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

**e-Meeting, May 9th – 20th, 2022**

**Agenda Item: 9.3.3**

**Source: Moderator (LG Electronics)**

**Title:** **Summary #2 of [109-e-R18-Duplex-04] Email discussion on dynamic/flexible TDD**

**Document for:** **Discussion and Decision**

# Introduction

The following email thread for AI 9.3.3 Potential enhancements on dynamic/flexible TDD is announced by chair:

[109-e-R18-Duplex-04] Email discussion on dynamic/flexible TDD by May 20 – Hyunsoo (LGE)

* Check points: May 12, May 18, May 20

In this documentation, proposals based on the technical documentation submitted in RAN1#109-e and the email discussion on dynamic/flexible TDD are summarized.

# Deployment Scenarios for Potential Enhancement on Dynamic/flexible TDD

## (Closed)Deployment scenarios

### *Submitted proposal*

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| **ZTE [2]** | ***Proposal 1****: RAN1 studies the following two kinds of dynamic/flexible TDD in Rel-18 Duplex.*   * ***Understanding#1 (1st priority)****: Two cells are configured with different semi-static slot format configurations.* * ***Understanding#2 (2nd priority)****: At least one cell is configured with L1 slot format indication, i.e., SFI.*   ***Proposal 3****: During the interference cancellation/management study, the impact to the legacy macro base stations should be minimized.* |
| **vivo [7]** | *Error: Reference source not foundError: Reference source not found* |
| **xiaomi [9]** | ***Proposal 1:*** *Further evaluation on the two-layer layout scenario should be prioritized in Rel-18, where the macro layer operates with semi-static TDD and the small cell layer operates with dynamic TDD.* |
| **Samsung [10]** | ***Observation 2:*** *TDD urban micro deployments experience high CLI and less variation of the offered UL/DL traffic ratio*  ***Observation 3:*** *TDD indoor hotspot and factory deployments offer most potential for improved configuration flexibility to use dynamic TDD operation* |
| **Apple [17]** | ***Proposal:*** *The scope of R18 study on dynamic TDD shall be limited to cell-center aggressor UE with reduced transmit power.* |
| **Nokia, Nokia Shanghai Bell [20]** | ***Observation 1:*** *Dynamic TDD operation for FR1 deployments is primarily applicable for low power gNBs, while being problematic for high power macro gNBs without causing adjacent channel coexistence problems, i.e. macro gNB use static and fully aligned/synchronized TDD radio frame configurations.*  ***Proposal 1:*** *In line with Rel-16 TDD coexistence findings (3GPP TR 38.828), it is proposed that the FR1 macro gNBs use a static DL-heavy TDD radio frame configuration, while low power gNBs are allowed to use dynamic TDD, where the ratio of DL and UL resources is dynamically adjusted.* |
| **Qualcomm Incorporated [30]** | ***Observation 1:*** *For FR1, deployments scenario with large Tx Power BS suffers from inter-gNB interference.*  *• In general, inter-UE CLI is not an issue except for macro-to-indoor deployment.*  ***Observation 2:*** *For FR2, Dynamic TDD is possible under careful assumption of layout and power parameterization to avoid inter-gNB interference.*  ***Observation 6:*** *Link budget analysis shows that SB-based dynamic TDD is feasible for macro-cell deployment.*  ***Observation 7:*** *Qualcomm OTA test network validated the feasibility of dynamic TDD in macro-cell deployment using subband half-duplex.*  ***Proposal 1:*** *The focus of Rel-18 study on potential enhancement for dynamic TDD should be limited to co-channel intra-operator deployment.*  ***Proposal 2:*** *Support subband half-duplex as solution to enable dynamic TDD at least for FR1* |

### *Summary*

Companies considers Hetnet scenario as a deployment scenarios for study of potential enhancement of dynamic/flexible TDD [2][9][10][20].

