokia: 340.50, | vivo: -2.33%,  SPRD: 6.68%,  CATT: 4.64%,  ZTE: -10.91%,  Sony: -8.36%,  Qualcomm: -5.09%,  Nokia: 4.77%, |
| **5%** | CMCC: 212.57,  vivo: 523.64,  SPRD: 160.23,  CATT: 245.65,  ZTE: 166.69,  Sony: 180.35,  Qualcomm: 12.66,  Nokia: 562.80, | CMCC: 213.96,  vivo: 620.30,  SPRD: 155.95,  CATT: 264.30,  ZTE: 168.74,  Sony: 130.98,  Qualcomm: 350.50,  Nokia: 545.30, | CMCC: 0.65%,  vivo: 18.46%,  SPRD: -2.67%,  CATT: 7.59%,  ZTE: 1.23%,  Sony: -27.37%,  Qualcomm: -1.48%,  Nokia: -3.11%, | CMCC: 165.76,  vivo: 291.85,  SPRD: 119.57,  CATT: 162.63,  ZTE: 127.78,  Sony: 120.30,  Qualcomm: 6.79,  Nokia: 261.90, | CMCC: 167.47,  vivo: 349.18,  SPRD: 126.86,  CATT: 192.06,  ZTE: 123.01,  Sony: 110.32,  Qualcomm: 238.50,  Nokia: 243.40, | CMCC: 1.03%,  vivo: 19.64%,  SPRD: 6.10%,  CATT: 18.10%,  ZTE: -3.73%,  Sony: -8.30%,  Qualcomm: -8.46%,  Nokia: -7.06%, | vivo: 132.71,  SPRD: 48.80,  CATT: 73.87,  ZTE: 64.03,  Sony: 45.70,  Qualcomm: 2.00,  Nokia: 120.00, | vivo: 146.47,  SPRD: 49.50,  CATT: 76.11,  ZTE: 34.89,  Sony: 42.87,  Qualcomm: 133.51,  Nokia: 116.60, | vivo: 10.36%,  SPRD: 1.43%,  CATT: 3.03%,  ZTE: -45.51%,  Sony: -6.19%,  Qualcomm: -5.67%,  Nokia: -2.83%, |
| **50%** | CMCC: 226.88,  vivo: 709.43,  SPRD: 366.93,  CATT: 327.14,  ZTE: 563.97,  Sony: 450.19,  Qualcomm: 33.55,  Nokia: 605.03, | CMCC: 229.16,  vivo: 698.12,  SPRD: 388.25,  CATT: 407.96,  ZTE: 527.81,  Sony: 430.55,  Qualcomm: 548.02,  Nokia: 617.60, | CMCC: 1.00%,  vivo: -1.59%,  SPRD: 5.81%,  CATT: 24.71%,  ZTE: -6.41%,  Sony: -4.36%,  Qualcomm: -5.38%,  Nokia: 2.08%, | CMCC: 194.66,  vivo: 507.99,  SPRD: 261.27,  CATT: 224.90,  ZTE: 487.60,  Sony: 300.12,  Qualcomm: 18.97,  Nokia: 447.95, | CMCC: 193.74,  vivo: 543.58,  SPRD: 276.26,  CATT: 243.91,  ZTE: 452.32,  Sony: 255.21,  Qualcomm: 404.54,  Nokia: 466.00, | CMCC: -0.47%,  vivo: 7.01%,  SPRD: 5.74%,  CATT: 8.46%,  ZTE: -7.24%,  Sony: -14.96%,  Qualcomm: -7.12%,  Nokia: 4.03%, | vivo: 322.75,  SPRD: 154.80,  CATT: 89.54,  ZTE: 421.94,  Sony: 120.91,  Qualcomm: 6.86,  Nokia: 319.60, | vivo: 316.81,  SPRD: 172.60,  CATT: 93.20,  ZTE: 379.14,  Sony: 113.23,  Qualcomm: 252.73,  Nokia: 336.50, | vivo: -1.84%,  SPRD: 11.50%,  CATT: 4.08%,  ZTE: -10.14%,  Sony: -6.35%,  Qualcomm: -3.50%,  Nokia: 5.29%, |
| **UL Average-UPT (Mbps)** | **Mean** | CMCC: 37.11,  vivo: 204.43,  SPRD: 48.33,  CATT: 130.32,  ZTE: 143.85,  Sony: 120.65,  Qualcomm: 0.92,  Nokia: 96.75, | CMCC: 40.22,  vivo: 178.73,  SPRD: 61.60,  CATT: 161.12,  ZTE: 163.28,  Sony: 160.12,  Qualcomm: 102.53,  Nokia: 90.90, | CMCC: 8.38%,  vivo: -12.57%,  SPRD: 27.46%,  CATT: 23.64%,  ZTE: 13.51%,  Sony: 32.71%,  Qualcomm: 7.18%,  Nokia: -6.05%, | CMCC: 34.43,  vivo: 186.08,  SPRD: 46.22,  CATT: 79.45,  ZTE: 130.01,  Sony: 75.28,  Qualcomm: 0.42,  Nokia: 85.59, | CMCC: 37.81,  vivo: 161.15,  SPRD: 57.07,  CATT: 93.66,  ZTE: 149.45,  Sony: 100.64,  Qualcomm: 73.03,  Nokia: 81.02, | CMCC: 9.82%,  vivo: -13.40%,  SPRD: 23.47%,  CATT: 17.88%,  ZTE: 14.95%,  Sony: 33.69%,  Qualcomm: 13.09%,  Nokia: -5.34%, | vivo: 152.01,  SPRD: 39.10,  CATT: 27.26,  ZTE: 114.77,  Sony: 50.01,  Qualcomm: 0.15,  Nokia: 69.29, | vivo: 120.61,  SPRD: 46.40,  CATT: 26.50,  ZTE: 125.33,  Sony: 61.67,  Qualcomm: 47.00,  Nokia: 67.09, | vivo: -20.66%,  SPRD: 18.67%,  CATT: -2.80%,  ZTE: 9.20%,  Sony: 23.32%,  Qualcomm: 22.97%,  Nokia: -3.18%, |
| **5%** | CMCC: 29.94,  vivo: 193.90,  SPRD: 18.21,  CATT: 73.17,  ZTE: 98.69,  Sony: 68.33,  Qualcomm: 0.42,  Nokia: 89.70, | CMCC: 37.01,  vivo: 171.62,  SPRD: 31.93,  CATT: 112.24,  ZTE: 94.75,  Sony: 121.55,  Qualcomm: 65.94,  Nokia: 78.39, | CMCC: 23.61%,  vivo: -11.49%,  SPRD: 75.34%,  CATT: 53.40%,  ZTE: -3.99%,  Sony: 77.89%,  Qualcomm: 1.31%,  Nokia: -12.61%, | CMCC: 26.41,  vivo: 171.15,  SPRD: 17.13,  CATT: 53.01,  ZTE: 100.14,  Sony: 50.20,  Qualcomm: 0.09,  Nokia: 72.10, | CMCC: 33.46,  vivo: 152.95,  SPRD: 28.41,  CATT: 65.12,  ZTE: 114.60,  Sony: 80.30,  Qualcomm: 39.75,  Nokia: 61.73, | CMCC: 26.69%,  vivo: -10.63%,  SPRD: 65.85%,  CATT: 22.85%,  ZTE: 14.44%,  Sony: 59.96%,  Qualcomm: 35.01%,  Nokia: -14.38%, | vivo: 121.33,  SPRD: 11.70,  CATT: 16.80,  ZTE: 51.43,  Sony: 31.45,  Qualcomm: 0.02,  Nokia: 42.40, | vivo: 94.20,  SPRD: 19.60,  CATT: 23.33,  ZTE: 44.52,  Sony: 37.32,  Qualcomm: 17.94,  Nokia: 38.09, | vivo: -22.36%,  SPRD: 67.52%,  CATT: 38.85%,  ZTE: -13.44%,  Sony: 18.66%,  Qualcomm: 46.12%,  Nokia: -10.17%, |
| **50%** | CMCC: 37.99,  vivo: 204.07,  SPRD: 42.21,  CATT: 130.48,  ZTE: 148.95,  Sony: 120.65,  Qualcomm: 1.00,  Nokia: 97.20, | CMCC: 40.40,  vivo: 179.00,  SPRD: 59.93,  CATT: 157.09,  ZTE: 173.63,  Sony: 169.36,  Qualcomm: 104.50,  Nokia: 92.80, | CMCC: 6.34%,  vivo: -12.28%,  SPRD: 41.98%,  CATT: 20.39%,  ZTE: 16.57%,  Sony: 40.37%,  Qualcomm: 4.29%,  Nokia: -4.53%, | CMCC: 34.91,  vivo: 187.05,  SPRD: 42.23,  CATT: 82.37,  ZTE: 132.75,  Sony: 79.34,  Qualcomm: 0.40,  Nokia: 85.90, | CMCC: 38.07,  vivo: 161.36,  SPRD: 53.71,  CATT: 95.77,  ZTE: 152.41,  Sony: 107.40,  Qualcomm: 70.71,  Nokia: 81.60, | CMCC: 9.05%,  vivo: -13.74%,  SPRD: 27.18%,  CATT: 16.26%,  ZTE: 14.81%,  Sony: 35.37%,  Qualcomm: 11.37%,  Nokia: -5.01%, | vivo: 153.22,  SPRD: 35.00,  CATT: 26.90,  ZTE: 119.33,  Sony: 56.85,  Qualcomm: 0.12,  Nokia: 70.40, | vivo: 122.72,  SPRD: 42.90,  CATT: 26.49,  ZTE: 133.03,  Sony: 80.04,  Qualcomm: 43.58,  Nokia: 68.52, | vivo: -19.90%,  SPRD: 22.57%,  CATT: -1.51%,  ZTE: 11.48%,  Sony: 40.79%,  Qualcomm: 26.13%,  Nokia: -2.67%, |
| **DL Packet-Latency CDF (ms)** | **Mean** | CMCC: 9.60,  vivo: 6.35,  SPRD: 12.83,  CATT: 11.80,  ZTE: 12.08,   Qualcomm: 7.70,  Nokia: 6.92, | CMCC: 9.30,  vivo: 6.15,  SPRD: 12.67,  CATT: 10.50,  ZTE: 12.63,   Qualcomm: 8.06,  Nokia: 6.82, | CMCC: -3.12%,  vivo: 3.21%,  SPRD: -1.25%,  CATT: -11.07%,  ZTE: 4.55%,  Sony: 0.00%,  Qualcomm: -4.66%,  Nokia: -1.45%, | CMCC: 12.70,  vivo: 10.09,  SPRD: 19.54,  CATT: 17.48,  ZTE: 16.32,   Qualcomm: 10.50,  Nokia: 12.49, | CMCC: 12.40,  vivo: 9.30,  SPRD: 18.40,  CATT: 16.41,  ZTE: 17.69,   Qualcomm: 10.92,  Nokia: 11.86, | CMCC: -2.36%,  vivo: 7.88%,  SPRD: -5.83%,  CATT: -6.11%,  ZTE: 8.39%,  Sony: 0.00%,  Qualcomm: -4.00%,  Nokia: -5.04%, | vivo: 23.65,  SPRD: 40.36,  CATT: 46.23,  ZTE: 32.67,   Qualcomm: 18.31,  Nokia: 23.50, | vivo: 22.86,  SPRD: 43.93,  CATT: 43.71,  ZTE: 50.38,   Qualcomm: 18.47,  Nokia: 22.15, | vivo: 3.33%,  SPRD: 8.85%,  CATT: -5.45%,  ZTE: 54.21%,  Sony: 0.00%,  Qualcomm: -0.91%,  Nokia: -5.74%, |
| **5%** | CMCC: 8.50,  vivo: 4.63,  SPRD: 4.92,  CATT: 6.97,  ZTE: 6.02,   Qualcomm: 4.00,  Nokia: 5.92, | CMCC: 8.50,  vivo: 5.04,  SPRD: 5.22,  CATT: 6.56,  ZTE: 6.48,   Qualcomm: 4.36,  Nokia: 5.95, | CMCC: 0.00%,  vivo: -8.79%,  SPRD: 6.10%,  CATT: -5.97%,  ZTE: 7.64%,  Sony: 0.00%,  Qualcomm: -8.78%,  Nokia: 0.51%, | CMCC: 8.50,  vivo: 4.97,  SPRD: 7.41,  CATT: 12.04,  ZTE: 6.02,   Qualcomm: 4.99,  Nokia: 5.98, | CMCC: 8.50,  vivo: 5.08,  SPRD: 6.98,  CATT: 11.96,  ZTE: 6.48,   Qualcomm: 5.16,  Nokia: 5.98, | CMCC: 0.00%,  vivo: -2.27%,  SPRD: -5.80%,  CATT: -0.67%,  ZTE: 7.64%,  Sony: 0.00%,  Qualcomm: -3.49%,  Nokia: 0.00%, | vivo: 5.23,  SPRD: 7.78,  CATT: 33.91,  ZTE: 6.05,   Qualcomm: 6.89,  Nokia: 6.08, | vivo: 5.31,  SPRD: 7.32,  CATT: 33.96,  ZTE: 6.52,   Qualcomm: 7.27,  Nokia: 6.06, | vivo: -1.57%,  SPRD: -5.91%,  CATT: 0.15%,  ZTE: 7.77%,  Sony: 0.00%,  Qualcomm: -5.55%,  Nokia: -0.33%, |
| **50%** | CMCC: 8.50,  vivo: 5.36,  SPRD: 11.69,  CATT: 11.40,  ZTE: 6.88,   Qualcomm: 6.77,  Nokia: 6.26, | CMCC: 8.50,  vivo: 5.35,  SPRD: 11.44,  CATT: 9.66,  ZTE: 6.91,   Qualcomm: 7.07,  Nokia: 6.21, | CMCC: 0.00%,  vivo: 0.24%,  SPRD: -2.14%,  CATT: -15.26%,  ZTE: 0.44%,  Sony: 0.00%,  Qualcomm: -4.49%,  Nokia: -0.80%, | CMCC: 9.00,  vivo: 7.81,  SPRD: 15.43,  CATT: 16.47,  ZTE: 10.27,   Qualcomm: 9.05,  Nokia: 8.96, | CMCC: 9.00,  vivo: 7.20,  SPRD: 15.15,  CATT: 15.39,  ZTE: 11.52,   Qualcomm: 9.38,  Nokia: 8.45, | CMCC: 0.00%,  vivo: 7.78%,  SPRD: -1.81%,  CATT: -6.59%,  ZTE: 12.17%,  Sony: 0.00%,  Qualcomm: -3.55%,  Nokia: -5.69%, | vivo: 13.06,  SPRD: 24.62,  CATT: 44.94,  ZTE: 12.41,   Qualcomm: 14.84,  Nokia: 14.10, | vivo: 13.42,  SPRD: 23.48,  CATT: 42.74,  ZTE: 13.63,   Qualcomm: 15.39,  Nokia: 13.63, | vivo: -2.74%,  SPRD: -4.63%,  CATT: -4.90%,  ZTE: 9.83%,  Sony: 0.00%,  Qualcomm: -3.73%,  Nokia: -3.33%, |
| **UL Packet-Latency CDF (ms)** | **Mean** | CMCC: 16.50,  vivo: 5.24,  SPRD: 29.11,  CATT: 7.21,  ZTE: 9.44,   Qualcomm: 10.12,  Nokia: 10.81, | CMCC: 14.30,  vivo: 5.82,  SPRD: 19.33,  CATT: 5.79,  ZTE: 7.85,   Qualcomm: 10.20,  Nokia: 11.45, | CMCC: -13.33%,  vivo: -11.15%,  SPRD: -33.60%,  CATT: -19.63%,  ZTE: -16.84%,  Sony: 0.00%,  Qualcomm: -0.76%,  Nokia: 5.92%, | CMCC: 18.90,  vivo: 6.20,  SPRD: 31.44,  CATT: 12.47,  ZTE: 9.82,   Qualcomm: 18.58,  Nokia: 13.73, | CMCC: 16.00,  vivo: 6.90,  SPRD: 21.88,  CATT: 11.02,  ZTE: 8.73,   Qualcomm: 16.13,  Nokia: 14.39, | CMCC: -15.34%,  vivo: -11.28%,  SPRD: -30.41%,  CATT: -11.61%,  ZTE: -11.10%,  Sony: 0.00%,  Qualcomm: 13.19%,  Nokia: 4.81%, | vivo: 9.72,  SPRD: 49.05,  CATT: 37.37,  ZTE: 18.85,   Qualcomm: 43.42,  Nokia: 25.19, | vivo: 11.75,  SPRD: 31.70,  CATT: 36.37,  ZTE: 27.05,   Qualcomm: 32.35,  Nokia: 24.91, | vivo: -20.83%,  SPRD: -35.37%,  CATT: -2.70%,  ZTE: 43.50%,  Sony: 0.00%,  Qualcomm: 25.49%,  Nokia: -1.11%, |
| **5%** | CMCC: 11.50,  vivo: 3.64,  SPRD: 11.15,  CATT: 4.79,  ZTE: 5.59,   Qualcomm: 6.82,  Nokia: 8.76, | CMCC: 13.00,  vivo: 5.03,  SPRD: 10.62,  CATT: 3.42,  ZTE: 5.45,   Qualcomm: 7.15,  Nokia: 10.16, | CMCC: 13.04%,  vivo: -38.07%,  SPRD: -4.75%,  CATT: -28.61%,  ZTE: -2.50%,  Sony: 0.00%,  Qualcomm: -4.95%,  Nokia: 15.98%, | CMCC: 11.50,  vivo: 3.68,  SPRD: 10.66,  CATT: 8.09,  ZTE: 5.63,   Qualcomm: 7.59,  Nokia: 8.81, | CMCC: 13.00,  vivo: 5.04,  SPRD: 10.02,  CATT: 6.55,  ZTE: 5.48,   Qualcomm: 7.55,  Nokia: 10.17, | CMCC: 13.04%,  vivo: -37.08%,  SPRD: -6.00%,  CATT: -19.04%,  ZTE: -2.66%,  Sony: 0.00%,  Qualcomm: 0.52%,  Nokia: 15.44%, | vivo: 3.76,  SPRD: 11.50,  CATT: 20.76,  ZTE: 5.63,   Qualcomm: 10.51,  Nokia: 8.89, | vivo: 5.10,  SPRD: 11.28,  CATT: 26.57,  ZTE: 5.48,   Qualcomm: 10.25,  Nokia: 10.19, | vivo: -35.60%,  SPRD: -1.91%,  CATT: 27.95%,  ZTE: -2.66%,  Sony: 0.00%,  Qualcomm: 2.44%,  Nokia: 14.62%, |
| **50%** | CMCC: 14.00,  vivo: 4.91,  SPRD: 23.97,  CATT: 6.21,  ZTE: 6.77,   Qualcomm: 8.82,  Nokia: 10.03, | CMCC: 13.00,  vivo: 5.30,  SPRD: 17.43,  CATT: 5.58,  ZTE: 5.73,   Qualcomm: 8.79,  Nokia: 10.40, | CMCC: -7.14%,  vivo: -8.07%,  SPRD: -27.28%,  CATT: -10.05%,  ZTE: -15.36%,  Sony: 0.00%,  Qualcomm: 0.40%,  Nokia: 3.69%, | CMCC: 15.50,  vivo: 5.24,  SPRD: 25.35,  CATT: 11.33,  ZTE: 7.20,   Qualcomm: 14.92,  Nokia: 10.52, | CMCC: 13.00,  vivo: 5.42,  SPRD: 18.74,  CATT: 10.84,  ZTE: 5.80,   Qualcomm: 12.88,  Nokia: 10.51, | CMCC: -16.13%,  vivo: -3.51%,  SPRD: -26.07%,  CATT: -4.33%,  ZTE: -19.44%,  Sony: 0.00%,  Qualcomm: 13.73%,  Nokia: -0.10%, | vivo: 6.21,  SPRD: 31.11,  CATT: 35.27,  ZTE: 7.63,   Qualcomm: 27.07,  Nokia: 13.86, | vivo: 8.66,  SPRD: 24.87,  CATT: 36.52,  ZTE: 5.91,   Qualcomm: 21.77,  Nokia: 14.74, | vivo: -39.48%,  SPRD: -20.06%,  CATT: 3.55%,  ZTE: -22.54%,  Sony: 0.00%,  Qualcomm: 19.59%,  Nokia: 6.35%, |
| **DL RU (%)** | **Type-1** | CMCC: 3.43%,  vivo: 7.37%,  SPRD: 2.80%,  CATT: 6.02%,  ZTE: 6.01%,  Sony: 5.13%,  Qualcomm: 7.02%, | CMCC: 3.43%,  vivo: 6.98%,  SPRD: 2.96%,  CATT: 5.53%,  ZTE: 5.76%,  Sony: 6.16%,  Qualcomm: 7.02%, | CMCC: 0.00%,  vivo: -0.39%,  SPRD: 0.16%,  CATT: -0.49%,  ZTE: -0.25%,  Sony: 1.03%,  Qualcomm: 0.01%, | CMCC: 14.23%,  vivo: 22.18%,  SPRD: 25.36%,  CATT: 19.89%,  ZTE: 20.51%,  Sony: 21.20%,  Qualcomm: 17.29%, | CMCC: 14.26%,  vivo: 20.45%,  SPRD: 26.00%,  CATT: 19.16%,  ZTE: 19.65%,  Sony: 15.22%,  Qualcomm: 17.31%, | CMCC: 0.03%,  vivo: -1.73%,  SPRD: 0.64%,  CATT: -0.73%,  ZTE: -0.86%,  Sony: -5.98%,  Qualcomm: 0.01%, | vivo: 52.22%,  SPRD: 40.96%,  CATT: 40.94%,  ZTE: 33.82%,  Sony: 43.55%,  Qualcomm: 43.49%, | vivo: 52.10%,  SPRD: 41.52%,  CATT: 41.26%,  ZTE: 32.14%,  Sony: 30.44%,  Qualcomm: 42.32%, | vivo: -0.12%,  SPRD: 0.56%,  CATT: 0.32%,  ZTE: -1.68%,  Sony: -13.11%,  Qualcomm: -1.17%, |
| **Type-2** | CMCC: 4.31%,  vivo: 9.55%,  SPRD: 3.50%,  CATT: 7.52%,  ZTE: 7.52%,  Sony: 8.54%,  Qualcomm: 8.77%,  Nokia: 6.83%, | CMCC: 4.34%,  vivo: 8.90%,  SPRD: 3.70%,  CATT: 6.91%,  ZTE: 7.59%,  Sony: 10.33%,  Qualcomm: 9.37%,  Nokia: 6.85%, | CMCC: 0.03%,  vivo: -0.65%,  SPRD: 0.20%,  CATT: -0.61%,  ZTE: 0.07%,  Sony: 1.79%,  Qualcomm: 0.60%,  Nokia: 0.02%, | CMCC: 17.92%,  vivo: 28.75%,  SPRD: 31.70%,  CATT: 24.86%,  ZTE: 25.63%,  Sony: 26.55%,  Qualcomm: 21.62%,  Nokia: 29.58%, | CMCC: 18.03%,  vivo: 26.09%,  SPRD: 32.50%,  CATT: 23.95%,  ZTE: 25.88%,  Sony: 29.06%,  Qualcomm: 23.09%,  Nokia: 29.29%, | CMCC: 0.11%,  vivo: -2.66%,  SPRD: 0.80%,  CATT: -0.91%,  ZTE: 0.25%,  Sony: 2.51%,  Qualcomm: 1.47%,  Nokia: -0.29%, | vivo: 67.69%,  SPRD: 51.20%,  CATT: 51.18%,  ZTE: 42.27%,  Sony: 46.38%,  Qualcomm: 54.36%,  Nokia: 51.73%, | vivo: 66.46%,  SPRD: 51.90%,  CATT: 51.57%,  ZTE: 42.33%,  Sony: 41.54%,  Qualcomm: 56.46%,  Nokia: 50.68%, | vivo: -1.23%,  SPRD: 0.70%,  CATT: 0.39%,  ZTE: 0.06%,  Sony: -4.84%,  Qualcomm: 2.10%,  Nokia: -1.05%, |
| **UL RU (%)** | **Type-1** | CMCC: 1.13%,  vivo: 2.03%,  SPRD: 1.26%,  CATT: 1.53%,  ZTE: 2.39%,  Sony: 0.95%,  Qualcomm: 1.68%, | CMCC: 0.94%,  vivo: 2.02%,  SPRD: 0.82%,  CATT: 1.65%,  ZTE: 2.23%,  Sony: 2.45%,  Qualcomm: 1.77%, | CMCC: -0.19%,  vivo: -0.01%,  SPRD: -0.44%,  CATT: 0.12%,  ZTE: -0.16%,  Sony: 1.50%,  Qualcomm: 0.09%, | CMCC: 4.08%,  vivo: 5.04%,  SPRD: 4.72%,  CATT: 5.74%,  ZTE: 6.23%,  Sony: 7.00%,  Qualcomm: 5.59%, | CMCC: 3.39%,  vivo: 5.00%,  SPRD: 3.26%,  CATT: 5.53%,  ZTE: 6.01%,  Sony: 10.13%,  Qualcomm: 5.21%, | CMCC: -0.69%,  vivo: -0.04%,  SPRD: -1.46%,  CATT: -0.21%,  ZTE: -0.22%,  Sony: 3.13%,  Qualcomm: -0.38%, | vivo: 11.41%,  SPRD: 10.42%,  CATT: 10.52%,  ZTE: 10.32%,  Sony: 10.28%,  Qualcomm: 13.04%, | vivo: 11.54%,  SPRD: 7.84%,  CATT: 10.17%,  ZTE: 10.42%,  Sony: 18.48%,  Qualcomm: 11.90%, | vivo: 0.13%,  SPRD: -2.58%,  CATT: -0.35%,  ZTE: 0.10%,  Sony: 8.20%,  Qualcomm: -1.14%, |
| **Type-2** | CMCC: 5.47%,  vivo: 10.14%,  SPRD: 6.30%,  CATT: 7.66%,  ZTE: 11.93%,  Sony: 6.66%,  Qualcomm: 8.38%,  Nokia: 7.38%, | CMCC: 4.47%,  vivo: 10.22%,  SPRD: 4.10%,  CATT: 8.22%,  ZTE: 11.09%,  Sony: 6.81%,  Qualcomm: 8.61%,  Nokia: 7.44%, | CMCC: -1.00%,  vivo: 0.08%,  SPRD: -2.20%,  CATT: 0.56%,  ZTE: -0.84%,  Sony: 0.15%,  Qualcomm: 0.23%,  Nokia: 0.06%, | CMCC: 19.82%,  vivo: 25.20%,  SPRD: 23.60%,  CATT: 28.69%,  ZTE: 31.16%,  Sony: 35.07%,  Qualcomm: 27.95%,  Nokia: 25.82%, | CMCC: 16.19%,  vivo: 25.27%,  SPRD: 16.30%,  CATT: 27.65%,  ZTE: 29.96%,  Sony: 26.72%,  Qualcomm: 25.32%,  Nokia: 25.76%, | CMCC: -3.63%,  vivo: 0.07%,  SPRD: -7.30%,  CATT: -1.04%,  ZTE: -1.20%,  Sony: -8.35%,  Qualcomm: -2.63%,  Nokia: -0.06%, | vivo: 57.06%,  SPRD: 52.10%,  CATT: 52.61%,  ZTE: 51.61%,  Sony: 40.06%,  Qualcomm: 65.19%,  Nokia: 51.82%, | vivo: 58.36%,  SPRD: 39.20%,  CATT: 50.84%,  ZTE: 51.90%,  Sony: 44.60%,  Qualcomm: 57.88%,  Nokia: 51.67%, | vivo: 1.29%,  SPRD: -12.90%,  CATT: -1.77%,  ZTE: 0.29%,  Sony: 4.54%,  Qualcomm: -7.31%,  Nokia: -0.15%, |
| Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1 - For Latency, the increase can be calculated as: Increase (%) = SBFD latency / TDD latency - 1 - For RU, the increase can be calculated as: Increase (%) = SBFD RU (%) - TDD RU (%) | | | | | | | | | | |