* Macro layer operates with semi-static TDD and the small cell layer operates with dynamic TDD [9]
* The FR1 macro gNBs use a static DL-heavy TDD radio frame configuration, while low power gNBs are allowed to use dynamic TDD, where the ratio of DL and UL resources is dynamically adjusted [20]
* TDD indoor hotspot and factory deployments offer most potential for improved configuration flexibility to use dynamic TDD operation [10]

Also, it is proposed to consider cell-center aggressor UE with reduced transmit power [17]. And the other proposal is to support subband half-duplex as solution to enable dynamic TDD at least for FR1 [30]

### *1st Round Discussion*

Initial FL Proposal #1-1

Co-channel HetNet scenario is considered as a deployment scenarios for study of potential enhancement of dynamic/flexible TDD.

* Macro layer operates with semi-static TDD and the small cell layer operates with dynamic TDD

**Companies are invited to provide views on the above proposal.**

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| **Companies** | **Views** |
| ZTE | Firstly, we need to clarify the intention of this proposal, Is it only for simulation? If yes, then we propose to discuss it in AI9.3.1. If it is to clarify the understanding of dynamic TDD, then we propose to update it as following.  **Proposal:**  Study the following co-channel scenarios for dynamic/flexible TDD   * Cell#1 operates with semi-static TDD (e.g., DL dominant configuration) and Cell#2 operates with another semi-static TDD pattern (e.g., UL dominant configuration) * Cell#1 operates with semi-static TDD and Cell#2 operates with dynamic TDD pattern (e.g., SFI) |
| Sony | Is this to restrict the possible enhancements for dynamic/flexible TDD? That is any enhancements that benefit macro-macro deployment is ruled out unless it also benefits HetNet deployment? |
| vivo | Same issue is being discussed in [109-e-R18-Duplex-02] (issue #2 Deployment scenarios for dynamic/flexible TDD), it is better to coordinate to avoid the overlapped discussions.  We are fine to study Co-channel HetNet scenario for dynamic/flexible TDD. In addition, it is also important to study the adjacent channel coexistence scenario, it is our understanding that adjacent-channel co-existence issue is the key problem that makes dynamic TDD unsuccessful in the commercial deployment. |
| New H3C | We have the same view on avoiding the overlapped discussions with [109-e-R18-Duplex-02].  In addition we need also consider two cells with semi-static TDD case, where the two cells have the different frame structure. |
| Spreadtrum | We prefer DL dominant semi-static TDD can be configured in Macro layer and UL dominant semi-static TDD can be used in small cell layer for dynamic/flexible TDD deployment scenarios. |
| Huawei, HiSilicon | The discussion on applicable and relevant deployment scenario for dynamic/flexible TDD is ongoing in AI 9.3.1, and we should avoid duplicated discussions. Nevertheless, As we commented in 9.3.1, when selecting deployment scenarios, one should take the realistic commercial need from vertical industries into account. It is worth noting that there is an increasing demand for higher uplink data rate and capacity which has not been well addressed, e.g., high definition video traffic in factories. Based on this observation, we believe the first scenario proposed by ZTE should be prioritized which target to meet the high UL capacity requirement in smart factories. |
| Lenovo | Co-Channel HetNet could be a typical scenario. Similar with vivo, we support to study adjacent channel coexistence scenario. |
| Nokia, NSB | Support FL’s proposal. |
| CMCC | This issue should be discussed in AI 9.3.1 |
| InterDigital | Support the FL proposal in principle. We are fine with studying co-channel HetNet scenarios in addition to adjacent channel coexistence for dynamic TDD. Also, as many companies mentioned, since the same discussions including both SBFD and dynamic TDD are already on-going in [109-e-R18-Duplex-02], coordination to avoid overlap in discussion is needed. |
| Intel | Do not support this proposal. While we’re open to considering HetNet scenarios (e.g., UMa + Hotspot) and see their value, we rather prefer to evaluate the performances for UMa and InH as baseline scenarios  It is not clear to us whether we need to discuss this proposal under this AI. It would be better to follow the agreement/proposal in evaluation methodology AI. |
| NEC | For simulation purpose, it should be in 9.3.1. Otherwise, we prefer the more general proposal from ZTE. |
| QC | Don’t support. Urban Macro and InH should be considered as baseline scenario for evaluation of dynamic TDD. In addition, we believe that deployment scenario should be discussed under agenda 9.3.1. |
| Ericsson | Similar to other companies' views, we don't support making an agreement in this AI on deployment scenarios to study, since that discussion is ongoing in AI 9.3.1. We think that a common set of scenarios should be defined in AI 9.3.1, and both SBFD and dynamic/flexible TDD can be studied under those common scenarios. We fully support the comments made by several companies, that adjacent channel coexistence is vital to study, and in AI 9.3.1 it will be important to define such a scenario for study. We don't agree with the view from some companies that adjacent channel coexistence was fully evaluated in Rel-16 SI and thus should not be studied in this SI. There were some shortcomings of the Rel-16 SI such as impact of from legacy operator (static TDD) to dynamic TDD operator, unrealistic traffic models (full buffer), unrealistic indoor/outdoor user ratio, etc. |
| Apple | Similar to majority, we think this should be discussed under 9.3.1 |
| OPPO | Although we respect the majority view, we are ok to discuss/decide the scenario in AI 9.3.3 for dynamic/flexible TDD. We concern a bit that the scenario discussion in AI 9.3.1 has to consider a customization to dynamic/flexible TDD. |
| CATT1 | This issue is also discussed in other email thread, it’s better to coordinate the discussion.  As for the scenario for dynamic TDD, we think indoor hotspot should be included. |
| Samsung | We understand the Co-channel HetNet scenario is a promising deployment scenario to enable dynamic TDD operation. However, the intention of this proposal is not well justified. With this proposal, does RAN1 focus on co-channel HetNet scenarios to design CLI handling scheme? Other FL proposals are not related to the co-channel HetNet scenario.  Deployment scenarios for dynamic/flexible TDD are also under discussion in [109-e-R18-Duplex-02] (Issue #2) and corresponding FL proposals (2-1 and 2-2) are up for consideration there. To avoid duplication of the same RAN1 discussion, we propose to not further include Section 2 deployment scenarios in Round 2 of [109-e-R18-Duplex-04]. |
| Sharp | We have similar view with companies that simulation assumption could be discussed under AI9.3.1. |
| LG | We share similar view with other companies that similar issue is being discussed in 9.3.1, duplication should be avoided. Putting that aside, it seems the deployment scenario is too restrictive. Since it is study item phase, we do not think deployment scenario should be limited. |
| Xiaomi | Support the proposal. |
| ITRI | Deployment scenario should be discussed under agenda 9.3.1. |
| TCL | We share similar views with the majority companies, to discuss this proposal in 9.3.1. |
| MediaTek | Similar to other companies, we think this should be discussed in AI 9.3.1 |