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| ***Simple description for the sub-case (RSI based on 1dB desense, SBFD Alt-4, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte)*** | | | |
|  | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | |
| **DL: Low, UL: Low** | **DL: Medium, UL: Medium** | **DL: High, UL: High** |
| Gain of DL resource **(%)** | CMCC: -1.22%,  vivo: 1.62%,  SPRD: -1.22%,  CATT: -1.24%,  ZTE: -8.29%,  Sony: -1.22%,  Qualcomm: -22.22%,  Nokia: -1.22%, | CMCC: -1.22%,  vivo: 1.62%,  SPRD: -1.22%,  CATT: -1.24%,  ZTE: -8.29%,  Sony: -1.22%,  Qualcomm: -22.22%,  Nokia: -1.22%, | vivo: 1.62%,  SPRD: -1.22%,  CATT: -1.24%,  ZTE: -8.29%,  Sony: -1.22%,  Qualcomm: -22.22%,  Nokia: -1.22%, |
| **Net gain of mean value of DL average-UPT (%)** | CMCC: 2.13%,  vivo: -0.78%,  SPRD: 3.78%,  CATT: 17.68%,  ZTE: 3.68%,  Sony: -16.95%,  Qualcomm: 16.06%,  Nokia: 2.56%, | CMCC: 1.64%,  vivo: 2.84%,  SPRD: 6.96%,  CATT: 8.65%,  ZTE: 2.37%,  Sony: -16.03%,  Qualcomm: 16.32%,  Nokia: 4.72%, | vivo: -3.95%,  SPRD: 7.90%,  CATT: 5.87%,  ZTE: -2.62%,  Sony: -7.13%,  Qualcomm: 17.14%,  Nokia: 5.99%, |
| **Net gain of 5% value of DL average-UPT (%)** | CMCC: 1.88%,  vivo: 16.84%,  SPRD: -1.45%,  CATT: 8.83%,  ZTE: 9.52%,  Sony: -26.15%,  Qualcomm: 20.74%,  Nokia: -1.89%, | CMCC: 2.25%,  vivo: 18.03%,  SPRD: 7.32%,  CATT: 19.33%,  ZTE: 4.56%,  Sony: -7.07%,  Qualcomm: 13.77%,  Nokia: -5.84%, | vivo: 8.75%,  SPRD: 2.66%,  CATT: 4.27%,  ZTE: -37.22%,  Sony: -4.97%,  Qualcomm: 16.55%,  Nokia: -1.61%, |
| **Net gain of 50% value of DL average-UPT (%)** | CMCC: 2.23%,  vivo: -3.21%,  SPRD: 7.03%,  CATT: 25.94%,  ZTE: 1.88%,  Sony: -3.14%,  Qualcomm: 16.84%,  Nokia: 3.30%, | CMCC: 0.75%,  vivo: 5.39%,  SPRD: 6.96%,  CATT: 9.69%,  ZTE: 1.05%,  Sony: -13.74%,  Qualcomm: 15.10%,  Nokia: 5.25%, | vivo: -3.46%,  SPRD: 12.72%,  CATT: 5.32%,  ZTE: -1.85%,  Sony: -5.13%,  Qualcomm: 18.72%,  Nokia: 6.51%, |
| Gain of UL resource **(%)** | CMCC: 0.50%,  vivo: -1.10%,  SPRD: 0.50%,  CATT: 0.75%,  ZTE: -6.45%,  Sony: 0.50%,  Qualcomm: 35.00%,  Nokia: 0.70%, | CMCC: 0.50%,  vivo: -1.10%,  SPRD: 0.50%,  CATT: 0.75%,  ZTE: -6.45%,  Sony: 0.50%,  Qualcomm: 35.00%,  Nokia: 0.70%, | vivo: -1.10%,  SPRD: 0.50%,  CATT: 0.75%,  ZTE: -6.45%,  Sony: 0.50%,  Qualcomm: 35.00%,  Nokia: 0.70%, |
| **Net gain of mean value of UL average-UPT (%)** | CMCC: 7.88%,  vivo: -11.47%,  SPRD: 26.96%,  CATT: 22.89%,  ZTE: 19.96%,  Sony: 32.21%,  Qualcomm: -27.82%,  Nokia: -6.75%, | CMCC: 9.32%,  vivo: -12.30%,  SPRD: 22.97%,  CATT: 17.13%,  ZTE: 21.40%,  Sony: 33.19%,  Qualcomm: -21.91%,  Nokia: -6.04%, | vivo: -19.56%,  SPRD: 18.17%,  CATT: -3.55%,  ZTE: 15.65%,  Sony: 22.82%,  Qualcomm: -12.03%,  Nokia: -3.88%, |
| **Net gain of 5% value of UL average-UPT (%)** | CMCC: 23.11%,  vivo: -10.39%,  SPRD: 74.84%,  CATT: 52.65%,  ZTE: 2.46%,  Sony: 77.39%,  Qualcomm: -33.69%,  Nokia: -13.31%, | CMCC: 26.19%,  vivo: -9.53%,  SPRD: 65.35%,  CATT: 22.10%,  ZTE: 20.89%,  Sony: 59.46%,  Qualcomm: 0.01%,  Nokia: -15.08%, | vivo: -21.26%,  SPRD: 67.02%,  CATT: 38.10%,  ZTE: -6.99%,  Sony: 18.16%,  Qualcomm: 11.12%,  Nokia: -10.87%, |
| **Net gain of 50% value of UL average-UPT (%)** | CMCC: 5.84%,  vivo: -11.18%,  SPRD: 41.48%,  CATT: 19.64%,  ZTE: 23.02%,  Sony: 39.87%,  Qualcomm: -30.71%,  Nokia: -5.23%, | CMCC: 8.55%,  vivo: -12.64%,  SPRD: 26.68%,  CATT: 15.51%,  ZTE: 21.26%,  Sony: 34.87%,  Qualcomm: -23.63%,  Nokia: -5.71%, | vivo: -18.80%,  SPRD: 22.07%,  CATT: -2.26%,  ZTE: 17.93%,  Sony: 40.29%,  Qualcomm: -8.87%,  Nokia: -3.37%, |
| Note: - Gain of resource (%) = SBFD resource percentage / TDD resource percentage - 1, wherein, for legacy TDD, DL resource percentage per TDD period is 77.1%, and UL resource percentage per TDD period is 20%.  - Net gain of UPT (%) = Gain of UPT - Gain of UL/DL resource | | | |

For subcase SBFD#1\_InH\_FR1\_Sub#3, assuming RSI based on 1dB desense, SBFD Alt-4, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte, key findings are summarized below.

* Traffic load with {DL,UL} = {Low,Low},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 5 sources reported an improvement in the range of {0.83%~16.44%} for SBFD, and 3 sources reported a degradation in the range of {-4.61%~-18.17%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {0.65%~18.46%} for SBFD, and 4 sources reported a degradation in the range of {-1.48%~-27.37%} for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {1.00%~24.71%} for SBFD, and 4 sources reported a degradation in the range of {-1.59%~-6.41%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 2 sources reported an increase in the range of {3.21%~4.55%} for SBFD, and 5 sources reported a decrease in the range of {-1.25%~-11.07%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 3 sources reported an increase in the range of {0.51%~7.64%} for SBFD, and 3 sources reported a decrease in the range of {-5.97%~-8.79%} for SBFD, and 2 sources reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 2 sources reported an increase in the range of {0.24%~0.44%} for SBFD, and 4 sources reported a decrease in the range of {-0.80%~-15.26%} for SBFD, and 2 sources reported no change for SBFD
    - Regarding DL Type-1 RU CDF, 3 sources reported an increase in the range of {0.01%~1.03%} for SBFD, and 3 sources reported a decrease in the range of {-0.25%~-0.49%} for SBFD, and 1 source reported no change for SBFD
    - Regarding DL Type-2 RU CDF, 6 sources reported an increase in the range of {0.02%~1.79%} for SBFD, and 2 sources reported a decrease in the range of {-0.61%~-0.65%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 6 sources reported an improvement in the range of {2.13%~17.68%} for SBFD, and 2 sources reported a degradation in the range of {-0.78%~-16.95%} for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 5 sources reported an improvement in the range of {1.88%~20.74%} for SBFD, and 3 sources reported a degradation in the range of {-1.45%~-26.15%} for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 6 sources reported an improvement in the range of {1.88%~25.94%} for SBFD, and 2 sources reported a degradation in the range of {-3.14%~-3.21%} for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 6 sources reported an improvement in the range of {7.18%~32.71%} for SBFD, and 2 sources reported a degradation in the range of {-6.05%~-12.57%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {1.31%~77.89%} for SBFD, and 3 sources reported a degradation in the range of {-3.99%~-12.61%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {4.29%~41.98%} for SBFD, and 2 sources reported a degradation in the range of {-4.53%~-12.28%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 1 source reported an increase of 5.92% for SBFD, and 6 sources reported a decrease in the range of {-0.76%~-33.60%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {13.04%~15.98%} for SBFD, and 5 sources reported a decrease in the range of {-2.50%~-38.07%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {0.40%~3.69%} for SBFD, and 5 sources reported a decrease in the range of {-7.14%~-27.28%} for SBFD, and 1 source reported no change for SBFD
    - Regarding UL Type-1 RU CDF, 3 sources reported an increase in the range of {0.09%~1.50%} for SBFD, and 4 sources reported a decrease in the range of {-0.01%~-0.44%} for SBFD
    - Regarding UL Type-2 RU CDF, 5 sources reported an increase in the range of {0.06%~0.56%} for SBFD, and 3 sources reported a decrease in the range of {-0.84%~-2.20%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 5 sources reported an improvement in the range of {7.88%~32.21%} for SBFD, and 3 sources reported a degradation in the range of {-6.75%~-27.82%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {2.46%~77.39%} for SBFD, and 3 sources reported a degradation in the range of {-10.39%~-33.69%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {5.84%~41.48%} for SBFD, and 3 sources reported a degradation in the range of {-5.23%~-30.71%} for SBFD
* Traffic load with {DL,UL} = {Medium, Medium},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 5 sources reported an improvement in the range of {0.42%~7.41%} for SBFD, and 3 sources reported a degradation in the range of {-5.91%~-17.25%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {1.03%~19.64%} for SBFD, and 4 sources reported a degradation in the range of {-3.73%~-8.46%} for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {4.03%~8.46%} for SBFD, and 4 sources reported a degradation in the range of {-0.47%~-14.96%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 2 sources reported an increase in the range of {7.88%~8.39%} for SBFD, and 5 sources reported a decrease in the range of {-2.36%~-6.11%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 1 source reported an increase of 7.64% for SBFD, and 4 sources reported a decrease in the range of {-0.67%~-5.80%} for SBFD, and 3 sources reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 2 sources reported an increase in the range of {7.78%~12.17%} for SBFD, and 4 sources reported a decrease in the range of {-1.81%~-6.59%} for SBFD, and 2 sources reported no change for SBFD
    - Regarding DL Type-1 RU CDF, 3 sources reported an increase in the range of {0.01%~0.64%} for SBFD, and 4 sources reported a decrease in the range of {-0.73%~-5.98%} for SBFD
    - Regarding DL Type-2 RU CDF, 5 sources reported an increase in the range of {0.11%~2.51%} for SBFD, and 3 sources reported a decrease in the range of {-0.29%~-2.66%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 7 sources reported an improvement in the range of {1.64%~16.32%} for SBFD, and 1 source reported a degradation of -16.03% for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 6 sources reported an improvement in the range of {2.25%~19.33%} for SBFD, and 2 sources reported a degradation in the range of {-5.84%~-7.07%} for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 7 sources reported an improvement in the range of {0.75%~15.10%} for SBFD, and 1 source reported a degradation of -13.74% for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 6 sources reported an improvement in the range of {9.82%~33.69%} for SBFD, and 2 sources reported a degradation in the range of {-5.34%~-13.40%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {14.44%~65.85%} for SBFD, and 2 sources reported a degradation in the range of {-10.63%~-14.38%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {9.05%~35.37%} for SBFD, and 2 sources reported a degradation in the range of {-5.01%~-13.74%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 2 sources reported an increase in the range of {4.81%~13.19%} for SBFD, and 5 sources reported a decrease in the range of {-11.10%~-30.41%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 3 sources reported an increase in the range of {0.52%~15.44%} for SBFD, and 4 sources reported a decrease in the range of {-2.66%~-37.08%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 1 source reported an increase of 13.73% for SBFD, and 6 sources reported a decrease in the range of {-0.10%~-26.07%} for SBFD, and 1 source reported no change for SBFD
    - Regarding UL Type-1 RU CDF, 1 source reported an increase of 3.13% for SBFD, and 6 sources reported a decrease in the range of {-0.04%~-1.46%} for SBFD
    - Regarding UL Type-2 RU CDF, 1 source reported an increase of 0.07% for SBFD, and 7 sources reported a decrease in the range of {-0.06%~-8.35%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 5 sources reported an improvement in the range of {9.32%~33.19%} for SBFD, and 3 sources reported a degradation in the range of {-6.04%~-21.91%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {0.01%~65.35%} for SBFD, and 2 sources reported a degradation in the range of {-9.53%~-15.08%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {8.55%~34.87%} for SBFD, and 3 sources reported a degradation in the range of {-5.71%~-23.63%} for SBFD
* Traffic load with {DL,UL} = {High, High},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 3 sources reported an improvement in the range of {4.64%~6.68%} for SBFD, and 4 sources reported a degradation in the range of {-2.33%~-10.91%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 3 sources reported an improvement in the range of {1.43%~10.36%} for SBFD, and 4 sources reported a degradation in the range of {-2.83%~-45.51%} for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 3 sources reported an improvement in the range of {4.08%~11.50%} for SBFD, and 4 sources reported a degradation in the range of {-1.84%~-10.14%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 3 sources reported an increase in the range of {3.33%~54.21%} for SBFD, and 3 sources reported a decrease in the range of {-0.91%~-5.74%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 2 sources reported an increase in the range of {0.15%~7.77%} for SBFD, and 4 sources reported a decrease in the range of {-0.33%~-5.91%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 1 source reported an increase of 9.83% for SBFD, and 5 sources reported a decrease in the range of {-2.74%~-4.90%} for SBFD, and 1 source reported no change for SBFD
    - Regarding DL Type-1 RU CDF, 2 sources reported an increase in the range of {0.32%~0.56%} for SBFD, and 4 sources reported a decrease in the range of {-0.12%~-13.11%} for SBFD
    - Regarding DL Type-2 RU CDF, 4 sources reported an increase in the range of {0.06%~2.10%} for SBFD, and 3 sources reported a decrease in the range of {-1.05%~-4.84%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 4 sources reported an improvement in the range of {5.87%~17.14%} for SBFD, and 3 sources reported a degradation in the range of {-2.62%~-7.13%} for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {2.66%~16.55%} for SBFD, and 3 sources reported a degradation in the range of {-1.61%~-37.22%} for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {5.32%~18.72%} for SBFD, and 3 sources reported a degradation in the range of {-1.85%~-5.13%} for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 4 sources reported an improvement in the range of {9.20%~23.32%} for SBFD, and 3 sources reported a degradation in the range of {-2.80%~-20.66%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 4 sources reported an improvement in the range of {18.66%~67.52%} for SBFD, and 3 sources reported a degradation in the range of {-10.17%~-22.36%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 4 sources reported an improvement in the range of {11.48%~40.79%} for SBFD, and 3 sources reported a degradation in the range of {-1.51%~-19.90%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 2 sources reported an increase in the range of {25.49%~43.50%} for SBFD, and 4 sources reported a decrease in the range of {-1.11%~-35.37%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 3 sources reported an increase in the range of {2.44%~27.95%} for SBFD, and 3 sources reported a decrease in the range of {-1.91%~-35.60%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 3 sources reported an increase in the range of {3.55%~19.59%} for SBFD, and 3 sources reported a decrease in the range of {-20.06%~-39.48%} for SBFD, and 1 source reported no change for SBFD
    - Regarding UL Type-1 RU CDF, 3 sources reported an increase in the range of {0.10%~8.20%} for SBFD, and 3 sources reported a decrease in the range of {-0.35%~-2.58%} for SBFD
    - Regarding UL Type-2 RU CDF, 3 sources reported an increase in the range of {0.29%~4.54%} for SBFD, and 4 sources reported a decrease in the range of {-0.15%~-12.90%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 3 sources reported an improvement in the range of {15.65%~22.82%} for SBFD, and 4 sources reported a degradation in the range of {-3.55%~-19.56%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 4 sources reported an improvement in the range of {11.12%~67.02%} for SBFD, and 3 sources reported a degradation in the range of {-6.99%~-21.26%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 3 sources reported an improvement in the range of {17.93%~40.29%} for SBFD, and 4 sources reported a degradation in the range of {-2.26%~-18.80%} for SBFD

*SBFD#1\_InH\_FR1\_Sub#4*

Table ‑**: Key assumption for SBFD#1\_InH\_FR1\_Sub#4.**

|  |  |  |
| --- | --- | --- |
| **Sub-cases  Key assumptions** | | **SBFD#1\_InH\_FR1\_Sub#4** |
| **SBFD slot configuration** | **Alt-2: {DDDSU} vs. {XXXXU}** |  |
| **Alt-4: {DDDSU} vs. {XXXXX}** | √ |
| **Alt-1: {DDDSU} vs. {DXXXX}** |  |
| **Alt-3: {DDSUU} vs. {XXXXU}** |  |
| **SBFD antenna configuration** | **Twice area&same TxRUs (Option 2)** | √ |
| **Same area&same TxRUs (Option 1)** |  |
| **Same area&half TxRUs (Option 3)** |  |
| **Packet Size** | **DL: 0.5Mbytes, UL: 0.125Mbyte** |  |
| **DL: 4Kbytes, UL: 1Kbyte** | √ |
| **Others** | |  |
| **Sources** | | vivo, CATT, ZTE, Qualcomm, OPPO, Nokia |

Table ‑**: Summary of results for SBFD#1\_InH\_FR1\_Sub#4.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Simple description for the sub-case (RSI based on 1dB desense, SBFD Alt-4, Twice area&same TxRUs (Option 2), DL: 4kbytes, UL: 1kbyte)*** | | | | | | | | | | |
|  | | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase |
| **DL Average-UPT (Mbps)** | **Mean** | vivo: 39.59,  CATT: 37.70,  ZTE: 43.62,  Qualcomm: 0.15,  OPPO: 25.39,  Nokia: 26.60, | vivo: 40.78,  CATT: 42.76,  ZTE: 48.52,  Qualcomm: 42.60,  OPPO: 30.36,  Nokia: 27.96, | vivo: 3.01%,  CATT: 13.43%,  ZTE: 11.23%,  Qualcomm: 8.98%,  OPPO: 19.57%,  Nokia: 5.11%, | vivo: 38.48,  CATT: 37.62,  ZTE: 42.87,  Qualcomm: 0.15,  OPPO: 25.35,  Nokia: 23.41, | vivo: 36.88,  CATT: 42.64,  ZTE: 47.95,  Qualcomm: 41.89,  OPPO: 27.72,  Nokia: 27.06, | vivo: -4.16%,  CATT: 13.35%,  ZTE: 11.85%,  Qualcomm: 8.50%,  OPPO: 9.38%,  Nokia: 15.59%, | vivo: 36.10,  CATT: 37.26,  ZTE: 40.80,  Qualcomm: 0.15,  Nokia: 19.97, | vivo: 30.16,  CATT: 41.62,  ZTE: 46.11,  Qualcomm: 41.28,  Nokia: 22.24, | vivo: -16.47%,  CATT: 11.71%,  ZTE: 13.01%,  Qualcomm: 8.41%,  Nokia: 11.37%, |
| **5%** | vivo: 37.97,  CATT: 35.30,  ZTE: 42.29,  Qualcomm: 0.14,  OPPO: 23.66,  Nokia: 26.39, | vivo: 39.29,  CATT: 41.58,  ZTE: 47.40,  Qualcomm: 41.24,  OPPO: 29.16,  Nokia: 27.73, | vivo: 3.50%,  CATT: 17.80%,  ZTE: 12.08%,  Qualcomm: 9.55%,  OPPO: 23.22%,  Nokia: 5.08%, | vivo: 37.00,  CATT: 35.26,  ZTE: 40.54,  Qualcomm: 0.14,  OPPO: 24.72,  Nokia: 16.05, | vivo: 35.68,  CATT: 41.59,  ZTE: 45.98,  Qualcomm: 40.70,  OPPO: 26.59,  Nokia: 23.33, | vivo: -3.55%,  CATT: 17.97%,  ZTE: 13.42%,  Qualcomm: 8.93%,  OPPO: 7.56%,  Nokia: 45.36%, | vivo: 30.13,  CATT: 34.61,  ZTE: 36.72,  Qualcomm: 0.13,  Nokia: 11.52, | vivo: 23.93,  CATT: 36.61,  ZTE: 40.74,  Qualcomm: 39.33,  Nokia: 14.80, | vivo: -20.59%,  CATT: 5.77%,  ZTE: 10.95%,  Qualcomm: 7.98%,  Nokia: 28.47%, |
| **50%** | vivo: 39.29,  CATT: 37.76,  ZTE: 43.75,  Qualcomm: 0.15,  OPPO: 25.35,  Nokia: 26.64, | vivo: 40.53,  CATT: 42.81,  ZTE: 48.58,  Qualcomm: 42.47,  OPPO: 30.22,  Nokia: 27.97, | vivo: 3.14%,  CATT: 13.37%,  ZTE: 11.04%,  Qualcomm: 8.81%,  OPPO: 19.22%,  Nokia: 4.99%, | vivo: 38.00,  CATT: 37.72,  ZTE: 43.05,  Qualcomm: 0.15,  OPPO: 25.24,  Nokia: 24.65, | vivo: 36.50,  CATT: 42.69,  ZTE: 48.14,  Qualcomm: 41.84,  OPPO: 27.68,  Nokia: 27.81, | vivo: -3.94%,  CATT: 13.18%,  ZTE: 11.82%,  Qualcomm: 8.56%,  OPPO: 9.67%,  Nokia: 12.82%, | vivo: 36.57,  CATT: 37.62,  ZTE: 41.36,  Qualcomm: 0.15,  Nokia: 20.56, | vivo: 30.88,  CATT: 42.47,  ZTE: 46.81,  Qualcomm: 41.46,  Nokia: 22.66, | vivo: -15.56%,  CATT: 12.88%,  ZTE: 13.18%,  Qualcomm: 8.69%,  Nokia: 10.21%, |
| **UL Average-UPT (Mbps)** | **Mean** | vivo: 3.87,  CATT: 4.55,  ZTE: 5.76,  Qualcomm: 0.00,  OPPO: 4.07,  Nokia: 3.73, | vivo: 6.39,  CATT: 10.71,  ZTE: 11.97,  Qualcomm: 4.29,  OPPO: 7.56,  Nokia: 5.88, | vivo: 65.28%,  CATT: 135.66%,  ZTE: 107.81%,  Qualcomm: 60.22%,  OPPO: 85.76%,  Nokia: 57.64%, | vivo: 3.76,  CATT: 4.55,  ZTE: 5.36,  Qualcomm: 0.00,  OPPO: 4.14,  Nokia: 3.27, | vivo: 6.24,  CATT: 10.69,  ZTE: 11.66,  Qualcomm: 4.28,  OPPO: 7.58,  Nokia: 5.87, | vivo: 65.79%,  CATT: 135.03%,  ZTE: 117.54%,  Qualcomm: 60.89%,  OPPO: 83.34%,  Nokia: 79.51%, | vivo: 3.69,  CATT: 4.54,  ZTE: 4.80,  Qualcomm: 0.00,  Nokia: 2.93, | vivo: 5.77,  CATT: 10.66,  ZTE: 10.98,  Qualcomm: 4.16,  Nokia: 5.69, | vivo: 56.44%,  CATT: 134.79%,  ZTE: 128.75%,  Qualcomm: 65.07%,  Nokia: 94.20%, |
| **5%** | vivo: 3.66,  CATT: 3.97,  ZTE: 5.38,  Qualcomm: 0.00,  OPPO: 3.74,  Nokia: 3.60, | vivo: 6.22,  CATT: 10.02,  ZTE: 11.63,  Qualcomm: 4.21,  OPPO: 7.27,  Nokia: 5.83, | vivo: 70.16%,  CATT: 152.61%,  ZTE: 116.17%,  Qualcomm: 64.58%,  OPPO: 94.39%,  Nokia: 61.94%, | vivo: 3.54,  CATT: 3.99,  ZTE: 5.08,  Qualcomm: 0.00,  OPPO: 4.02,  Nokia: 2.40, | vivo: 6.06,  CATT: 10.06,  ZTE: 11.33,  Qualcomm: 4.20,  OPPO: 7.51,  Nokia: 5.80, | vivo: 71.19%,  CATT: 152.29%,  ZTE: 123.03%,  Qualcomm: 64.61%,  OPPO: 86.78%,  Nokia: 141.67%, | vivo: 3.42,  CATT: 3.99,  ZTE: 4.50,  Qualcomm: 0.00,  Nokia: 2.10, | vivo: 5.09,  CATT: 9.92,  ZTE: 10.49,  Qualcomm: 3.75,  Nokia: 5.36, | vivo: 48.92%,  CATT: 148.39%,  ZTE: 133.11%,  Qualcomm: 65.32%,  Nokia: 155.24%, |
| **50%** | vivo: 3.86,  CATT: 4.49,  ZTE: 5.75,  Qualcomm: 0.00,  OPPO: 4.05,  Nokia: 3.70, | vivo: 6.40,  CATT: 10.65,  ZTE: 11.96,  Qualcomm: 4.29,  OPPO: 7.48,  Nokia: 5.87, | vivo: 65.65%,  CATT: 137.26%,  ZTE: 108.00%,  Qualcomm: 59.96%,  OPPO: 84.67%,  Nokia: 58.65%, | vivo: 3.73,  CATT: 4.54,  ZTE: 5.35,  Qualcomm: 0.00,  OPPO: 4.14,  Nokia: 3.30, | vivo: 6.24,  CATT: 10.65,  ZTE: 11.67,  Qualcomm: 4.28,  OPPO: 7.59,  Nokia: 5.85, | vivo: 67.18%,  CATT: 134.49%,  ZTE: 118.13%,  Qualcomm: 61.17%,  OPPO: 83.30%,  Nokia: 77.27%, | vivo: 3.63,  CATT: 4.50,  ZTE: 4.78,  Qualcomm: 0.00,  Nokia: 3.60, | vivo: 5.81,  CATT: 10.62,  ZTE: 11.01,  Qualcomm: 4.23,  Nokia: 5.77, | vivo: 59.97%,  CATT: 135.73%,  ZTE: 130.33%,  Qualcomm: 66.34%,  Nokia: 60.28%, |
| **DL Packet-Latency CDF (ms)** | **Mean** | vivo: 1.02,  CATT: 0.87,  ZTE: 0.84,  Qualcomm: 1.14,  OPPO: 1.36,  Nokia: 1.25, | vivo: 0.88,  CATT: 0.76,  ZTE: 0.70,  Qualcomm: 1.16,  OPPO: 1.07,  Nokia: 1.16, | vivo: 13.32%,  CATT: -12.29%,  ZTE: -16.67%,  Qualcomm: -2.39%,  OPPO: -21.36%,  Nokia: -7.20%, | vivo: 1.10,  CATT: 0.87,  ZTE: 0.86,  Qualcomm: 1.18,  OPPO: 1.39,  Nokia: 1.84, | vivo: 1.02,  CATT: 0.76,  ZTE: 0.72,  Qualcomm: 1.21,  OPPO: 1.26,  Nokia: 1.28, | vivo: 6.69%,  CATT: -12.90%,  ZTE: -16.28%,  Qualcomm: -2.47%,  OPPO: -9.28%,  Nokia: -30.43%, | vivo: 1.32,  CATT: 0.90,  ZTE: 0.93,  Qualcomm: 1.21,  Nokia: 3.56, | vivo: 1.39,  CATT: 0.82,  ZTE: 0.77,  Qualcomm: 1.17,  Nokia: 2.02, | vivo: -5.27%,  CATT: -9.49%,  ZTE: -17.20%,  Qualcomm: 2.89%,  Nokia: -43.26%, |
| **5%** | vivo: 0.52,  CATT: 0.52,  ZTE: 0.45,  Qualcomm: 0.55,  OPPO: 1.00,  Nokia: 0.92, | vivo: 0.53,  CATT: 0.52,  ZTE: 0.45,  Qualcomm: 0.54,  OPPO: 1.00,  Nokia: 0.95, | vivo: -2.72%,  CATT: -0.61%,  ZTE: 0.00%,  Qualcomm: 2.28%,  OPPO: 0.00%,  Nokia: 3.64%, | vivo: 0.52,  CATT: 0.52,  ZTE: 0.45,  Qualcomm: 0.55,  OPPO: 1.00,  Nokia: 0.92, | vivo: 0.54,  CATT: 0.52,  ZTE: 0.45,  Qualcomm: 0.54,  OPPO: 1.00,  Nokia: 0.95, | vivo: -4.47%,  CATT: -0.63%,  ZTE: 0.00%,  Qualcomm: 2.28%,  OPPO: 0.00%,  Nokia: 3.21%, | vivo: 0.52,  CATT: 0.52,  ZTE: 0.48,  Qualcomm: 0.54,  Nokia: 0.93, | vivo: 0.56,  CATT: 0.52,  ZTE: 0.56,  Qualcomm: 0.55,  Nokia: 0.96, | vivo: -8.48%,  CATT: -1.07%,  ZTE: 16.67%,  Qualcomm: -1.64%,  Nokia: 3.01%, |
| **50%** | vivo: 0.82,  CATT: 0.81,  ZTE: 0.77,  Qualcomm: 0.86,  OPPO: 1.00,  Nokia: 1.21, | vivo: 0.80,  CATT: 0.74,  ZTE: 0.70,  Qualcomm: 0.80,  OPPO: 1.00,  Nokia: 1.16, | vivo: 2.09%,  CATT: -7.96%,  ZTE: -9.09%,  Qualcomm: 6.25%,  OPPO: 0.00%,  Nokia: -3.97%, | vivo: 0.83,  CATT: 0.80,  ZTE: 0.77,  Qualcomm: 0.86,  OPPO: 1.00,  Nokia: 1.27, | vivo: 0.88,  CATT: 0.75,  ZTE: 0.67,  Qualcomm: 0.84,  OPPO: 1.00,  Nokia: 1.17, | vivo: -6.03%,  CATT: -7.00%,  ZTE: -12.99%,  Qualcomm: 2.08%,  OPPO: 0.00%,  Nokia: -7.84%, | vivo: 0.87,  CATT: 0.82,  ZTE: 0.80,  Qualcomm: 0.88,  Nokia: 1.39, | vivo: 1.16,  CATT: 0.75,  ZTE: 0.73,  Qualcomm: 0.87,  Nokia: 1.27, | vivo: -32.61%,  CATT: -7.90%,  ZTE: -8.75%,  Qualcomm: 2.02%,  Nokia: -8.94%, |
| **UL Packet-Latency CDF (ms)** | **Mean** | vivo: 2.41,  CATT: 1.78,  ZTE: 1.86,  Qualcomm: 3.24,  OPPO: 2.52,  Nokia: 2.39, | vivo: 1.28,  CATT: 0.76,  ZTE: 0.72,  Qualcomm: 2.20,  OPPO: 1.06,  Nokia: 1.37, | vivo: 46.82%,  CATT: -57.26%,  ZTE: -61.29%,  Qualcomm: 31.97%,  OPPO: -57.89%,  Nokia: -42.44%, | vivo: 2.52,  CATT: 1.76,  ZTE: 2.09,  Qualcomm: 3.28,  OPPO: 2.47,  Nokia: 2.98, | vivo: 1.33,  CATT: 0.76,  ZTE: 0.75,  Qualcomm: 2.18,  OPPO: 1.11,  Nokia: 1.38, | vivo: 47.21%,  CATT: -56.57%,  ZTE: -64.11%,  Qualcomm: 33.42%,  OPPO: -55.10%,  Nokia: -53.87%, | vivo: 2.61,  CATT: 1.78,  ZTE: 2.48,  Qualcomm: 3.65,  Nokia: 3.41, | vivo: 1.50,  CATT: 0.76,  ZTE: 0.84,  Qualcomm: 2.26,  Nokia: 1.47, | vivo: 42.55%,  CATT: -57.35%,  ZTE: -66.13%,  Qualcomm: 37.94%,  Nokia: -56.89%, |
| **5%** | vivo: 1.13,  CATT: 0.60,  ZTE: 0.59,  Qualcomm: 1.76,  OPPO: 1.00,  Nokia: 1.25, | vivo: 1.03,  CATT: 0.52,  ZTE: 0.45,  Qualcomm: 1.60,  OPPO: 1.00,  Nokia: 1.16, | vivo: 9.36%,  CATT: -13.84%,  ZTE: -23.73%,  Qualcomm: 8.97%,  OPPO: 0.00%,  Nokia: -7.01%, | vivo: 1.14,  CATT: 0.59,  ZTE: 0.59,  Qualcomm: 1.76,  OPPO: 1.00,  Nokia: 1.28, | vivo: 1.03,  CATT: 0.52,  ZTE: 0.45,  Qualcomm: 1.60,  OPPO: 1.00,  Nokia: 1.16, | vivo: 9.98%,  CATT: -11.62%,  ZTE: -23.73%,  Qualcomm: 8.97%,  OPPO: 0.00%,  Nokia: -9.46%, | vivo: 1.15,  CATT: 0.60,  ZTE: 0.63,  Qualcomm: 1.76,  Nokia: 1.32, | vivo: 1.04,  CATT: 0.50,  ZTE: 0.45,  Qualcomm: 1.63,  Nokia: 1.16, | vivo: 9.68%,  CATT: -16.77%,  ZTE: -28.57%,  Qualcomm: 7.61%,  Nokia: -12.06%, |
| **50%** | vivo: 2.33,  CATT: 1.77,  ZTE: 1.80,  Qualcomm: 3.06,  OPPO: 2.50,  Nokia: 2.37, | vivo: 1.26,  CATT: 0.74,  ZTE: 0.70,  Qualcomm: 1.88,  OPPO: 1.00,  Nokia: 1.37, | vivo: 45.99%,  CATT: -58.06%,  ZTE: -61.11%,  Qualcomm: 38.78%,  OPPO: -60.00%,  Nokia: -42.34%, | vivo: 2.40,  CATT: 1.74,  ZTE: 1.98,  Qualcomm: 3.03,  OPPO: 2.50,  Nokia: 2.73, | vivo: 1.28,  CATT: 0.75,  ZTE: 0.70,  Qualcomm: 1.91,  OPPO: 1.00,  Nokia: 1.37, | vivo: 46.79%,  CATT: -57.02%,  ZTE: -64.65%,  Qualcomm: 36.87%,  OPPO: -60.00%,  Nokia: -49.91%, | vivo: 2.45,  CATT: 1.77,  ZTE: 2.20,  Qualcomm: 3.20,  Nokia: 3.12, | vivo: 1.35,  CATT: 0.75,  ZTE: 0.77,  Qualcomm: 1.96,  Nokia: 1.39, | vivo: 44.82%,  CATT: -57.51%,  ZTE: -65.00%,  Qualcomm: 38.55%,  Nokia: -55.56%, |
| **DL RU (%)** | **Type-1** | vivo: 6.35%,  CATT: 6.12%,  ZTE: 8.21%,  Qualcomm: 7.56%,  OPPO: 1.34%, | vivo: 6.55%,  CATT: 5.92%,  ZTE: 8.02%,  Qualcomm: 7.27%,  OPPO: 1.25%, | vivo: 0.20%,  CATT: -0.20%,  ZTE: -0.19%,  Qualcomm: -0.28%,  OPPO: -0.09%, | vivo: 20.98%,  CATT: 19.87%,  ZTE: 14.33%,  Qualcomm: 21.71%,  OPPO: 21.42%, | vivo: 20.61%,  CATT: 19.02%,  ZTE: 13.98%,  Qualcomm: 20.82%,  OPPO: 21.99%, | vivo: -0.37%,  CATT: -0.85%,  ZTE: -0.35%,  Qualcomm: -0.88%,  OPPO: 0.57%, | vivo: 53.63%,  CATT: 41.34%,  ZTE: 26.48%,  Qualcomm: 36.60%, | vivo: 51.74%,  CATT: 41.11%,  ZTE: 25.75%,  Qualcomm: 35.72%, | vivo: -1.89%,  CATT: -0.23%,  ZTE: -0.73%,  Qualcomm: -0.89%, |
| **Type-2** | vivo: 8.23%,  CATT: 7.65%,  ZTE: 10.27%,  Qualcomm: 9.45%,  OPPO: 1.68%,  Nokia: 7.35%, | vivo: 8.36%,  CATT: 7.40%,  ZTE: 10.57%,  Qualcomm: 9.70%,  OPPO: 1.64%,  Nokia: 7.59%, | vivo: 0.13%,  CATT: -0.25%,  ZTE: 0.30%,  Qualcomm: 0.26%,  OPPO: -0.04%,  Nokia: 0.24%, | vivo: 27.19%,  CATT: 24.84%,  ZTE: 17.92%,  Qualcomm: 27.13%,  OPPO: 26.78%,  Nokia: 24.85%, | vivo: 26.29%,  CATT: 23.77%,  ZTE: 18.42%,  Qualcomm: 27.78%,  OPPO: 28.86%,  Nokia: 15.35%, | vivo: -0.90%,  CATT: -1.07%,  ZTE: 0.50%,  Qualcomm: 0.65%,  OPPO: 2.08%,  Nokia: -9.50%, | vivo: 69.53%,  CATT: 51.67%,  ZTE: 33.10%,  Qualcomm: 45.75%,  Nokia: 54.85%, | vivo: 66.01%,  CATT: 51.39%,  ZTE: 33.92%,  Qualcomm: 47.65%,  Nokia: 51.76%, | vivo: -3.52%,  CATT: -0.28%,  ZTE: 0.82%,  Qualcomm: 1.89%,  Nokia: -3.09%, |
| **UL RU (%)** | **Type-1** | vivo: 2.00%,  CATT: 1.51%,  ZTE: 1.56%,  Qualcomm: 1.96%,  OPPO: 0.54%, | vivo: 1.98%,  CATT: 1.57%,  ZTE: 1.45%,  Qualcomm: 1.54%,  OPPO: 0.80%, | vivo: -0.02%,  CATT: 0.06%,  ZTE: -0.11%,  Qualcomm: -0.42%,  OPPO: 0.26%, | vivo: 5.28%,  CATT: 5.68%,  ZTE: 3.03%,  Qualcomm: 5.35%,  OPPO: 6.85%, | vivo: 6.81%,  CATT: 5.75%,  ZTE: 2.88%,  Qualcomm: 5.05%,  OPPO: 6.06%, | vivo: 1.53%,  CATT: 0.07%,  ZTE: -0.15%,  Qualcomm: -0.30%,  OPPO: -0.79%, | vivo: 11.15%,  CATT: 10.35%,  ZTE: 4.77%,  Qualcomm: 11.51%, | vivo: 15.07%,  CATT: 50.65%,  ZTE: 4.61%,  Qualcomm: 12.23%, | vivo: 3.92%,  CATT: 40.30%,  ZTE: -0.16%,  Qualcomm: 0.72%, |
| **Type-2** | vivo: 10.00%,  CATT: 7.57%,  ZTE: 7.78%,  Qualcomm: 9.80%,  OPPO: 2.70%,  Nokia: 7.81%, | vivo: 10.00%,  CATT: 7.87%,  ZTE: 7.22%,  Qualcomm: 7.51%,  OPPO: 1.05%,  Nokia: 7.79%, | vivo: 0.00%,  CATT: 0.30%,  ZTE: -0.56%,  Qualcomm: -2.29%,  OPPO: -1.65%,  Nokia: -0.02%, | vivo: 26.38%,  CATT: 28.40%,  ZTE: 15.13%,  Qualcomm: 26.77%,  OPPO: 34.27%,  Nokia: 26.50%, | vivo: 34.42%,  CATT: 28.74%,  ZTE: 14.37%,  Qualcomm: 24.58%,  OPPO: 7.96%,  Nokia: 27.30%, | vivo: 8.04%,  CATT: 0.34%,  ZTE: -0.76%,  Qualcomm: -2.18%,  OPPO: -26.31%,  Nokia: 0.80%, | vivo: 55.77%,  CATT: 51.75%,  ZTE: 23.87%,  Qualcomm: 57.55%,  Nokia: 50.97%, | vivo: 76.21%,  CATT: 10.13%,  ZTE: 22.96%,  Qualcomm: 59.47%,  Nokia: 53.65%, | vivo: 20.44%,  CATT: -41.62%,  ZTE: -0.91%,  Qualcomm: 1.92%,  Nokia: 2.68%, |
| Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1 - For Latency, the increase can be calculated as: Increase (%) = SBFD latency / TDD latency - 1 - For RU, the increase can be calculated as: Increase (%) = SBFD RU (%) - TDD RU (%) | | | | | | | | | | |