**Summary of 1st Round Discussion**

Based on the 1st round discussion, we can summarize as below:

■ General comment for discussion

▶Support FL's proposal

Nokia, NSB, InterDigital, Xiaomi

▶Discuss under AI 9.3.3

OPPO

▶ Avoid the duplicated discussion

vivo, New H3C, Huawei/HiSilicon, CMCC (should be discuss under AI 9.3.1), InterDigital (coordination to avoid overlap in discussion is needed), Intel (better to follow the agreement/proposal in evaluating methodology AI), QC, Apple, CATT, Samsung, Sharp, LG Electronics, ITRI, TCL, MediaTek

■ Companies proposals for modification of initial FL proposal

▶ Consider other scenario

Intel (UMa+Hotspot, UMa+InH)

CATT (Indoor Hotspot)

▶ Adjacent channel co-existence scenario

Ericsson

▶ Assumption of TDD configuration

● Option 1) Operation with semi-static TDD (e.g., DL dominant configuration), another semi-static TDD pattern (e.g. UL dominant configuration),

ZTE

New H3C (two cells with semi-static TDD case)

Spreadtrum (DL dominant semi-static TDD in Macro layer, UL dominant semi-static TDD in small cell layer)

Huawei/HiSilicon (smart factory)

● Option 2) Semi-static TDD and dynamic TDD pattern (e.g., SFI)

ZTE

The intention of Initial FL Proposal #1-1 based on the observation and proposal from contribution submitted under AI 9.3.3. is to clarify what is typical scenario for study of potential enhancement on dynamic/flexible TDD because we can determined which CLI handling scheme is available depending on the deployment scenario, TDD configuration, backhaul assumption, and so on. But, in AI 9.3.1, similar issues are under discussion for evaluation. Also, it is observed that deployment scenarios and TDD configuration assumption for study of potential enhancement on dynamic/flexible TDD which are commented for Initial FL Proposal#1-1 are identical with proposals discussed under AI 9.3.1. So, to avoid duplicated discussion among multiple agenda items, we can conclude as below:

**Possible Conclusion for 2nd round discussion**

For discussion in AI 9.3.3, companies are encouraged to provide technical solution and have a technical discussion based on the deployment scenarios for dynamic/flexible TDD which are agreed for evaluation purpose under AI 9.3.1.

### *2nd Round Discussion*

Possible Conclusion for 2nd round discussion

For discussion in AI 9.3.3, companies are encouraged to provide technical solution and have a technical discussion based on the deployment scenarios for dynamic/flexible TDD which are agreed for evaluation purpose under AI 9.3.1.

**Companies are invited to provide views on the above proposal.**

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|  | **Company** |
| **Support** | NEC, Sony, QC, TCL, Samsung, CEWiT, ZTE, New H3C, DOCOMO, Xiaomi,vivo, Spreadtrum, CMCC, Nokia, NSB, Panasonic, SK Telecom, LG, IDC |
| **Not support** | Ericsson |

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| **Company** | **Views** |
| NEC | OK to have but this proposal seems not needed. |
| Intel | Not sure whether this is necessary. |
| QC | Seems not needed for this proposal. |
| CEWiT | Proposal does not seem necessary |
| ZTE | Agree with the intention, but it seems the proposal is not necessary. |
| New H3C | We have the same view as the above companies. |
| Xiaomi | No need to have this proposal. |
| CATT | NO need to have this conclusion |
| Ericsson | Agree with other companies views that this conclusion does not seem necessary |
| Huawei, HiSilicon | We are fine with this clarification. |
| Panasonic | We are ok with this clarification. |
| SK Telecom | We are fine with this clarification. |
| LG | Support this proposal to prevent diverge of future discussion. It is our understanding deployment scenario for evaluation decided in AI 9.3.1 is only considered for further discussion. |
| InterDigital | OK for the clarification |

**Summary of 2nd Round Discussion**

Based on the 2nd round discussion, we can summarize as below:

It is observed that most of company agree with the intention of the Possible Conclusion for 2nd round discussion, but companies are thinking that the conclusion is not necessary.

In this sense, FL recommends as below:

FL recommendation from 2nd round discussion

* For discussion in AI 9.3.3, consider the deployment scenarios for dynamic/flexible TDD which are agreed for evaluation purpose under AI 9.3.1.
* Under AI 9.3.3., no more discussion about the deployment scenario for potential enhancement on dynamic/flexible TDD

### *3rd Round Discussion*

In GTW session (5/16 Mon.), following was agreed.

**Agreement**

* For discussion in AI 9.3.3, consider the deployment scenarios for dynamic/flexible TDD which are agreed for evaluation purpose under AI 9.3.1 in RAN1#109-e.
* Under AI 9.3.3., no more discussion about the deployment scenario for potential enhancement on dynamic/flexible TDD

FL informs section 2.1 is closed because ‘no more discussion regarding the deployment scenario under AI 9.3.3’ is agreed.