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| ***Simple description for the sub-case (RSI based on 1dB desense, SBFD Alt-4, Twice area&same TxRUs (Option 2), DL: 4kbytes, UL: 1kbyte)*** | | | |
|  | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | |
| **DL: Low, UL: Low** | **DL: Medium, UL: Medium** | **DL: High, UL: High** |
| Gain of DL resource **(%)** | vivo: 1.62%,  CATT: -1.24%,  ZTE: -8.29%,  Qualcomm: -22.22%,  OPPO: -1.23%,  Nokia: -1.22%, | vivo: 1.62%,  CATT: -1.24%,  ZTE: -8.29%,  Qualcomm: -22.22%,  OPPO: -1.23%,  Nokia: -1.22%, | vivo: 1.62%,  CATT: -1.24%,  ZTE: -8.29%,  Qualcomm: -22.22%,  Nokia: -1.22%, |
| **Net gain of mean value of DL average-UPT (%)** | vivo: 1.39%,  CATT: 14.66%,  ZTE: 19.52%,  Qualcomm: 31.21%,  OPPO: 20.81%,  Nokia: 6.33%, | vivo: -5.78%,  CATT: 14.58%,  ZTE: 20.14%,  Qualcomm: 30.73%,  OPPO: 10.62%,  Nokia: 16.81%, | vivo: -18.09%,  CATT: 12.94%,  ZTE: 21.30%,  Qualcomm: 30.63%,  Nokia: 12.59%, |
| **Net gain of 5% value of DL average-UPT (%)** | vivo: 1.88%,  CATT: 19.04%,  ZTE: 20.37%,  Qualcomm: 31.78%,  OPPO: 24.45%,  Nokia: 6.30%, | vivo: -5.16%,  CATT: 19.20%,  ZTE: 21.71%,  Qualcomm: 31.16%,  OPPO: 8.79%,  Nokia: 46.58%, | vivo: -22.21%,  CATT: 7.00%,  ZTE: 19.24%,  Qualcomm: 30.20%,  Nokia: 29.69%, |
| **Net gain of 50% value of DL average-UPT (%)** | vivo: 1.52%,  CATT: 14.60%,  ZTE: 19.33%,  Qualcomm: 31.04%,  OPPO: 20.46%,  Nokia: 6.21%, | vivo: -5.55%,  CATT: 14.42%,  ZTE: 20.11%,  Qualcomm: 30.78%,  OPPO: 10.90%,  Nokia: 14.04%, | vivo: -17.17%,  CATT: 14.11%,  ZTE: 21.47%,  Qualcomm: 30.91%,  Nokia: 11.43%, |
| Gain of UL resource **(%)** | vivo: -1.10%,  CATT: 0.75%,  ZTE: -6.45%,  Qualcomm: 35.00%,  OPPO: 0.73%,  Nokia: 0.70%, | vivo: -1.10%,  CATT: 0.75%,  ZTE: -6.45%,  Qualcomm: 35.00%,  OPPO: 0.73%,  Nokia: 0.70%, | vivo: -1.10%,  CATT: 0.75%,  ZTE: -6.45%,  Qualcomm: 35.00%,  Nokia: 0.70%, |
| **Net gain of mean value of UL average-UPT (%)** | vivo: 66.38%,  CATT: 134.91%,  ZTE: 114.26%,  Qualcomm: 25.22%,  OPPO: 85.03%,  Nokia: 56.94%, | vivo: 66.89%,  CATT: 134.28%,  ZTE: 123.99%,  Qualcomm: 25.89%,  OPPO: 82.60%,  Nokia: 78.81%, | vivo: 57.54%,  CATT: 134.04%,  ZTE: 135.20%,  Qualcomm: 30.07%,  Nokia: 93.50%, |
| **Net gain of 5% value of UL average-UPT (%)** | vivo: 71.26%,  CATT: 151.86%,  ZTE: 122.62%,  Qualcomm: 29.58%,  OPPO: 93.66%,  Nokia: 61.24%, | vivo: 72.29%,  CATT: 151.54%,  ZTE: 129.48%,  Qualcomm: 29.61%,  OPPO: 86.04%,  Nokia: 140.97%, | vivo: 50.02%,  CATT: 147.64%,  ZTE: 139.56%,  Qualcomm: 30.32%,  Nokia: 154.54%, |
| **Net gain of 50% value of UL average-UPT (%)** | vivo: 66.75%,  CATT: 136.51%,  ZTE: 114.45%,  Qualcomm: 24.96%,  OPPO: 83.94%,  Nokia: 57.95%, | vivo: 68.28%,  CATT: 133.74%,  ZTE: 124.58%,  Qualcomm: 26.17%,  OPPO: 82.56%,  Nokia: 76.57%, | vivo: 61.07%,  CATT: 134.98%,  ZTE: 136.78%,  Qualcomm: 31.34%,  Nokia: 59.58%, |
| Note: - Gain of resource (%) = SBFD resource percentage / TDD resource percentage - 1, wherein, for legacy TDD, DL resource percentage per TDD period is 77.1%, and UL resource percentage per TDD period is 20%.  - Net gain of UPT (%) = Gain of UPT - Gain of UL/DL resource | | | |

For subcase SBFD#1\_InH\_FR1\_Sub#4, assuming RSI based on 1dB desense, SBFD Alt-4, Twice area&same TxRUs (Option 2), DL: 4kbytes, UL: 1kbyte, key findings are summarized below.

* Traffic load with {DL,UL} = {Low,Low},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 6 sources reported an improvement in the range of {3.01%~19.57%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 6 sources reported an improvement in the range of {3.50%~23.22%} for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 6 sources reported an improvement in the range of {3.14%~19.22%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 1 source reported an increase of 13.32% for SBFD, and 5 sources reported a decrease in the range of {-2.39%~-21.36%} for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 2 sources reported an increase in the range of {2.28%~3.64%} for SBFD, and 2 sources reported a decrease in the range of {-0.61%~-2.72%} for SBFD, and 2 sources reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 2 sources reported an increase in the range of {2.09%~6.25%} for SBFD, and 3 sources reported a decrease in the range of {-3.97%~-9.09%} for SBFD, and 1 source reported no change for SBFD
    - Regarding DL Type-1 RU CDF, 1 source reported an increase of 0.20% for SBFD, and 4 sources reported a decrease in the range of {-0.09%~-0.28%} for SBFD
    - Regarding DL Type-2 RU CDF, 4 sources reported an increase in the range of {0.13%~0.30%} for SBFD, and 2 sources reported a decrease in the range of {-0.04%~-0.25%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 6 sources reported an improvement in the range of {1.39%~31.21%} for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 6 sources reported an improvement in the range of {1.88%~31.78%} for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 6 sources reported an improvement in the range of {1.52%~31.04%} for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 6 sources reported an improvement in the range of {57.64%~135.66%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {61.94%~152.61%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {58.65%~137.26%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 2 sources reported an increase in the range of {31.97%~46.82%} for SBFD, and 4 sources reported a decrease in the range of {-42.44%~-61.29%} for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {8.97%~9.36%} for SBFD, and 3 sources reported a decrease in the range of {-7.01%~-23.73%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {38.78%~45.99%} for SBFD, and 4 sources reported a decrease in the range of {-42.34%~-61.11%} for SBFD
    - Regarding UL Type-1 RU CDF, 2 sources reported an increase in the range of {0.06%~0.26%} for SBFD, and 3 sources reported a decrease in the range of {-0.02%~-0.42%} for SBFD
    - Regarding UL Type-2 RU CDF, 1 source reported an increase of 0.30% for SBFD, and 4 sources reported a decrease in the range of {-0.02%~-2.29%} for SBFD, and 1 source reported no change for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 6 sources reported an improvement in the range of {25.22%~134.91%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {29.58%~151.86%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {24.96%~136.51%} for SBFD
* Traffic load with {DL,UL} = {Medium, Medium},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 5 sources reported an improvement in the range of {8.50%~15.59%} for SBFD, and 1 source reported a degradation of -4.16% for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 5 sources reported an improvement in the range of {7.56%~45.36%} for SBFD, and 1 source reported a degradation of -3.55% for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 5 sources reported an improvement in the range of {8.56%~13.18%} for SBFD, and 1 source reported a degradation of -3.94% for SBFD
    - Regarding mean value of DL packet-latency CDF, 1 source reported an increase of 6.69% for SBFD, and 5 sources reported a decrease in the range of {-2.47%~-30.43%} for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 2 sources reported an increase in the range of {2.28%~3.21%} for SBFD, and 2 sources reported a decrease in the range of {-0.63%~-4.47%} for SBFD, and 2 sources reported no change for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 1 source reported an increase of 2.08% for SBFD, and 4 sources reported a decrease in the range of {-6.03%~-12.99%} for SBFD, and 1 source reported no change for SBFD
    - Regarding DL Type-1 RU CDF, 1 source reported an increase of 0.57% for SBFD, and 4 sources reported a decrease in the range of {-0.35%~-0.88%} for SBFD
    - Regarding DL Type-2 RU CDF, 3 sources reported an increase in the range of {0.50%~2.08%} for SBFD, and 3 sources reported a decrease in the range of {-0.90%~-9.50%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 5 sources reported an improvement in the range of {10.62%~30.73%} for SBFD, and 1 source reported a degradation of -5.78% for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 5 sources reported an improvement in the range of {8.79%~46.58%} for SBFD, and 1 source reported a degradation of -5.16% for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 5 sources reported an improvement in the range of {10.90%~30.78%} for SBFD, and 1 source reported a degradation of -5.55% for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 6 sources reported an improvement in the range of {60.89%~135.03%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {64.61%~152.29%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {61.17%~134.49%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 2 sources reported an increase in the range of {33.42%~47.21%} for SBFD, and 4 sources reported a decrease in the range of {-53.87%~-64.11%} for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {8.97%~9.98%} for SBFD, and 3 sources reported a decrease in the range of {-9.46%~-23.73%} for SBFD, and 1 source reported no change for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {36.87%~46.79%} for SBFD, and 4 sources reported a decrease in the range of {-49.91%~-64.65%} for SBFD
    - Regarding UL Type-1 RU CDF, 2 sources reported an increase in the range of {0.07%~1.53%} for SBFD, and 3 sources reported a decrease in the range of {-0.15%~-0.79%} for SBFD
    - Regarding UL Type-2 RU CDF, 3 sources reported an increase in the range of {0.34%~8.04%} for SBFD, and 3 sources reported a decrease in the range of {-0.76%~-26.31%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 6 sources reported an improvement in the range of {25.89%~134.28%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {29.61%~151.54%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 6 sources reported an improvement in the range of {26.17%~133.74%} for SBFD
* Traffic load with {DL,UL} = {High, High},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 4 sources reported an improvement in the range of {8.41%~13.01%} for SBFD, and 1 source reported a degradation of -16.47% for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {5.77%~28.47%} for SBFD, and 1 source reported a degradation of -20.59% for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {8.69%~13.18%} for SBFD, and 1 source reported a degradation of -15.56% for SBFD
    - Regarding mean value of DL packet-latency CDF, 1 source reported an increase of 2.89% for SBFD, and 4 sources reported a decrease in the range of {-5.27%~-43.26%} for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 2 sources reported an increase in the range of {3.01%~16.67%} for SBFD, and 3 sources reported a decrease in the range of {-1.07%~-8.48%} for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 1 source reported an increase of 2.02% for SBFD, and 4 sources reported a decrease in the range of {-7.90%~-32.61%} for SBFD
    - Regarding DL Type-1 RU CDF, 4 sources reported a decrease in the range of {-0.23%~-1.89%} for SBFD
    - Regarding DL Type-2 RU CDF, 2 sources reported an increase in the range of {0.82%~1.89%} for SBFD, and 3 sources reported a decrease in the range of {-0.28%~-3.52%} for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 4 sources reported an improvement in the range of {12.59%~30.63%} for SBFD, and 1 source reported a degradation of -18.09% for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {7.00%~30.20%} for SBFD, and 1 source reported a degradation of -22.21% for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 4 sources reported an improvement in the range of {11.43%~30.91%} for SBFD, and 1 source reported a degradation of -17.17% for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 5 sources reported an improvement in the range of {56.44%~134.79%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {48.92%~155.24%} for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {59.97%~135.73%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 2 sources reported an increase in the range of {37.94%~42.55%} for SBFD, and 3 sources reported a decrease in the range of {-56.89%~-66.13%} for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {7.61%~9.68%} for SBFD, and 3 sources reported a decrease in the range of {-12.06%~-28.57%} for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 2 sources reported an increase in the range of {38.55%~44.82%} for SBFD, and 3 sources reported a decrease in the range of {-55.56%~-65.00%} for SBFD
    - Regarding UL Type-1 RU CDF, 3 sources reported an increase in the range of {0.72%~40.30%} for SBFD, and 1 source reported a decrease of -0.16% for SBFD
    - Regarding UL Type-2 RU CDF, 3 sources reported an increase in the range of {1.92%~20.44%} for SBFD, and 2 sources reported a decrease in the range of {-0.91%~-41.62%} for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 5 sources reported an improvement in the range of {30.07%~135.20%} for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {30.32%~154.54%} for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 5 sources reported an improvement in the range of {31.34%~136.78%} for SBFD

**(higher priority) Urban Macro (FR1) – based on “SBFD-Case1-v015\_OPPO\_Nokia.xlsx”**

[Huawei, ZTE, Ericsson, Qualcomm, CATT, OPPO, xiaomi, LG, Nokia, MediaTek, Intel] provide initial SLS evaluation results for Urban Macro (FR1) for SBFD Deployment Case 1, wherein, [CATT, ZTE, Mediatek, LG, Qualcomm, Samsung] upload evaluation results to the following draft FTP folder.

([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))

Based on the collected excel data in “SBFD-Case1-v015\_OPPO\_Nokia.xlsx”, the evaluation results are categorized into 10 sub-cases based on the different key assumptions.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sub-cases  Key assumptions** | | **SBFD#1\_UMA\_FR1\_Sub#1** | **SBFD#1\_UMA\_FR1\_Sub#2** | **SBFD#1\_UMA\_FR1\_Sub#3** | **SBFD#1\_UMA\_FR1\_Sub#4** | **SBFD#1\_UMA\_FR1\_Sub#5** | **SBFD#1\_UMA\_FR1\_Sub#6** | **SBFD#1\_UMA\_FR1\_Sub#7** | **SBFD#1\_UMA\_FR1\_Sub#8** | **SBFD#1\_UMA\_FR1\_Sub#9** | **SBFD#1\_UMA\_FR1\_Sub#10** |
| **Co-site: Spatial isolation + digital isolation** | **Opt 1:75+0dB** |  | √ |  | √ | √ |  |  |  |  |  |
| **Opt 2: 93+0dB** |  |  | √ |  |  |  |  |  |  |  |
| **Opt 3: 100+0dB** |  |  |  |  |  |  |  | √ |  |  |
| **Opt 4: 100+10 dB** | √ |  |  |  |  |  |  |  |  |  |
| **93+10 dB** |  |  |  |  |  | √ | √ |  |  |  |
| **based on 1dB desense** |  |  |  |  |  |  |  |  | √ |  |
| **122.5dB** |  |  |  |  |  |  |  |  |  | √ |
| **BS transmit power** | **53dBm** |  |  |  |  |  | √ | √ | √ | √ |  |
| **49dBm** | √ | √ | √ | √ | √ |  |  |  |  | √ |
| **SBFD slot configuration** | **Alt-2: {DDDSU} vs. {XXXXU}** | √ | √ | √ |  |  | √ |  | √ | √ | √ |
| **Alt-4: {DDDSU} vs. {XXXXX}** |  |  |  | √ | √ |  | √ |  |  |  |
| **Alt-1: {DDDSU} vs. {DXXXX}** |  |  |  |  |  |  |  |  |  |  |
| **Alt-3: {DDSUU} vs. {XXXXU}** |  |  |  |  |  |  |  |  |  |  |
| **SBFD antenna configuration** | **Twice area&same TxRUs (Option 2)** | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| **Same area&same TxRUs (Option 1)** |  |  |  |  |  |  |  |  |  |  |
| **Same area&half TxRUs (Option 3)** |  |  |  |  |  |  |  |  |  |  |
| **Packet Size** | **DL: 0.5Mbytes, UL: 0.125Mbyte** | √ | √ |  | √ |  |  |  | √ |  | √ |
| **DL: 4Kbytes, UL: 1Kbyte** |  |  | √ |  | √ | √ | √ |  | √ | √ |
| **Others** | |  |  |  |  |  |  |  | UE ICS not modelled |  | RSI=122.5dB |
| **Sources** | | Samsung | CATT | Samsung | CATT | CATT | Qualcomm | Qualcomm | Mediatek | ZTE | LG |

Only the first subcase is summarized in the following sub-section as an example.

*SBFD#1\_UMA\_FR1\_Sub#1*

Table ‑**: Key assumption for SBFD#1\_UMA\_FR1\_Sub#1.**

|  |  |  |
| --- | --- | --- |
| **Sub-cases  Key assumptions** | | **SBFD#1\_UMA\_FR1\_Sub#1** |
| **Co-site: Spatial isolation + digital isolation** | **Opt 1:75+0dB** |  |
| **Opt 2: 93+0dB** |  |
| **Opt 3: 100+0dB** |  |
| **Opt 4: 100+10 dB** | √ |
| **93+10 dB** |  |
| **based on 1dB desense** |  |
| **122.5dB** |  |
| **BS transmit power** | **53dBm** |  |
| **49dBm** | √ |
| **SBFD slot configuration** | **Alt-2: {DDDSU} vs. {XXXXU}** | √ |
| **Alt-4: {DDDSU} vs. {XXXXX}** |  |
| **Alt-1: {DDDSU} vs. {DXXXX}** |  |
| **Alt-3: {DDSUU} vs. {XXXXU}** |  |
| **SBFD antenna configuration** | **Twice area&same TxRUs (Option 2)** | √ |
| **Same area&same TxRUs (Option 1)** |  |
| **Same area&half TxRUs (Option 3)** |  |
| **Packet Size** | **DL: 0.5Mbytes, UL: 0.125Mbyte** | √ |
| **DL: 4Kbytes, UL: 1Kbyte** |  |
| **Others** | |  |
| **Sources** | | Samsung |

Table ‑**: Summary of results for SBFD#1\_UMA\_FR1\_Sub#1.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Simple description for the sub-case (RSI based on 1dB desense, Co-Site, 100+0dB, SBFD Alt-2, 49dBm gNB Tx power, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte)*** | | | | | | | | | | |
|  | | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase | TDD | SBFD | Gain /Increase |
| **DL Average-UPT (Mbps)** | **Mean** | Samsung: 465.00, | Samsung: 435.00, | Samsung: -6.45%, | Samsung: 296.00, | Samsung: 252.00, | Samsung: -14.86%, | Samsung: 215.00, | Samsung: 153.00, | Samsung: -28.84%, |
| **5%** | Samsung: 110.00, | Samsung: 88.70, | Samsung: -19.36%, | Samsung: 79.60, | Samsung: 55.10, | Samsung: -30.78%, | Samsung: 37.40, | Samsung: 24.70, | Samsung: -33.96%, |
| **50%** | Samsung: 359.00, | Samsung: 354.00, | Samsung: -1.39%, | Samsung: 222.00, | Samsung: 186.00, | Samsung: -16.22%, | Samsung: 173.00, | Samsung: 110.00, | Samsung: -36.42%, |
| **UL Average-UPT (Mbps)** | **Mean** | Samsung: 30.80, | Samsung: 58.20, | Samsung: 88.96%, | Samsung: 22.20, | Samsung: 42.20, | Samsung: 90.09%, | Samsung: 13.20, | Samsung: 24.50, | Samsung: 85.61%, |
| **5%** | Samsung: 1.00, | Samsung: 3.40, | Samsung: 240.00%, | Samsung: 0.75, | Samsung: 1.52, | Samsung: 102.67%, | Samsung: 0.48, | Samsung: 0.79, | Samsung: 64.58%, |
| **50%** | Samsung: 15.03, | Samsung: 27.00, | Samsung: 79.64%, | Samsung: 7.88, | Samsung: 20.60, | Samsung: 161.42%, | Samsung: 4.57, | Samsung: 10.20, | Samsung: 123.19%, |
| **DL Packet-Latency CDF (ms)** | **Mean** | Samsung: 14.60, | Samsung: 17.00, | Samsung: 16.44%, | Samsung: 26.30, | Samsung: 35.00, | Samsung: 33.08%, | Samsung: 61.30, | Samsung: 81.30, | Samsung: 32.63%, |
| **5%** | Samsung: 3.60, | Samsung: 3.80, | Samsung: 5.56%, | Samsung: 5.60, | Samsung: 6.00, | Samsung: 7.14%, | Samsung: 7.20, | Samsung: 8.30, | Samsung: 15.28%, |
| **50%** | Samsung: 11.20, | Samsung: 11.40, | Samsung: 1.79%, | Samsung: 20.20, | Samsung: 23.20, | Samsung: 14.85%, | Samsung: 31.10, | Samsung: 43.20, | Samsung: 38.91%, |
| **UL Packet-Latency CDF (ms)** | **Mean** | Samsung: 145.00, | Samsung: 74.50, | Samsung: -48.62%, | Samsung: 224.00, | Samsung: 147.00, | Samsung: -34.38%, | Samsung: 331.00, | Samsung: 265.00, | Samsung: -19.94%, |
| **5%** | Samsung: 10.50, | Samsung: 5.70, | Samsung: -45.71%, | Samsung: 11.30, | Samsung: 6.50, | Samsung: -42.48%, | Samsung: 13.90, | Samsung: 11.05, | Samsung: -20.50%, |
| **50%** | Samsung: 67.20, | Samsung: 38.00, | Samsung: -43.45%, | Samsung: 109.00, | Samsung: 63.00, | Samsung: -42.20%, | Samsung: 146.00, | Samsung: 80.00, | Samsung: -45.21%, |
| **DL RU (%)** | **Type-1** | Samsung: 4.80%, | Samsung: 6.40%, | Samsung: 1.60%, | Samsung: 21.70%, | Samsung: 31.05%, | Samsung: 9.35%, | Samsung: 49.44%, | Samsung: 63.96%, | Samsung: 14.52%, |
| **Type-2** | Samsung: 6.70%, | Samsung: 7.10%, | Samsung: 0.40%, | Samsung: 26.40%, | Samsung: 34.50%, | Samsung: 8.10%, | Samsung: 61.80%, | Samsung: 71.07%, | Samsung: 9.27%, |
| **UL RU (%)** | **Type-1** | Samsung: 2.30%, | Samsung: 2.44%, | Samsung: 0.14%, | Samsung: 5.20%, | Samsung: 5.14%, | Samsung: -0.06%, | Samsung: 11.74%, | Samsung: 14.43%, | Samsung: 2.69%, |
| **Type-2** | Samsung: 11.40%, | Samsung: 6.80%, | Samsung: -4.60%, | Samsung: 26.00%, | Samsung: 14.27%, | Samsung: -11.73%, | Samsung: 58.70%, | Samsung: 40.10%, | Samsung: -18.60%, |
| Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1 - For Latency, the increase can be calculated as: Increase (%) = SBFD latency / TDD latency - 1 - For RU, the increase can be calculated as: Increase (%) = SBFD RU (%) - TDD RU (%) | | | | | | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| ***Simple description for the sub-case (RSI based on 1dB desense, Co-Site, 100+0dB, SBFD Alt-2, 49dBm gNB Tx power, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte)*** | | | |
|  | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | |
| **DL: Low, UL: Low** | **DL: Medium, UL: Medium** | **DL: High, UL: High** |
| Gain of DL resource **(%)** | Samsung: -20.93%, | Samsung: -20.93%, | Samsung: -20.93%, |
| **Net gain of mean value of DL average-UPT (%)** | Samsung: 14.47%, | Samsung: 6.06%, | Samsung: -7.91%, |
| **Net gain of 5% value of DL average-UPT (%)** | Samsung: 1.56%, | Samsung: -9.85%, | Samsung: -13.03%, |
| **Net gain of 50% value of DL average-UPT (%)** | Samsung: 19.53%, | Samsung: 4.71%, | Samsung: -15.49%, |
| Gain of UL resource **(%)** | Samsung: 80.00%, | Samsung: 80.00%, | Samsung: 80.00%, |
| **Net gain of mean value of UL average-UPT (%)** | Samsung: 8.96%, | Samsung: 10.09%, | Samsung: 5.61%, |
| **Net gain of 5% value of UL average-UPT (%)** | Samsung: 160.00%, | Samsung: 22.67%, | Samsung: -15.42%, |
| **Net gain of 50% value of UL average-UPT (%)** | Samsung: -0.36%, | Samsung: 81.42%, | Samsung: 43.19%, |
| Note: - Gain of resource (%) = SBFD resource percentage / TDD resource percentage - 1, wherein, for legacy TDD, DL resource percentage per TDD period is 77.1%, and UL resource percentage per TDD period is 20%.  - Net gain of UPT (%) = Gain of UPT - Gain of UL/DL resource | | | |

For subcase SBFD#1\_UMA\_FR1\_Sub#1, assuming RSI based on 1dB desense, Co-Site, 100+0dB, SBFD Alt-2, 49dBm gNB Tx power, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte, key findings are summarized below.

* Traffic load with {DL,UL} = {Low,Low},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 1 source reported a degradation of -6.45% for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 1 source reported a degradation of -19.36% for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 1 source reported a degradation of -1.39% for SBFD
    - Regarding mean value of DL packet-latency CDF, 1 source reported an increase of 16.44% for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 1 source reported an increase of 5.56% for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 1 source reported an increase of 1.79% for SBFD
    - Regarding DL Type-1 RU CDF, 1 source reported an increase of 1.60% for SBFD
    - Regarding DL Type-2 RU CDF, 1 source reported an increase of 0.40% for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 1 source reported an improvement of 14.47% for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 1 source reported an improvement of 1.56% for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 1 source reported an improvement of 19.53% for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 1 source reported an improvement of 88.96% for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 1 source reported an improvement of 240.00% for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 1 source reported an improvement of 79.64% for SBFD
    - Regarding mean value of UL packet-latency CDF, 1 source reported a decrease of -48.62% for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 1 source reported a decrease of -45.71% for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 1 source reported a decrease of -43.45% for SBFD
    - Regarding UL Type-1 RU CDF, 1 source reported an increase of 0.14% for SBFD
    - Regarding UL Type-2 RU CDF, 1 source reported a decrease of -4.60% for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 1 source reported an improvement of 8.96% for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 1 source reported an improvement of 160.00% for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 1 source reported a degradation of -0.36% for SBFD
* Traffic load with {DL,UL} = {Medium, Medium},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 1 source reported a degradation of -14.86% for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 1 source reported a degradation of -30.78% for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 1 source reported a degradation of -16.22% for SBFD
    - Regarding mean value of DL packet-latency CDF, 1 source reported an increase of 33.08% for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 1 source reported an increase of 7.14% for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 1 source reported an increase of 14.85% for SBFD
    - Regarding DL Type-1 RU CDF, 1 source reported an increase of 9.35% for SBFD
    - Regarding DL Type-2 RU CDF, 1 source reported an increase of 8.10% for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 1 source reported an improvement of 6.06% for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 1 source reported a degradation of -9.85% for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 1 source reported an improvement of 4.71% for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 1 source reported an improvement of 90.09% for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 1 source reported an improvement of 102.67% for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 1 source reported an improvement of 161.42% for SBFD
    - Regarding mean value of UL packet-latency CDF, 1 source reported a decrease of -34.38% for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 1 source reported a decrease of -42.48% for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 1 source reported a decrease of -42.20% for SBFD
    - Regarding UL Type-1 RU CDF, 1 source reported a decrease of -0.06% for SBFD
    - Regarding UL Type-2 RU CDF, 1 source reported a decrease of -11.73% for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 1 source reported an improvement of 10.09% for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 1 source reported an improvement of 22.67% for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 1 source reported an improvement of 81.42% for SBFD
* Traffic load with {DL,UL} = {High, High},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 1 source reported a degradation of -28.84% for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 1 source reported a degradation of -33.96% for SBFD
    - Regarding 50%-tile of DL average-UPT CDF, 1 source reported a degradation of -36.42% for SBFD
    - Regarding mean value of DL packet-latency CDF, 1 source reported an increase of 32.63% for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 1 source reported an increase of 15.28% for SBFD
    - Regarding 50%-tile of DL packet-latency CDF, 1 source reported an increase of 38.91% for SBFD
    - Regarding DL Type-1 RU CDF, 1 source reported an increase of 14.52% for SBFD
    - Regarding DL Type-2 RU CDF, 1 source reported an increase of 9.27% for SBFD
    - Regarding net gain of mean value of DL average-UPT CDF, 1 source reported a degradation of -7.91% for SBFD
    - Regarding net gain of 5%-tile of DL average-UPT CDF, 1 source reported a degradation of -13.03% for SBFD
    - Regarding net gain of 50%-tile of DL average-UPT CDF, 1 source reported a degradation of -15.49% for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 1 source reported an improvement of 85.61% for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 1 source reported an improvement of 64.58% for SBFD
    - Regarding 50%-tile of UL average-UPT CDF, 1 source reported an improvement of 123.19% for SBFD
    - Regarding mean value of UL packet-latency CDF, 1 source reported a decrease of -19.94% for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 1 source reported a decrease of -20.50% for SBFD
    - Regarding 50%-tile of UL packet-latency CDF, 1 source reported a decrease of -45.21% for SBFD
    - Regarding UL Type-1 RU CDF, 1 source reported an increase of 2.69% for SBFD
    - Regarding UL Type-2 RU CDF, 1 source reported a decrease of -18.60% for SBFD
    - Regarding net gain of mean value of UL average-UPT CDF, 1 source reported an improvement of 5.61% for SBFD
    - Regarding net gain of 5%-tile of UL average-UPT CDF, 1 source reported a degradation of -15.42% for SBFD
    - Regarding net gain of 50%-tile of UL average-UPT CDF, 1 source reported an improvement of 43.19% for SBFD

#### **(higher priority) InH (FR2-1)**

[Nokia, Intel] provide initial SLS evaluation results for InH (FR2-1) for SBFD Deployment Case 1, wherein, [Nokia] uploads evaluation results to the following draft FTP folder.

([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))

Summary will be proposed after companies provide more inputs in the FTP draft folder.

#### **(higher priority) Dense Urban Macro layer (FR2-1)**

[Ericsson, Intel] provide initial SLS evaluation results for Dense Urban Macro layer (FR2-1) for SBFD Deployment Case 1, but no company uploads evaluation results to the following draft FTP folder.

([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))

Summary will be proposed after companies provide more inputs in the FTP draft folder.

#### **Dense Urban Macro layer (FR1)**

[Huawei, ZTE, OPPO, Nokia] provide initial SLS evaluation results for Dense Urban Macro layer (FR1) for SBFD Deployment Case 1, wherein, [ZTE, Nokia] upload evaluation results to the following draft FTP folder.

([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))

Summary will be proposed after companies provide more inputs in the FTP draft folder.

#### **Dense Urban with 2-layer (FR1)**

[ZTE] provides initial SLS evaluation results for Dense Urban with 2-layer (FR1) for SBFD Deployment Case 1, and uploads the evaluation results to the following draft FTP folder.

([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))

Summary will be proposed after companies provide more inputs in the FTP draft folder.

* + 1. 1st Round Proposals(Closed)

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

Capture the following in TR 38.858 as an example.

* The values in the table and the observations can be updated if companies’ evaluation results are updated.

Table Y**: Summary of results for SBFD#1\_InH\_FR1\_Sub#1.**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Simple description for the sub-case (RSI based on 1dB desense, SBFD Alt-2, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte)*** | | | | | | | | | | |
|  | | **DL and UL arrival rate for baseline static TDD (Type-2 RU: <10%, 20%-40% and ≥50%)** | | | | | | | | |
| **DL: Low, UL: Low** | | | **DL: Medium, UL: Medium** | | | **DL: High, UL: High** | | |
| TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) | TDD | SBFD | Gain (%) |
| **DL Average-UPT (Mbps)** | **Mean** | CMCC: 225.72,  vivo: 684.54,  SPRD: 400.52,  CATT: 336.84,  ZTE: 459.83,  New H3C: 400.52,  Sony: 380.53,  Mediatek: 630.50,  Samsung: 726.00, | CMCC: 180.64,  vivo: 543.09,  SPRD: 333.10,  CATT: 279.85,  ZTE: 349.44,  New H3C: 333.10,  Sony: 300.00,  Mediatek: 488.30,  Samsung: 720.00, | CMCC: -19.97%,  vivo: -20.66%,  SPRD: -16.83%,  CATT: -16.92%,  ZTE: -24.01%,  New H3C: -16.83%,  Sony: -21.16%,  Mediatek: -22.55%,  Samsung: -0.83%, | CMCC: 194.29,  vivo: 512.53,  SPRD: 281.77,  CATT: 225.83,  ZTE: 410.65,  New H3C: 281.77,  Sony: 300.23,  Mediatek: 492.60,  Samsung: 460.00, | CMCC: 148.29,  vivo: 393.63,  SPRD: 220.41,  CATT: 179.82,  ZTE: 301.54,  New H3C: 220.41,  Sony: 222.11,  Mediatek: 343.60,  Samsung: 444.00, | CMCC: -23.68%,  vivo: -23.20%,  SPRD: -21.78%,  CATT: -20.37%,  ZTE: -26.57%,  New H3C: -21.78%,  Sony: -26.02%,  Mediatek: -30.25%,  Samsung: -3.48%, | vivo: 346.01,  SPRD: 188.70,  CATT: 89.79,  ZTE: 368.92,  New H3C: 188.70,  Sony: 200.09,  Mediatek: 357.40,  Samsung: 321.00, | vivo: 207.73,  SPRD: 121.50,  CATT: 71.03,  ZTE: 252.89,  New H3C: 121.50,  Sony: 144.05,  Mediatek: 249.20,  Samsung: 228.00, | vivo: -39.96%,  SPRD: -35.61%,  CATT: -20.89%,  ZTE: -31.45%,  New H3C: -35.61%,  Sony: -28.01%,  Mediatek: -30.27%,  Samsung: -28.97%, |
| **5%** | CMCC: 212.57,  vivo: 523.64,  SPRD: 160.23,  CATT: 245.65,  ZTE: 166.69,  New H3C: 160.23,  Sony: 180.35,  Mediatek: 264.50,  Samsung: 396.00, | CMCC: 168.12,  vivo: 459.14,  SPRD: 127.20,  CATT: 192.71,  ZTE: 123.72,  New H3C: 127.20,  Sony: 127.20,  Mediatek: 127.40,  Samsung: 339.00, | CMCC: -20.91%,  vivo: -12.32%,  SPRD: -20.61%,  CATT: -21.55%,  ZTE: -25.78%,  New H3C: -20.61%,  Sony: -29.47%,  Mediatek: -51.83%,  Samsung: -14.39%, | CMCC: 165.76,  vivo: 291.85,  SPRD: 119.57,  CATT: 162.63,  ZTE: 127.78,  New H3C: 119.57,  Sony: 120.30,  Mediatek: 72.50,  Samsung: 242.00, | CMCC: 125.76,  vivo: 237.44,  SPRD: 87.74,  CATT: 121.44,  ZTE: 89.82,  New H3C: 87.74,  Sony: 100.06,  Mediatek: 21.70,  Samsung: 204.00, | CMCC: -24.13%,  vivo: -18.64%,  SPRD: -26.62%,  CATT: -25.32%,  ZTE: -29.71%,  New H3C: -26.62%,  Sony: -16.82%,  Mediatek: -70.07%,  Samsung: -15.70%, | vivo: 132.71,  SPRD: 48.80,  CATT: 73.87,  ZTE: 64.03,  New H3C: 48.80,  Sony: 45.70,  Mediatek: 10.80,  Samsung: 149.00, | vivo: 20.18,  SPRD: 17.90,  CATT: 52.97,  ZTE: 10.82,  New H3C: 17.90,  Sony: 40.27,  Mediatek: 1.20,  Samsung: 85.40, | vivo: -84.79%,  SPRD: -63.32%,  CATT: -28.30%,  ZTE: -83.10%,  New H3C: -63.32%,  Sony: -11.88%,  Mediatek: -88.89%,  Samsung: -42.68%, |
| **UL Average-UPT (Mbps)** | **Mean** | CMCC: 37.11,  vivo: 204.43,  SPRD: 48.33,  CATT: 131.50,  ZTE: 143.85,  New H3C: 48.33,  Sony: 120.65,  Mediatek: 137.50,  Samsung: 79.90, | CMCC: 67.51,  vivo: 290.76,  SPRD: 93.80,  CATT: 193.87,  ZTE: 191.48,  New H3C: 93.80,  Sony: 164.33,  Mediatek: 217.00,  Samsung: 125.00, | CMCC: 81.92%,  vivo: 42.23%,  SPRD: 94.08%,  CATT: 47.43%,  ZTE: 33.11%,  New H3C: 94.08%,  Sony: 36.20%,  Mediatek: 57.82%,  Samsung: 56.45%, | CMCC: 34.43,  vivo: 186.08,  SPRD: 46.22,  CATT: 79.45,  ZTE: 130.01,  New H3C: 46.22,  Sony: 75.28,  Mediatek: 128.60,  Samsung: 68.80, | CMCC: 64.85,  vivo: 274.05,  SPRD: 91.10,  CATT: 109.25,  ZTE: 182.97,  New H3C: 91.10,  Sony: 103.64,  Mediatek: 199.60,  Samsung: 110.00, | CMCC: 88.35%,  vivo: 47.27%,  SPRD: 97.10%,  CATT: 37.51%,  ZTE: 40.74%,  New H3C: 97.10%,  Sony: 37.67%,  Mediatek: 55.21%,  Samsung: 59.88%, | vivo: 152.01,  SPRD: 39.10,  CATT: 27.26,  ZTE: 114.77,  New H3C: 39.10,  Sony: 50.01,  Mediatek: 111.20,  Samsung: 45.50, | vivo: 222.37,  SPRD: 84.10,  CATT: 36.62,  ZTE: 170.18,  New H3C: 84.10,  Sony: 77.76,  Mediatek: 171.10,  Samsung: 82.70, | vivo: 46.29%,  SPRD: 115.09%,  CATT: 34.34%,  ZTE: 48.28%,  New H3C: 115.09%,  Sony: 55.49%,  Mediatek: 53.87%,  Samsung: 81.76%, |
| **5%** | CMCC: 29.94,  vivo: 193.90,  SPRD: 18.21,  CATT: 74.10,  ZTE: 98.69,  New H3C: 18.21,  Sony: 68.33,  Mediatek: 76.10,  Samsung: 15.40, | CMCC: 59.94,  vivo: 280.32,  SPRD: 46.74,  CATT: 135.73,  ZTE: 104.51,  New H3C: 46.74,  Sony: 90.25,  Mediatek: 170.00,  Samsung: 18.50, | CMCC: 100.20%,  vivo: 44.57%,  SPRD: 156.67%,  CATT: 83.17%,  ZTE: 5.90%,  New H3C: 156.67%,  Sony: 32.08%,  Mediatek: 123.39%,  Samsung: 20.13%, | CMCC: 26.41,  vivo: 171.15,  SPRD: 17.13,  CATT: 53.01,  ZTE: 100.14,  New H3C: 17.13,  Sony: 50.20,  Mediatek: 76.50,  Samsung: 18.90, | CMCC: 56.47,  vivo: 258.96,  SPRD: 42.06,  CATT: 82.72,  ZTE: 120.81,  New H3C: 42.06,  Sony: 75.51,  Mediatek: 106.40,  Samsung: 22.00, | CMCC: 113.82%,  vivo: 51.31%,  SPRD: 145.53%,  CATT: 56.05%,  ZTE: 20.64%,  New H3C: 145.53%,  Sony: 50.42%,  Mediatek: 39.08%,  Samsung: 16.40%, | vivo: 121.33,  SPRD: 11.70,  CATT: 16.80,  ZTE: 51.43,  New H3C: 11.70,  Sony: 31.45,  Mediatek: 58.70,  Samsung: 4.40, | vivo: 156.00,  SPRD: 39.20,  CATT: 25.53,  ZTE: 91.93,  New H3C: 39.20,  Sony: 60.48,  Mediatek: 5.20,  Samsung: 7.10, | vivo: 28.57%,  SPRD: 235.04%,  CATT: 51.98%,  ZTE: 78.75%,  New H3C: 235.04%,  Sony: 92.31%,  Mediatek: -91.14%,  Samsung: 61.36%, |
| **DL Packet-Latency CDF (ms)** | **Mean** | CMCC: 9.60,  vivo: 6.35,  SPRD: 12.83,  CATT: 11.80,  ZTE: 12.08,  New H3C: 12.83,   Mediatek: 17.50,  Samsung: 7.27, | CMCC: 11.80,  vivo: 7.98,  SPRD: 16.05,  CATT: 14.15,  ZTE: 16.06,  New H3C: 16.05,   Mediatek: 17.70,  Samsung: 7.31, | CMCC: 22.92%,  vivo: 25.65%,  SPRD: 25.10%,  CATT: 19.88%,  ZTE: 32.95%,  New H3C: 25.10%,   Mediatek: 1.14%,  Samsung: 0.55%, | CMCC: 12.70,  vivo: 10.09,  SPRD: 19.54,  CATT: 17.48,  ZTE: 16.32,  New H3C: 19.54,   Mediatek: 23.10,  Samsung: 13.20, | CMCC: 16.90,  vivo: 13.42,  SPRD: 26.08,  CATT: 21.01,  ZTE: 25.50,  New H3C: 26.08,   Mediatek: 35.60,  Samsung: 13.90, | CMCC: 33.07%,  vivo: 32.98%,  SPRD: 33.47%,  CATT: 20.23%,  ZTE: 56.25%,  New H3C: 33.47%,   Mediatek: 54.11%,  Samsung: 5.30%, | vivo: 23.65,  SPRD: 40.36,  CATT: 46.23,  ZTE: 32.67,  New H3C: 40.36,   Mediatek: 46.90,  Samsung: 45.90, | vivo: 150.97,  SPRD: 85.10,  CATT: 56.09,  ZTE: 55.27,  New H3C: 85.10,   Mediatek: 39.80,  Samsung: 70.70, | vivo: 538.29%,  SPRD: 110.85%,  CATT: 21.33%,  ZTE: 69.18%,  New H3C: 110.85%,   Mediatek: -15.14%,  Samsung: 54.03%, |
| **5%** | CMCC: 8.50,  vivo: 4.63,  SPRD: 4.92,  CATT: 6.97,  ZTE: 6.02,  New H3C: 4.92,   Mediatek: 6.50,  Samsung: 3.10, | CMCC: 10.50,  vivo: 6.07,  SPRD: 6.55,  CATT: 10.55,  ZTE: 8.02,  New H3C: 6.55,   Mediatek: 8.30,  Samsung: 2.90, | CMCC: 23.53%,  vivo: 31.04%,  SPRD: 33.13%,  CATT: 51.29%,  ZTE: 33.22%,  New H3C: 33.13%,   Mediatek: 27.69%,  Samsung: -6.45%, | CMCC: 8.50,  vivo: 4.97,  SPRD: 7.41,  CATT: 12.04,  ZTE: 6.02,  New H3C: 7.41,   Mediatek: 6.50,  Samsung: 4.70, | CMCC: 10.50,  vivo: 6.21,  SPRD: 8.71,  CATT: 15.72,  ZTE: 8.04,  New H3C: 8.71,   Mediatek: 7.90,  Samsung: 4.60, | CMCC: 23.53%,  vivo: 24.86%,  SPRD: 17.54%,  CATT: 30.63%,  ZTE: 33.55%,  New H3C: 17.54%,   Mediatek: 21.54%,  Samsung: -2.13%, | vivo: 5.23,  SPRD: 7.78,  CATT: 33.91,  ZTE: 6.05,  New H3C: 7.78,   Mediatek: 6.50,  Samsung: 6.20, | vivo: 6.75,  SPRD: 8.78,  CATT: 41.79,  ZTE: 8.09,  New H3C: 8.78,   Mediatek: 7.90,  Samsung: 7.40, | vivo: 29.02%,  SPRD: 12.85%,  CATT: 23.24%,  ZTE: 33.72%,  New H3C: 12.85%,   Mediatek: 21.54%,  Samsung: 19.35%, |
| **UL Packet-Latency CDF (ms)** | **Mean** | CMCC: 16.50,  vivo: 5.24,  SPRD: 29.11,  CATT: 7.21,  ZTE: 9.44,  New H3C: 29.11,   Mediatek: 11.80,  Samsung: 27.50, | CMCC: 8.70,  vivo: 3.52,  SPRD: 12.66,  CATT: 4.91,  ZTE: 7.93,  New H3C: 12.66,   Mediatek: 13.90,  Samsung: 19.40, | CMCC: -47.27%,  vivo: -32.84%,  SPRD: -56.51%,  CATT: -31.88%,  ZTE: -16.00%,  New H3C: -56.51%,   Mediatek: 17.80%,  Samsung: -29.45%, | CMCC: 18.90,  vivo: 6.20,  SPRD: 31.44,  CATT: 12.47,  ZTE: 9.82,  New H3C: 31.44,   Mediatek: 19.90,  Samsung: 35.20, | CMCC: 9.40,  vivo: 3.87,  SPRD: 13.66,  CATT: 8.72,  ZTE: 6.75,  New H3C: 13.66,   Mediatek: 27.50,  Samsung: 29.90, | CMCC: -50.26%,  vivo: -37.66%,  SPRD: -56.55%,  CATT: -30.09%,  ZTE: -31.26%,  New H3C: -56.55%,   Mediatek: 38.19%,  Samsung: -15.06%, | vivo: 9.72,  SPRD: 49.05,  CATT: 37.37,  ZTE: 18.85,  New H3C: 49.05,   Mediatek: 23.50,  Samsung: 124.00, | vivo: 5.48,  SPRD: 15.87,  CATT: 26.89,  ZTE: 8.63,  New H3C: 15.87,   Mediatek: 54.70,  Samsung: 85.50, | vivo: -43.65%,  SPRD: -67.65%,  CATT: -28.05%,  ZTE: -54.22%,  New H3C: -67.65%,   Mediatek: 132.77%,  Samsung: -31.05%, |
| **5%** | CMCC: 11.50,  vivo: 3.64,  SPRD: 11.15,  CATT: 4.79,  ZTE: 5.59,  New H3C: 11.15,   Mediatek: 5.20,  Samsung: 10.10, | CMCC: 7.00,  vivo: 3.03,  SPRD: 6.70,  CATT: 2.89,  ZTE: 3.27,  New H3C: 6.70,   Mediatek: 4.60,  Samsung: 5.60, | CMCC: -39.13%,  vivo: -16.74%,  SPRD: -39.91%,  CATT: -39.79%,  ZTE: -41.50%,  New H3C: -39.91%,   Mediatek: -11.54%,  Samsung: -44.55%, | CMCC: 11.50,  vivo: 3.68,  SPRD: 10.66,  CATT: 8.09,  ZTE: 5.63,  New H3C: 10.66,   Mediatek: 5.70,  Samsung: 10.10, | CMCC: 7.00,  vivo: 3.04,  SPRD: 6.07,  CATT: 5.47,  ZTE: 3.38,  New H3C: 6.07,   Mediatek: 4.60,  Samsung: 5.60, | CMCC: -39.13%,  vivo: -17.31%,  SPRD: -43.06%,  CATT: -32.36%,  ZTE: -39.96%,  New H3C: -43.06%,   Mediatek: -19.30%,  Samsung: -44.55%, | vivo: 3.76,  SPRD: 11.50,  CATT: 20.76,  ZTE: 5.63,  New H3C: 11.50,   Mediatek: 5.70,  Samsung: 10.60, | vivo: 3.08,  SPRD: 6.58,  CATT: 18.52,  ZTE: 3.41,  New H3C: 6.58,   Mediatek: 4.60,  Samsung: 5.90, | vivo: -18.19%,  SPRD: -42.78%,  CATT: -10.81%,  ZTE: -39.43%,  New H3C: -42.78%,   Mediatek: -19.30%,  Samsung: -44.34%, |
| **DL RU (%)** | **Type-1** | CMCC: 3.43%,  vivo: 7.37%,  SPRD: 2.80%,  CATT: 6.02%,  ZTE: 6.01%,  New H3C: 2.80%,  Sony: 5.13%,  Mediatek: 7.40%,  Samsung: 6.20%, | CMCC: 3.43%,  vivo: 7.35%,  SPRD: 2.94%,  CATT: 5.16%,  ZTE: 5.79%,  New H3C: 2.94%,  Sony: 6.16%,  Mediatek: 10.30%,  Samsung: 7.40%, | CMCC: 0.00%,  vivo: -0.02%,  SPRD: 0.14%,  CATT: -0.86%,  ZTE: -0.22%,  New H3C: 0.14%,  Sony: 1.03%,  Mediatek: 2.90%,  Samsung: 1.20%, | CMCC: 14.23%,  vivo: 22.18%,  SPRD: 25.36%,  CATT: 19.89%,  ZTE: 20.51%,  New H3C: 25.36%,  Sony: 21.20%,  Mediatek: 27.10%,  Samsung: 18.60%, | CMCC: 14.60%,  vivo: 22.20%,  SPRD: 27.20%,  CATT: 16.52%,  ZTE: 19.96%,  New H3C: 27.20%,  Sony: 15.22%,  Mediatek: 34.30%,  Samsung: 21.50%, | CMCC: 0.37%,  vivo: 0.02%,  SPRD: 1.84%,  CATT: -3.37%,  ZTE: -0.55%,  New H3C: 1.84%,  Sony: -5.98%,  Mediatek: 7.20%,  Samsung: 2.90%, | vivo: 52.22%,  SPRD: 40.96%,  CATT: 40.94%,  ZTE: 33.82%,  New H3C: 40.96%,  Sony: 43.55%,  Mediatek: 44.50%,  Samsung: 53.60%, | vivo: 56.30%,  SPRD: 39.87%,  CATT: 32.98%,  ZTE: 31.73%,  New H3C: 39.87%,  Sony: 30.44%,  Mediatek: 49.70%,  Samsung: 62.20%, | vivo: 4.08%,  SPRD: -1.09%,  CATT: -7.96%,  ZTE: -2.09%,  New H3C: -1.09%,  Sony: -13.11%,  Mediatek: 5.20%,  Samsung: 8.60%, |
| **Type-2** | CMCC: 4.31%,  vivo: 9.55%,  SPRD: 3.50%,  CATT: 7.52%,  ZTE: 7.52%,  New H3C: 3.50%,  Sony: 8.54%,  Mediatek: 9.50%,  Samsung: 7.70%, | CMCC: 5.47%,  vivo: 11.72%,  SPRD: 4.60%,  CATT: 8.06%,  ZTE: 9.53%,  New H3C: 4.60%,  Sony: 10.33%,  Mediatek: 12.50%,  Samsung: 7.80%, | CMCC: 1.16%,  vivo: 2.17%,  SPRD: 1.10%,  CATT: 0.54%,  ZTE: 2.01%,  New H3C: 1.10%,  Sony: 1.79%,  Mediatek: 3.00%,  Samsung: 0.10%, | CMCC: 17.92%,  vivo: 28.75%,  SPRD: 31.70%,  CATT: 24.86%,  ZTE: 25.63%,  New H3C: 31.70%,  Sony: 26.55%,  Mediatek: 31.10%,  Samsung: 23.20%, | CMCC: 23.25%,  vivo: 35.41%,  SPRD: 42.50%,  CATT: 25.82%,  ZTE: 32.87%,  New H3C: 42.50%,  Sony: 29.06%,  Mediatek: 41.60%,  Samsung: 24.00%, | CMCC: 5.33%,  vivo: 6.65%,  SPRD: 10.80%,  CATT: 0.96%,  ZTE: 7.24%,  New H3C: 10.80%,  Sony: 2.51%,  Mediatek: 10.50%,  Samsung: 0.80%, | vivo: 67.69%,  SPRD: 51.20%,  CATT: 51.18%,  ZTE: 42.27%,  New H3C: 51.20%,  Sony: 46.38%,  Mediatek: 54.90%,  Samsung: 67.10%, | vivo: 89.77%,  SPRD: 62.30%,  CATT: 51.54%,  ZTE: 52.25%,  New H3C: 62.30%,  Sony: 41.54%,  Mediatek: 60.30%,  Samsung: 70.30%, | vivo: 22.08%,  SPRD: 11.10%,  CATT: 0.36%,  ZTE: 9.98%,  New H3C: 11.10%,  Sony: -4.84%,  Mediatek: 5.40%,  Samsung: 3.20%, |
| **UL RU (%)** | **Type-1** | CMCC: 1.13%,  vivo: 2.03%,  SPRD: 1.26%,  CATT: 1.53%,  ZTE: 2.39%,  New H3C: 1.26%,  Sony: 0.95%,  Mediatek: 7.20%,  Samsung: 1.88%, | CMCC: 1.01%,  vivo: 1.99%,  SPRD: 0.97%,  CATT: 2.45%,  ZTE: 2.45%,  New H3C: 0.97%,  Sony: 2.45%,  Mediatek: 2.50%,  Samsung: 2.06%, | CMCC: -0.12%,  vivo: -0.04%,  SPRD: -0.29%,  CATT: 0.92%,  ZTE: 0.06%,  New H3C: -0.29%,  Sony: 1.50%,  Mediatek: -4.70%,  Samsung: 0.18%, | CMCC: 4.08%,  vivo: 5.04%,  SPRD: 4.72%,  CATT: 5.74%,  ZTE: 6.23%,  New H3C: 4.72%,  Sony: 7.00%,  Mediatek: 22.80%,  Samsung: 4.70%, | CMCC: 3.63%,  vivo: 4.91%,  SPRD: 3.74%,  CATT: 8.05%,  ZTE: 6.07%,  New H3C: 3.74%,  Sony: 10.13%,  Mediatek: 5.80%,  Samsung: 5.07%, | CMCC: -0.45%,  vivo: -0.13%,  SPRD: -0.98%,  CATT: 2.31%,  ZTE: -0.16%,  New H3C: -0.98%,  Sony: 3.13%,  Mediatek: -17.00%,  Samsung: 0.37%, | vivo: 11.41%,  SPRD: 10.42%,  CATT: 10.52%,  ZTE: 10.32%,  New H3C: 10.42%,  Sony: 10.28%,  Mediatek: 33.60%,  Samsung: 10.90%, | vivo: 10.78%,  SPRD: 8.13%,  CATT: 18.48%,  ZTE: 10.41%,  New H3C: 8.13%,  Sony: 18.48%,  Mediatek: 10.10%,  Samsung: 12.00%, | vivo: -0.64%,  SPRD: -2.29%,  CATT: 7.96%,  ZTE: 0.09%,  New H3C: -2.29%,  Sony: 8.20%,  Mediatek: -23.50%,  Samsung: 1.10%, |
| **Type-2** | CMCC: 5.47%,  vivo: 10.14%,  SPRD: 6.30%,  CATT: 7.66%,  ZTE: 11.93%,  New H3C: 6.30%,  Sony: 6.66%,  Mediatek: 11.10%,  Samsung: 9.40%, | CMCC: 2.70%,  vivo: 5.56%,  SPRD: 2.70%,  CATT: 6.81%,  ZTE: 6.81%,  New H3C: 2.70%,  Sony: 6.81%,  Mediatek: 7.60%,  Samsung: 5.90%, | CMCC: -2.77%,  vivo: -4.58%,  SPRD: -3.60%,  CATT: -0.85%,  ZTE: -5.12%,  New H3C: -3.60%,  Sony: 0.15%,  Mediatek: -3.50%,  Samsung: -3.50%, | CMCC: 19.82%,  vivo: 25.20%,  SPRD: 23.60%,  CATT: 28.69%,  ZTE: 31.16%,  New H3C: 23.60%,  Sony: 35.07%,  Mediatek: 30.30%,  Samsung: 23.60%, | CMCC: 9.77%,  vivo: 13.71%,  SPRD: 10.40%,  CATT: 22.36%,  ZTE: 16.82%,  New H3C: 10.40%,  Sony: 26.72%,  Mediatek: 22.30%,  Samsung: 14.50%, | CMCC: -10.05%,  vivo: -11.48%,  SPRD: -13.20%,  CATT: -6.33%,  ZTE: -14.34%,  New H3C: -13.20%,  Sony: -8.35%,  Mediatek: -8.00%,  Samsung: -9.10%, | vivo: 57.06%,  SPRD: 52.10%,  CATT: 52.61%,  ZTE: 51.61%,  New H3C: 52.10%,  Sony: 40.06%,  Mediatek: 50.90%,  Samsung: 54.80%, | vivo: 30.08%,  SPRD: 22.60%,  CATT: 51.34%,  ZTE: 28.87%,  New H3C: 22.60%,  Sony: 44.60%,  Mediatek: 41.90%,  Samsung: 34.50%, | vivo: -26.99%,  SPRD: -29.50%,  CATT: -1.27%,  ZTE: -22.74%,  New H3C: -29.50%,  Sony: 4.54%,  Mediatek: -9.00%,  Samsung: -20.30%, |
| Note: - For UPT, the gain can be calculated as: Gain (%) = SBFD UPT / TDD UPT - 1 - For Latency, the gain can be calculated as: Gain (%) = SBFD latency / TDD latency - 1 - For RU, the gain can be calculated as: Gain (%) = SBFD RU (%) – TDD RU (%) | | | | | | | | | | |

For subcase SBFD#1\_InH\_FR1\_Sub#1, assuming RSI based on 1dB desense, SBFD Alt-2, Twice area&same TxRUs (Option 2), DL: 0.5Mbytes, UL: 0.125Mbyte, key findings are summarized below.

* Traffic load with {DL,UL} = {Low,Low},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 9 sources reported a degradation in the range of {-0.83%~-24.01%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 9 sources reported a degradation in the range of {-12.32%~-51.83%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 8 sources reported an increase in the range of {0.55%~32.95%} for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 7 sources reported an increase in the range of {23.53%~51.29%} for SBFD, and 1 source reported a decrease of -6.45% for SBFD
    - Regarding DL Type-1 RU CDF, 5 sources reported an increase in the range of {0.14%~2.90%} for SBFD, and 3 sources reported a decrease in the range of {-0.02%~-0.86%} for SBFD, and 1 source reported no change for SBFD
    - Regarding DL Type-2 RU CDF, 9 sources reported an increase in the range of {0.10%~3.00%} for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 9 sources reported an improvement in the range of {33.11%~94.08%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 9 sources reported an improvement in the range of {5.90%~156.67%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 1 source reported an increase of 17.80% for SBFD, and 7 sources reported a decrease in the range of {-16.00%~-56.51%} for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 8 sources reported a decrease in the range of {-11.54%~-44.55%} for SBFD
    - Regarding UL Type-1 RU CDF, 4 sources reported an increase in the range of {0.06%~1.50%} for SBFD, and 5 sources reported a decrease in the range of {-0.04%~-4.70%} for SBFD
    - Regarding UL Type-2 RU CDF, 1 source reported an increase of 0.15% for SBFD, and 8 sources reported a decrease in the range of {-0.85%~-5.12%} for SBFD
* Traffic load with {DL,UL} = {Medium, Medium},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 9 sources reported a degradation in the range of {-3.48%~-30.25%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 9 sources reported a degradation in the range of {-15.70%~-70.07%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 8 sources reported an increase in the range of {5.30%~56.25%} for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 7 sources reported an increase in the range of {17.54%~33.55%} for SBFD, and 1 source reported a decrease of -2.13% for SBFD
    - Regarding DL Type-1 RU CDF, 6 sources reported an increase in the range of {0.02%~7.20%} for SBFD, and 3 sources reported a decrease in the range of {-0.55%~-5.98%} for SBFD
    - Regarding DL Type-2 RU CDF, 9 sources reported an increase in the range of {0.80%~10.80%} for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 9 sources reported an improvement in the range of {37.51%~97.10%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 9 sources reported an improvement in the range of {16.40%~145.53%} for SBFD
    - Regarding mean value of UL packet-latency CDF, 1 source reported an increase of 38.19% for SBFD, and 7 sources reported a decrease in the range of {-15.06%~-56.55%} for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 8 sources reported a decrease in the range of {-17.31%~-44.55%} for SBFD
    - Regarding UL Type-1 RU CDF, 3 sources reported an increase in the range of {0.37%~3.13%} for SBFD, and 6 sources reported a decrease in the range of {-0.13%~-17.00%} for SBFD
    - Regarding UL Type-2 RU CDF, 9 sources reported a decrease in the range of {-6.33%~-14.34%} for SBFD
* Traffic load with {DL,UL} = {High, High},
  + DL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of DL average-UPT CDF, 8 sources reported a degradation in the range of {-20.89%~-39.96%} for SBFD
    - Regarding 5%-tile of DL average-UPT CDF, 8 sources reported a degradation in the range of {-11.88%~-88.89%} for SBFD
    - Regarding mean value of DL packet-latency CDF, 6 sources reported an increase in the range of {21.33%~538.29%} for SBFD, and 1 source reported a decrease of -15.14% for SBFD
    - Regarding 5%-tile of DL packet-latency CDF, 7 sources reported an increase in the range of {12.85%~33.72%} for SBFD
    - Regarding DL Type-1 RU CDF, 3 sources reported an increase in the range of {4.08%~8.60%} for SBFD, and 5 sources reported a decrease in the range of {-1.09%~-13.11%} for SBFD
    - Regarding DL Type-2 RU CDF, 7 sources reported an increase in the range of {0.36%~22.08%} for SBFD, and 1 source reported a decrease of -4.84% for SBFD
  + UL performance comparison between SBFD and legacy TDD,
    - Regarding mean value of UL average-UPT CDF, 8 sources reported an improvement in the range of {34.34%~115.09%} for SBFD
    - Regarding 5%-tile of UL average-UPT CDF, 7 sources reported an improvement in the range of {28.57%~235.04%} for SBFD, and 1 source reported a degradation of -91.14% for SBFD
    - Regarding mean value of UL packet-latency CDF, 1 source reported an increase of 132.77% for SBFD, and 6 sources reported a decrease in the range of {-28.05%~-67.65%} for SBFD
    - Regarding 5%-tile of UL packet-latency CDF, 7 sources reported a decrease in the range of {-10.81%~-44.34%} for SBFD
    - Regarding UL Type-1 RU CDF, 4 sources reported an increase in the range of {0.09%~8.20%} for SBFD, and 4 sources reported a decrease in the range of {-0.64%~-23.50%} for SBFD
    - Regarding UL Type-2 RU CDF, 1 source reported an increase of 4.54% for SBFD, and 7 sources reported a decrease in the range of {-1.27%~-29.50%} for SBFD

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| New H3C | OK |
| LG | We have updated our result. Please review and add it to above table. Thank you. |
| Huawei, HiSilicon | We suggest to dicuss the evaluation results later since some assumptions are still under discussion. |
| Xiaomi | We are fine with the proposal. |
| Intel | Agree with HW. We also suggest postponing sthis discussion later as some assumptions are still pending. |
| Samsung | We are fine with the proposal (at least Indoor Office scenario @ FR1). But, we would like to suggest adding a bracket on the observation and results and revisit in the next meetings.  We have uploaded all our result on 3GU FTP server and updated Table 5-22 and 5-24 (SBFD#1\_UMA\_FR1\_Sub#6 and #7) in this document. The evaluation results of Urban Macro @ High RU and some datas which were wrongly captured and now fixed. |
| Ericsson | Agree with Huawei |
| Nokia/NSB | Share view with Huawei, Intel and Ericsson. |
| Sony | We are ok with the proposal but similar to other companies’ comments, we think we may also update our results based on later assumptions. |
| QC | Many thanks to the FL, for the great efforts on the summary table! |
| ZTE | Thanks for the effort from FL. We are supportive to capture the info in the TR. If more companies provide simulation results later on, this part can be updated accordingly. |

* + 1. 2nd Round Proposals (Open)

***Initial question 4-2-1a***(Open)***:***

Regarding the evaluation results for Indoor office scenario of SBFD deployment case 1 in FR1, as an exercise before next meeting, moderator provides an initial summary and observation for four sub-cases in section 5.2.2. Regarding the format of the summary and observations, do you have any comments or suggestions to improve the quality?

Companies are encouraged to provide comments in the table below.

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

* 1. Issue#4-3: SLS evaluation results for SBFD Deployment Case 4
     1. Submitted proposal

#### **Urban Macro (FR1)**

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Ericsson (R1-2302769) | Observation 18: For two operator scenarios in FR1, the conclusions on performance gains of SBFD networks are similar to the conclusions from single operator analysis.  Observation 21: For FR1 two-operator urban macro scenario, UL coverage gains, if any, are only at low loads. To achieve this gain in a SBFD urban macro network, it is necessary to have same loads in coexisting network of another operator in the same frequency band, which is not realistic.  Observation 22: For FR1 two-operator urban macro scenario, UL gains for SBFD network in terms of cell-edge throughput, latency and coverage quickly diminish as the load increases.  Observation 23: For higher power BS class in Urban Macro scenario, system level simulations have shown that there is little to no improvement in UL coverage or cell-edge throughput performance by deploying an SBFD network as opposed to using a simple scheme such as static TDD 2UL or a semi-static DTDD in both single and multi-operator scenario. |
| Samsung (R1-2303126) | Observation 12 *In case of two operator case, UL Average-UPT gain is reduced compared to single operator environment. Nevertheless, the UL Average-UPT gain of SBFD remains high in 0 % Grid-Shift case*  Observation 13 *There is marginal UPT performance degradation due to SBFD UL UE-TDD DL UE adajcent channel CLI*  Observation 14 *Overall UL Average-UPT gain is reduced compared to single operator environment. Nevertheless, the UL Average-UPT gain of SBFD remins high due to the use of UL subband.in 100 % Grid-Shift case*  Observation 15 *There was marginal reduction in UPT performance due to SBFD UL UE-TDD DL UE adajcent channel CLI effect* |

#### **Dense Urban Macro layer (FR2-1)**

|  |  |
| --- | --- |
| **Company** | **Proposals** |
|  |  |

* + 1. Summary

#### **Urban Macro (FR1)**

[Ericsson, Samsung] provide initial SLS evaluation results for Urban Macro (FR1) for SBFD Deployment Case 4, but no company uploads evaluation results to the following draft FTP folder.

([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))

Summary will be proposed after companies provide more inputs in the FTP draft folder.

* 1. Issue#4-4: SLS evaluation results for Dynamic/Flexible TDD
     1. Submitted proposal

#### **InH (FR1)**

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Qualcomm (R1-2303588) | **Observation 20: Reducing the aggressor cell transmit power allows to boost dynamic TDD uplink mean UPT by 82% at high load. The downlink average UPT decreases by up to 20% when applying 10 dB back off. The reduction in DL performance is modest when 6 dB or 3dB power back off are adopted.**  **Observation 21: Increasing UE transmit power improves UL performance of dynamic TDD. The drawback is the reduction of DL UPT especially at high load.**  **Observation 22: Reducing UE transmit power to handle UE-UE CLI is not recommended as more than 92% UEs have zero UL median throughput at high and medium load.**  **Observation 23: Transmission beam nulling allows to increase mean UL performance by up to 114%. It modestly affects downlink performance however as the aggressor gNB beamforming is designed not only to serve the DL users but also to suppress the interference to the victim gNBs.**  **Observation 24: Frequency domain coordinated scheduling does not provide any gains in both UL and DL for large packet size as it underutilizes resources.**  **Observation 25: Power control-based solutions and transmission beam nulling look mitigate gNB-to-gNB CLI in the case of is however a large packet size. There is however trade-off between the gains in UL and the negative impact in the DL performance.**  **Observation 26: The percentile of links affected by gNB-to-gNB CLI is very limited when the packet size is small. Reducing the aggressor gNB cell transmit power is mainly increasing the UL performance of the 5th percentile at high load with an insignificant negative affect of the DL results.**  **Observation 27: Adjusting the UE transmission power allows to increase 5th percentile of the average UL throughput by 70% at high load.**  **Observation 28: Beam nulling allows increases 5th percentile of the average UL throughput by 56% in high load scenario. There is practically no impact on DL throughput; the worst case is less than 1%.**  **Observation 29: Frequency domain coordinated scheduling allows also to increase 5th percentile of the average UL throughput by 58%. The impact on DL performance is less than 1% in the worst case.**  **Observation 30: The impact of CLI on the UL performance is insignificant at low and medium load when the packet size is small. At high load, the impact is very limited on UL performance and all the four considered enhancement techniques provide large improvement without scarifying DL throughput.** |
|  |  |

#### **2-layer Scenario B (FR1)**

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Huawei (R1-2302347) | ***Observation 18:*** *For Dynamic/Flexible TDD, under 2-layer scenario B, the co-channel CLI CLI dominates the UL interferences at the probability of 50% regard less of high RU or medium RU.*  ***Observation 19:*** *For Dynamic/Flexible TDD, under 2-layer scenario B, E-MMSE-IRC receiver with/without joint reception achieve considerable gain than MMSE-IRC receiver.*  ***Observation 20****: For Dynamic/Flexible TDD, under 2-layer scenario B, joint reception can greatly enhance the UL performance of indoor small cell.*  ***Proposal 18****: Capture the system level simulation results in Fig. 20 under 2-layer scenario B and the following observations into TR 38.858:*   * *E-MMSE-IRC receiver to suppress the inter-site gNB-gNB co-channel CLI is beneficial.*   ***Observation 21:*** *For Dynamic/Flexible TDD, under 2-layer scenario B, the legacy interferences dominate the DL interferences, but not UE-to-UE co-channel CLI, regardless of low RU, medium RU or high RU.* |
| ZTE (R1-2302756) | ***Observation 13****: Regarding dynamic TDD with HetNet, Packet size 0.5Mbps/0.125Mbps*   * *For Macro layer, the DL average UPT (mean) is decreased by around 2% - 10% due to the UE-UE CLI; for indoor office, the DL average UPT (mean) is decreased by around 77% - 87% mainly due to the decreased DL resource.* * *For Macro layer, the DL Packet-Latency (mean) of SBFD is increased by around 3%-18% due to the UE-UE CLI; for indoor office, the DL Packet-Latency (mean) of SBFD is increased by around 404%-916% due to the decreased DL resource.* * *For Macro layer, the UL average UPT (mean) of SBFD is almost the same; for indoor office, the UL average UPT (mean) of SBFD is increased by around 189%-254% due to the increased UL resource.* * *For Macro layer, the UL Packet-Latency (mean) of SBFD is almost the same; for indoor office, the UL Packet-Latency (mean) of SBFD is decreased by around 56% - 79% due to the increased UL resource.* |
| Qualcomm (R1-2303588) | **Observation 31: There is large coupling loss between the Indoor TRP and Macro TRP in the HetNet deployment that make the inter-gNB CLI insignificant.**  **Proposal 12: RAN1 should reconsider the configurations of HetNet deployment, mainly indoor TRP placement (e.g. wall mounted vs ceiling mounted) and uplink power control configuration (e.g. different values for Po).** |
|  |  |

* + 1. Summary

#### **InH (FR1)**

[Qualcomm] provides initial SLS evaluation results for InH (FR1) for Dynamic/Flexible TDD, and uploads evaluation results to the following draft FTP folder.

([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))

Summary will be proposed after companies provide more inputs in the FTP draft folder.

#### **2-layer Scenario B (FR1)**

[Huawei, ZTE] provides initial SLS evaluation results for 2-layer Scenario B (FR1) for Dynamic/Flexible TDD, wherein, [ZTE] uploads evaluation results to the following draft FTP folder..

([ftp://ftp.3gpp.org/tsg\_ran/WG1\_RL1/TSGR1\_112/Inbox/drafts/9.3(FS\_NR\_duplex\_evo)/9.3.1/Evaluation Results/](ftp://ftp.3gpp.org/tsg_ran/WG1_RL1/TSGR1_112/Inbox/drafts/9.3(FS_NR_duplex_evo)/9.3.1/Evaluation%20Results/))

Summary will be proposed after companies provide more inputs in the FTP draft folder.

# Issue#5: Initial LLS evaluation results and others

## Issue#5-1: Coverage performance evaluation for SBFD

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| CMCC (R1-2303232) | ***Observation 9:*** For PUSCH coverage performance with 1Mbps target data rate for Urban Macro O2I scenario for FR1, assuming 24 PRB and MCS = 5, legacy TDD with {DDDSU} and SBFD with {XXXXU}, SBFD coverage enhancement technique of Case 2 (SBFD with PUSCH repetition type A, wherein, PUSCH for SBFD is repeated across 4 SBFD slots and one UL slot with RV {0,2,3,1,0}),   * The coverage performance of SBFD is much better than legacy TDD * The coverage performance gain of SBFD over legacy TDD decreases with the traffic load increases * Regarding MPL metric,   + The MPL for legacy TDD is 128.9dB,   + The MPL for SBFD is 14.233.1dB, 132.5dB and 131.9dB for low load, medium load, and high load, respectively * Regarding MCL metric,   + The MCL for legacy TDD is 142.0dB,   + The MCL for SBFD is 146.1dB, 145.5dB and 144.9dB for low load, medium load, and high load, respectively * Regarding MIL metric,   + The MIL for legacy TDD is 111.2dB,   + The MIL for SBFD is 115.4dB, 114.8dB and 114.2dB for low load, medium load, and high load, respectively * Regarding maximum range metric,   + The maximum range for legacy TDD is 155.3m,   + The maximum range for SBFD is 198.6m (gain = 27.8%), 191.8 (gain = 23.5%) and 184.8 (gain = 19.0%) for low load, medium load, and high load, respectively |
| Samsung (R1-2303126) | Observation 16 *The PUSCH transmission with 5 repetitions over SBFD slots and UL slot can provide around 6.5dB performance gain over the PUSCH tranmsision only on UL slot.*  Observation 17 *The TBoMS transmission with 4 SBFD slots and 1 UL slot can provide around 6.5dB performance gain over the PUSCH tranmsision only on UL slot.* |
| Qualcomm (R1-2303588) | Table ‑: SBFD coverage gain (Case 2)   |  |  |  |  |  | | --- | --- | --- | --- | --- | |  | Static TDD | SBFD  Load-load | SBFD  Medium Load | SBFD  High load | | Required SINR (dB) per RxAnt | -13.36 | -16.34 | -15.475 | -14.12 | | MCL (dB) | 134.75 | 137.73 | 136.86 | 135.51 | | MIL (dB) | 140.55 | 143.53 | 142.67 | 141.31 | | Available Path Loss (dB) | 109.82 | 112.80 | 111.94 | 110.58 | | Overall gain |  | 3 dB | 2.12 dB | 0.76 dB | |
| Intel (R1-2302794) | **Observation 4: Without self-interference modelling, 2~3dB link-level performance gain can be observed by doubling the repetition levels for PUSCH transmission in both FR1 and FR2.** |
| DOCOMO (R1-2303710) | **Observation 1: In the case of FR1, SINR improvement is not found for SBFD operation with PUSCH repetition, since interference for SBFD is too strong.**  **Observation 2: In the case of FR2-1, SINR improvement of about 4 dB is expected for SBFD with PUSCH repetition assuming smaller inter-site interference in SBFD slot compared with that in FR1.** |
|  |  |

* + 1. Summary

[Samsung, Qualcomm, Intel, DoCoMo, CMCC] provide initial LLS evaluation results for SBFD PUSCH coverage performance gain over legacy TDD.

* CMCC
  + For Case 2 (SBFD with PUSCH repetition type A): 4.2 dB, 3.6 dB, and 3 dB gain for low load, medium load, and high load, respectively
* Qualcomm
  + For Case 2: 3 dB, 2.12 dB, and 0.76 dB gain for low load, medium load, and high load, respectively
* Samsung
  + For Case 2: 6.5 dB gain
  + For Case 3 (SBFD with TBoMS PUSCH): 6.5 dB gain
* Intel: 2~3dB
* DoCoMo: no SINR improvement for FR1, and 4 dB gain for FR2-1

## Issue#5-2: Link budget analysis and LLS for other purposes

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| Samsung (R1-2303126) | Observation 1 *SBFD (with UL subband for all DL symbols) can provide 46.1%~73.3 UL* *U-plane latency reduction compared to static TDD systems with DDDSU.*  Observation 2 *SBFD (with UL subband for all DL symbols) can provide 2.7%~25.6 DL U-plane latency reduction compared to static TDD systems with DDDSU.*  Observation 3 *SBFD can provide 2.14 ~ 3.78dB UL coverage gain for the case of the same number of antenna elements or 4.36~6dB UL coverage gain for the case of the same antenna gain.*  **Observation 4** *Given a specific deployment scenario, UL SINR of SBFD operation is degraded by up to 1dB*   * *Scenario: Urban Macro deployment with 500m ISD, 100/200/300m UE-gNB distance, 1 aggressor gNB, 1dB desense by self-interference.*   **Observation 5** *Given a specific deployment scenario, DL SINR of SBFD operation is degraded by up to 0.2dB*   * *Scenario: Urban Macro deployment with 500m ISD, 100/200/300m gNB-UE distance, 10 aggressor UEs* |
| Huawei (R1-2302347) | ***Observation 17:*** *The UL performance is greatly affected by the gNB-gNB CLI when enhancement scheme is not adopted.*   * *Considering 4 gNB-gNB CLI and 10dB INR for each CLI, 9dB performance deterioration is observed when enhancement scheme is not adopted.* * *Considering 4 gNB-gNB CLI and 10dB INR for each CLI, 1.2dB performance deterioration is observed when enhancement scheme is adopted.*   ***Proposal 17****:* *Study UL resource muting based interference suppression schemes to handle the gNB-gNB CLI.* |
| InterDigital (R1-2302521) | ***Observation 2:*** *DL throughput performance suffers considerably as a result of intra-subband CLI when there is an overlap in DL and UL subbands.*  ***Proposal 3.*** *Study performance of applying a frequency gap or guard RBs for a UL transmission in an SBFD framework for interference mitigation with regards to adjacent DL subbands.* |
|  |  |

* + 1. Summary

[Samsung] performs theoretical analysis to study U-plane latency, and performs link budget analysis to study UL coverage performence.

[Huawei] performs LLS to study the effect of gNB-gNB CLI to the demodulation performance of the PUSCH.

[InterDigital] performs LLS to study the effect of frequency gap or guard RBs on gNB-gNB / UE-UE CLI.

## Issue#5-3: SBFD prototype

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| ZTE (R1-2302756) | ***Observation 1****: The 1st SBFD prototype achieves more than 130dB self-interference suppression capability (55 dB antenna isolation, 45 dB ACLR and more than 30 dB sub-band filtering and digital cancellation) and less than 1dB receiver sensitivity degradation at the gNB side.*  ***Observation 2****:*   * *The first prototype verifies the SBFD feasibility and achieves 3.9ms E2E round trip latency on average and up to 1.4Gbps peak UL data rate with 4T4R TUE.* * *The second prototype verifies that legacy commercial UEs supporting flexible symbols are compatible to the SBFD base station.* *The peak UL data rate is higher than 700Mbps and the E2E round trip latency is around 4ms for commercial UE with 2T4R.*   ***Proposal 1****: Capture the SBFD prototype info in section 2 of R1-2302756 into TR38.858.* |
|  |  |

* + 1. Summary

ZTE provides information on two SBFD BS prototypes,

* The first prototype (based on 4T4R TUE) verifies the SBFD feasibility and achieves 3.9ms E2E round trip latency on average and up to 1.4Gbps peak UL data rate.
* The second prototype (based on commercial UE with 2T4R) verifies that legacy commercial UEs supporting flexible symbols are compatible to the SBFD base station. The peak UL data rate is higher than 700Mbps and the E2E round trip latency is around 4ms.

# Stable Proposals

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

Confirm the previous working assumption in RAN1#112 meeting as below.

**Working Assumption:**

For co-site inter-sector co-channel inter-subband CLI modelling, before receiving RAN4’s reply on the value of , RAN1 assume the following only for evaluation:

* FR1:
  + 75dB for spatial isolation (RAN4 typical value).
  + 93dB for spatial isolation (RAN4 best value).
  + 100dB for spatial isolation
* FR2:
  + 88dB for spatial isolation (RAN4 typical value).
  + 98dB for spatial isolation (RAN4 best value).
  + 105dB for spatial isolation
* In addition to spatial isolation and frequency isolation, companies can use digital cancelation and report the value, e,g., 10dB. Above does not imply that RAN1 assumes or does not assume digital cancelation is feasible.
* The feasibility of these values is up to RAN4. These values can be revisited based on further RAN4 inputs.
* The 100dB/105dB isolation values for FR1 and FR2 are not from RAN4, but based on RAN4 input that some companies have proposed that isolating material could be added between sectors to increase the isolation. RAN4 has not yet discussed the details whether such approaches can be applied to outdoor sites.

#### ***Initial proposal 2-3-4:***

Update the previous agreement in RAN1#112 meeting as below.

For SLS in RAN1, if only large scale fading is modelled and small scale fading is not modelled for UE-UE co-channel channel model, the power of UE-UE co-channel inter-subband CLI experienced by the victim UE on each receiver chain at DL RB *n* can be modelled as

where

* is the power of UE-UE co-channel inter-subband CLI from aggressor UE to victim UE on each receiver chain at one DL RB *n* (linear value).
* is UL transmission power of UE across all transmit chains over the allocated UL RBs (linear value)
* is the coupling loss between UE and UE (linear value), accounting for analog beamforming at the aggressor UE and victim UE
* is the total number of UL RBs in the UL subband
* is in linear scale. For the value of , it is up to RAN4. Companies can report the value used in their simulation before receiving RAN4’s further input.
* , wherein,
  + For SBFD Subband configuration with {DUD} pattern, can be ignored
  + is UL transmission power of UE across all transmit chains per RB (linear value). , and is the number of UL RBs allocated for UL transmission of UE .
  + is the Transmission Bandwidth Configuration, referring to Table 5.3.2-1 in TS 38.101-1 for FR1 and in TS 38.101-2 for FR2-1.
    - for FR1 with 100MHz transmission bandwidth and 30kHz SCS
    - for FR2-1 with 200MHz transmission bandwidth and 120kHz SCS
  + is the starting frequency offset between the allocated UL RBs and the measured non-allocated RB (e.g. *∆RB*= 1 or *∆RB*= -1 for the first adjacent RB outside of the allocated UL RBs)
  + EVM is the limit specified in Table 6.4.2.1-1 in TS 38.101-1 for FR1 and in TS 38.101-2 for FR2-1 for the modulation format used in the allocated RBs.

Include the above in the LS to RAN4 to inform them of the agreement and to check if the RAN1 agreement is in line with RAN4’s understanding.

#### ***Initial proposal 2-5-1:***

For Deployment case 3-2 (2-layer Scenario B), update Indoor-TRP to outdoor UE channel model as below.

|  |  |
| --- | --- |
| Large-scale channel parameters | Indoor TRP to Outdoor UE:   * Option 1:   + UMi-Street canyon in TR 38.901 (hBS =3 m) * Option 2:   + For Indoor office layer: InH-Office in TR 38.901   + For Indoor factory layer: InF in TR 38.901 * For both options, O2I penetration loss between indoor TRP and outdoor UE follows Table A.2.1-12 in TR38.802 ( is the distance between the indoor TRP and the building boundary along the direction from Indoor TRP to outdoor UE. The may be different for different indoor-TRP-outdoor-UE links associated with the same indoor TRP) |
| Fast fading parameters | Indoor TRP to Outdoor UE:   * Option 1:   + UMi-Street canyon in TR 38.901. ASD and ZSD statistics updated to be the same as ASA and ZSA * Option 2:   + For Indoor office layer: InH-Office (NLOS) in TR 38.901   + For Indoor factory layer: InF (NLOS) in TR 38.901 |

***Initial proposal 3-1-6:***

For link level evaluation of coverage performance, MPL, MCL and MIL as defined in TR38.830 are used as the performance metrics.

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

LLS for other purpose besides coverage performance evaluation is left up to companies’ interests.

***Updated proposal 2-2-1a:***

Regarding SLS for the potential enhancements of CLI handling for SBFD and dynamic/flexible TDD in AI 9.3.3,

* The basic evaluation methodologies and assumptions for SBFD and dynamic/flexible TDD agreed in AI 9.3.1 are used.
* If additional scheme-specific assumptions are needed for some enhancement schemes, it is up to companies to report the scheme-specific assumptions.

***Updated proposal 2-2-3b:***

For evaluation of SBFD and dynamic/flexible TDD, the maximum BS transmit power for legacy TDD in FR2-1 are modified as below.

|  |  |
| --- | --- |
| **FR2-1** | |
| **Dense Urban Macro layer** | * Option-1: 30 dBm for both 100MHz and 200MHz. * Option-2: 40 dBm for both 100MHz and 200MHz. |
| **Dense Urban Micro layer** | * 30 dBm for both 100MHz and 200MHz. |
| **Indoor hotspot** | * 23 dBm for both 100MHz and 200MHz. |

#### ***Updated proposal 2-3-5a:***

Confirm the following working assumption made in RAN1#112 meeting with modifications.

**Working assumption:**

For SLS in RAN1, if both large-scale and small-scale fading are modelled for UE-UE co-channel channel model, the UE-UE co-channel inter-subband CLI signal across all Rx chains at DL RB at victim UE can be modeled as:

where,

* is the first part of UE-UE co-channel inter-subband CLI across all Rx chains at DL RB , caused by power leakage at aggressor UE,
  + is the channel matrix between aggressor UE and victim UE at DL RB , the beamforming of the aggressor UE and the victim UE can be taken into account by
  + is the number of Rx chains and is the number of Tx chains
  + is the normalized wideband UL digital precoder of the aggressor UE, .
  + ,
    - , , is modelled as white Gaussian noise
    - has the same meaning as in the agreement for the case only large-scale fading is modelled
* is modelled as frequency flat
  + , , is modelled as white Gaussian noise
  + is the channel matrix between aggressor UE and victim UE at UL RB , the analog beams of the aggressor UE and the victim gNB can be taken into account by ,
  + is the normalized wideband UL digital precoder of the aggressor UE,
  + is the symbol transmitted at UL RB at aggressor UE with transmission power for each layer as .
    - has the same meaning as in the agreement for the case only large-scale fading is modelled
  + is the total number of UL RBs in the UL subbands,
  + is in linear scale. For the value of , it is up to RAN4. Companies can report the value used in their simulation before receiving RAN4’s further input.

# Proposals for offline discussion

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

Update the previous agreement in RAN1#111 meeting as below:

Regarding the modelling of inter-site gNB-gNB co-channel inter-subband CLI agreed in RAN1#110bis for the case that both large scale fading and small scale fading are modelled for gNB-gNB co-channel channel model, consider two options for the second part of inter-site gNB-gNB co-channel inter-subband, and companies to report which option is used:

* Option-1: Do not model the second part of inter-site gNB-gNB co-channel inter-subband
* Option-2: Model the second part of inter-site gNB-gNB co-channel inter-subband as below
  + the second part of inter-site gNB-gNB co-channel inter-subband CLI across all Rx chains at one UL RB, caused by receiver selectivity at victim gNB, can be modelled as

* + , , is modelled as white Gaussian noise
  + is the channel matrix between aggressor gNB and victim gNB at DL RB , the analog beams of the aggressor gNB and the victim gNB can be taken into account by ,
  + is the digital precoder at DL RB at aggressor gNB, ,
  + is the symbol transmitted at DL RB at aggressor gNB with transmission power for each layer as .
  + is the total number of DL RBs in the DL subbands.
  + RAN1 can assume (in channel selectivity) is given by gNB ACS.
    - Other values for , if provided by RAN4, can be used.

Note: Regardless option-1 or option-2, the piece wise BS noise figure model should be used

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

For SLS of SBFD in RAN1, the BS noise figure is modelled as piece wise linear based on the total received power (P) as

* For FR1, *A* = -43dBm, *B* = -25dBm, *C* = 5dB, *D* = 14dB
* *P* is in dB scale. The linear value of total received power is the linear sum of all received power, including wanted signal, co-channel and adjacent-channel UE-gNB interference, self-interference, co-channel and adjacent-channel co-site inter-sector interference and co-channel and adjacent-channel inter-site gNB-gNB interference.
* If *P* is larger than *B*, the receiver will be blocked.
* Before receiving further RAN4 inputs, the fixed noise figure is used in RAN1 evaluation as below.
  + Dense Urban Macro layer: 10dB for FR2
  + Dense Urban Micro layer: 10dB for FR2
  + Indoor: 10dB for FR2
* Send LS to RAN4 to ask the following questions:
  + Whether the above values of A, B, C and D can be used for all the BS classes in FR1?
  + What are the values of A, B, C and D for BS classes in FR2-1?
  + The feasibility and applicable scenarios of improved noise figure, e.g., by introducing additional interference reduction techniques like subband filtering.

***Updated proposal 3-1-4b-v1:***

For LLS coverage evaluation, RAN1 should consider self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference in TDD system and SBFD system.

* **Option-1**
* The modelling method is as below**:**
  + For TDD UL slot, additive white Gaussian noise with variance of is generated, where
    - is UE-gNB interference and is noise (in linear scale).
  + For SBFD slot, additive white Gaussian noise with variance of is generated, where
    - ,, , are self-interference, co-site inter-sector interference, inter-site gNB-gNB co-channel inter-subband CLI and UE-gNB interference (in linear scale), respectively
  + Companies to report the details of deriving and . Some examples are as below:
    - Example-1: and are derived based on link budget analysis based on a certain assumption of the topology of gNBs and UEs ( is derived based on 1dB desense and is derived based on as agreed in last meeting).
    - Example-2: is derived based on statistic in SLS, and then is used in LLS to increase the Gaussian noise power in SBFD symbol compared to TDD UL symbol.
    - Companies to report the RU assumption for the interference.
  + Note: For simplicity, the interference is independently updated/generated in each slot.
* Based on the modelling method, the following high-level evaluation method can be used as an example for coverage performance evaluation:
  + Step 1: For legacy TDD system, assume the SNR in UL only slot is , perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL
  + Step 2: For SBFD system with frame structure XXXXU, assume the SNR in UL only slot is and the SNR in SBFD slot is . Perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL for a given SBFD coverage enhancement scheme (e.g., SBFD with PUSCH repetition type A, etc.)
  + Step 3: Use Link budget template to obtain MPL, MCL and MIL for legacy TDD and SBFD.
    - For legacy TDD, the required SNR () obtained in Step 1 is used to calculate MPL, MCL, MIL.
    - For SBFD, the required SNR () obtained in Step 2 is used to calculate MPL, MCL, MIL.
* **Option-2**
* The UE-gNB interference and inter-site gNB-gNB co-channel inter-subband CLI in LLS coverage evaluation are explicitly modelled based on a given topology of aggressor UEs and gNBs. The UE-gNB and gNB-gNB fast fading channels are explicitly modelled in LLS. The signal model is as follows

  + is the received signal vector at the victim gNB
  + is the channel matrix from target UE to gNB, is the transmitted signal of the target user
  + , , are the channel matrix and transmitted signal of the UE in the same cell as the target user
  + and are the channel matrix and transmitted signal of the UEs in the adjacent cell
  + , and are the channel matrix, the precoding matrix, and leakage CLI signal from gNB to the victim gNB . The power of the signal and interference is included in the channel marix respectively
  + and are the self-interference vector of the co-site sectors and the thermal noise signal vector on the receiving antennas
* Companies to report the topology of gNBs and UEs to derive the detailed signals and interferences above. One example is as below



* Based on the above modelling, the following high-level evaluation method can be used as an example for coverage performance evaluation:
  + Step 1: For legacy TDD system, perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL
  + Step 2: For SBFD system with frame structure XXXXU, perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL for a given SBFD coverage enhancement scheme (e.g., SBFD with PUSCH repetition type A, etc.)
  + Step 3: Use Link budget template to obtain MPL, MCL and MIL for legacy TDD and SBFD.
    - For legacy TDD, the required SNR () obtained in Step 1 is used to calculate MPL, MCL, MIL.
    - For SBFD, the required SNR () obtained in Step 2 is used to calculate MPL, MCL, MIL.

***Updated proposal 3-1-4b-v2:***

The UE-gNB interference and inter-site gNB-gNB co-channel inter-subband CLI in LLS coverage evaluation are explicitly modelled based on a given topology of aggressor UEs and gNBs. The UE-gNB and gNB-gNB fast fading channels are explicitly modelled in LLS. The signal model is as follows

* is the received signal vector at the victim gNB
* is the channel matrix from target UE to gNB, is the transmitted signal of the target user
* , , are the channel matrix and transmitted signal of the UE in the same cell as the target user
* and are the channel matrix and transmitted signal of the UEs in the adjacent cell
* , and are the channel matrix, the precoding matrix, and leakage CLI signal from gNB to the victim gNB . The power of the signal and interference is included in the channel marix respectively
* and are the self-interference vector of the co-site sectors and the thermal noise signal vector on the receiving antennas

Companies to report the topology of gNBs and UEs to derive the detailed signals and interferences above. One example is as below



Based on the above modelling, the following high-level evaluation method can be used as an example for coverage performance evaluation:

* Step 1: For legacy TDD system, perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL
* Step 2: For SBFD system with frame structure XXXXU, perform LLS to get the required SNR () with which UE can achieve a certain bit rate in UL for a given SBFD coverage enhancement scheme (e.g., SBFD with PUSCH repetition type A, etc.)
* Step 3: Use Link budget template to obtain MPL, MCL and MIL for legacy TDD and SBFD.
  + For legacy TDD, the required SNR () obtained in Step 1 is used to calculate MPL, MCL, MIL.
  + For SBFD, the required SNR () obtained in Step 2 is used to calculate MPL, MCL, MIL.

***Initial proposal 2-2-2 (open):***

Companies are encouraged to report the assumption of UL/DL resource percentage per TDD period together with the evaluation results, which can be calculated as below:

* UL resource percentage per TDD period = (Number of UL RBs per cell per TDD period excluding guard bands and guard symbols) / (Total number of RBs per cell per TDD period including DL, UL, guard bands and guard symbols)
* DL resource percentage per TDD period = (Number of DL RBs per cell per TDD period excluding guard bands and guard symbols) / (Total number of RBs per cell per TDD period including DL, UL, guard bands and guard symbols)
* Note: DL+UL resource percentage may not always be 100% since guard bands and guard symbols may be assumed.

***Updated proposal 3-1-1b(Open):***

Regarding the Case 4 and Case 5 of schemes for PUSCH LLS coverage evaluation, two options are considered:

* Option 1 ~~(baseline)~~: joint channel estimation is applied only for the same symbol type
* Option 2: joint channel estimation is applied across SBFD and non-SBFD slots

***Updated proposal 3-1-5a (Open):***

Companies to report whether receiver blocking model is considered in link budget analysis or not.

***Updated proposal 3-1-7b(Open):***

Adopt the following evaluation assumptions for LLS for coverage performance evaluation.

Table X-1: General parameters for FR1

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario and frequency | Urban Macro: 4GHz |
| Frame structure for TDD | TDD: DDDSU (S: 10D:2G:2U)  SBFD: XXXXU, where X denotes SBFD slot.   * For SBFD slot, {DUD} pattern is assumed. * 100MHz channel bandwidth and 30kHz SCS (273 PRB): < ND, NU,NG > = <104, 55, 5> |
| Target data rates for eMBB | UL 1Mbps |
| Pathloss model (select from LoS or NLoS) | gNB-UE: NLOS  gNB-gNB (if modelled in LLS): LOS: NLOS = 3:1 |
| BWP | 100MHz |
| Channel model for link-level simulation | gNB-UE: TDL-C, CDL-C  Note: Company can provide simulation results based on either TDL channel or CDL model  Note: Companies can report gNB-gNB channel model if modelled in LLS. |
| Delay spread | 300ns  Note: Other values can be reported by companies. |
| UE velocity | 3km/h for indoor |
| Number of antenna elements for BS | SBFD antenna configuration option-2,  - 192 antenna elements  - (M,N,P,Mg,Ng) = (12,8,2,1,1)  - (optional) 128 antenna elements  - (M,N,P,Mg,Ng) = (8,8,2,1,1)  - Note: it is the same for both SBFD and non-SBFD slots  Note: Companies to report the details if other antenna configurations are used. |
| Number of TxRUs for BS | gNB architectures to study:  SBFD antenna configuration option-2,  - 64 TxRUs  - Note: it is the same for both SBFD and non-SBFD slots  Note: Companies to report the details if other antenna configurations are used.  gNB modelling in LLS for TDL:  - Option 1: 2 or 4 gNB RF chains in LLS.  - Option 2 (Optional): Number of gNB RF chains = number of TXRUs in LLS.  - Companies can report if and how correlation is modelled. |

Table X-2: Channel-specific parameters for PUSCH for FR1

|  |  |
| --- | --- |
| Parameter | Value |
| Frequency hopping | w/ or w/o frequency hopping |
| BLER | For eMBB, w/ HARQ, 10% iBLER; w/o HARQ, 10% iBLER. |
| Number of UE transmit chains | 1, 2 (optional) |
| DMRS configuration | For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data.  For frequency hopping: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. |
| Waveform | DFT-s-OFDM |
| SCS | 30kHz |
| PUSCH duration | 14 OS |
| HARQ configuration | For eMBB, whether HARQ is adopted is reported by companies.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| PRBs/TBS/MCS for eMBB | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use 30 PRBs for 1Mbps as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |

Table X-3: General parameters for FR2

|  |  |
| --- | --- |
| Parameter | Value |
| Scenario and frequency | Dense Urban Macro: 30GHz |
| Frame structure for TDD | TDD: DDDSU (S: 10D:2G:2U)  SBFD: XXXXU where X denotes SBFD slot.   * For SBFD slot, {DUD} pattern is assumed, * 200MHz channel bandwidth and 120kHz SCS (132 PRB): < ND, NU, NG > = <52, 26, 1> |
| Target data rates for eMBB | UL: 5Mbps |
| BWP | ~~100MHz~~ 200MHz |
| Pathloss model (select from LoS or NLoS) | gNB-UE: NLOS  gNB-gNB (if modelled in LLS): LOS: NLOS = 3:1 |
| Channel model for link-level simulation | gNB-UE: CDL- A, TDL-A  Note: Company can provide simulation results based on either TDL channel or CDL model  Note: Companies can report gNB-gNB channel model if modelled in LLS. |
| Delay spread | 100ns  Note: Other values can be reported by companies. |
| UE velocity | 30 km/h for outdoor |
| Number of antenna elements for BS | SBFD antenna configuration option-2,  256 antenna elements  (M,N,P,Mg,Ng) = (16,8,2,1,1)  Note: it is the same for both SBFD and non-SBFD slots |
| Number of TxRUs for BS | 2  Note: Analog beamforming is assumed. |
| Number of UE antenna elements | 8, one panel:(M, N, P) = (2,2,2) |

Table X-4: Channel-specific parameters for PUSCH for FR2

|  |  |
| --- | --- |
| Parameter | Value |
| Frequency hopping | w/ or w/o frequency hopping |
| BLER | For eMBB,  w/ HARQ, 10% iBLER, Optional: companies report iBLER.  w/o HARQ, 10% iBLER. |
| Number of UE Tx/Rx chains | 1T2R, 2T2R |
| DMRS configuration | For 30km/h: Type I, 2 or 3 DMRS symbol, no multiplexing with data.  For frequency hopping for PUSCH: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH/PDSCH mapping Type, the number of DMRS symbols and DMRS position(s) are reported by companies. |
| Waveform | DFT-s-OFDM |
| SCS | 120kHz. |
| PUSCH duration | 14 OS |
| HARQ configuration | For eMBB, whether HARQ is adopted is reported by companies.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| PRBs/TBS/MCS for eMBB | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use ~~30~~ 26 PRBs for 5Mbps for PUSCH as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |

***Initial proposal 3-1-8(Open):***

For coverage performance evaluation for SBFD, the link budget template in Table A.3 in TR 38.830 is reused with the following modifications.

|  |  |
| --- | --- |
| (10) Number of receive antenna elements | SBFD antenna configuration option-2,  FR1:  - 192 antenna elements  - (M,N,P,Mg,Ng) = (12,8,2,1,1)  - (optional) 128 antenna elements  - (M,N,P,Mg,Ng) = (8,8,2,1,1)  FR2:  - 256 antenna elements  - (M,N,P,Mg,Ng) = (16,8,2,1,1)  Note: Companies to report the details if other antenna configurations are used. |
| (10a) Number of receive TxRUs | SBFD antenna configuration option-2,  FR1:  - 64 TxRUs  FR2:  - 2 TxRUs  Note: Companies to report the details if other antenna configurations are used. |

***Initial proposal 3-1-9 (Open):***

The following table is used to collect companies’ link level evaluation results for coverage performance.

* Each company can input multiple groups of evaluation results, and each group corresponds to one kind of key assumptions, e.g., coverage enhancement schemes for SBFD, traffic load, etc.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| PUSCH-FR1-Urban Macro/ PUSCH-FR2-Dense Urban Macro | | | | | | |
| Company name | TDD/SBFD | Required SNR | MCL | MIL | MPL | Key assumptions |
| Source 1 | TDD |  |  |  |  |  |
| SBFD |  |  |  |  |
| Gain |  |  |  |  |
| Source X | TDD |  |  |  |  |  |
| SBFD |  |  |  |  |
| Gain |  |  |  |  |
| … | TDD |  |  |  |  |  |
| SBFD |  |  |  |  |
| Gain |  |  |  |  |

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