# Cross Link Interference Handling

## Interference Scenarios for potential enhancement on dynamic/flexible TDD

### *Submitted proposal*

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| **Huawei, HiSilicon [1]** | ***Observation 2:*** *For flexible TDD scenario, the downlink cross link interference from the interfering cell consists of various downlink signals and are precoded differently according to the signal type, user etc.*  ***Observation 3:*** *Various types of downlink interference signal with various precoding will result in various downlink cross link interference and should be considered separately at the victim uplink receiver.* |
| **ZTE [2]** | ***Proposal 2****: The following interferences are to be considered for dynamic/flexible TDD study.*   * *Gnb-Gnb co-channel intra-subband interference;* * *UE-UE co-channel intra-subband interference;* * *Gnb-Gnb adjacent-channel interference;* * *UE-UE adjacent-channel interference;* * *Gnb-UE co-channel intra-subband interference (Legacy);* * *UE-Gnb co-chanel intra-subband interference (Legacy).* |
| **Vivo [7]** | *Error: Reference source not found*  *Error: Reference source not found* |
| **OPPO [12]** | ***Proposal 2:*** *It should be clarified whether the dynamic/flexible TDD (from UE/Gnb perspective) and subband non-overlapping full duplex (from Gnb-only perspective) should be assumed to operate together.*  *• If yes, interference mitigation to handle inter-Gnb/inter-UE CLI from adjacent full-duplex sub-band need to be studied.*  *• If yes, it should be further determined whether Rel-18 study of dynamic/flexible TDD should assume full-duplex being transparent to Gnb-side enhancement (if any) for dynamic/flexible TDD.* |
| **CEWiT [28]** | ***Observation 1:*** *Networks with SBFD enabled gNBs are subject to intra-cell UE-to-UE CLI, in addition to the CLI present in flexible TDD system.* |
| **Qualcomm Incorporated [30]** | ***Observation 3:*** *Rel-18 study on potential enhancement of dynamic TDD suggests utilizing the outcome of Rel-15 and Rel-16 studies outcome avoid repetition of same discussion, e.g., inter-operator Dynamic TDD coexistence study.* |

### *Summary*

It is considered that most of interference scenario is shared for both the subband non-overlapping full duplex and dynamic/flexible TDD. Hence, clarification which interference scenario(s) is/are considered for studying potential enhancement of dynamic/flexible TDD is required.

In [2], it is proposed that the following interferences are to be considered for dynamic/flexible TDD study.

* Gnb-Gnb co-channel intra-subband interference
* UE-UE co-channel intra-subband interference
* Gnb-Gnb adjacent-channel interference
* UE-UE adjacent-channel interference
* Gnb-UE co-channel intra-subband interference (Legacy)
* UE-Gnb co-chanel intra-subband interference (Legacy)

In [7], it is mentioned that for dynamic TDD, co-channel CLI at Gnb and UE side is the main challenge. Also, in [30], it is proposed to avoid repetition of same discussion, e.g., inter-operator Dynamic TDD coexistence study.

### *1st Round Discussion*

Initial FL Proposal #2-1

Following interference scenarios can be considered for study of dynamic/flexible TDD study:

* Gnb-to-Gnb co-channel intra-subband interference
* UE-to-UE co-channel intra-subband interference
* FFS: Gnb-to-Gnb adjacent-channel interference
* FFS: UE- to-UE adjacent-channel interference

**Companies are invited to provide views on the above proposal. Also, companies are encouraged to provide views which interference scenarios should be considered for dynamic/flexible TDD in agenda item 9.3.3.**

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| **Companies** | **Views** |
| ZTE | We are ok to focus on the two intra-subband interference in this AI. |
| Sony | In the description above, we have:   * Gnb-Gnb co-channel intra-subband interference * UE-UE co-channel intra-subband interference * Gnb-Gnb adjacent-channel interference * UE-UE adjacent-channel interference * Gnb-UE co-channel intra-subband interference (Legacy) * UE-Gnb co-chanel intra-subband interference (Legacy)   Please clarify what it meant by intra-subband interference and why would legacy system, where subband does not exists, have intra-subband interference? |
| Vivo | The benefit of dynamic TDD has been well justified by the studies in the past, the gain can be obtained even without any co-channel interference handling solution for some scenarios, e.g. in the low load scenario.  However, the fact that dynamic TDD cannot be deployed in the field is the adjacent channel interference between operators.  We therefore think the adjacent channel interference handling is also critical for the study in order to make dynamic TDD successful in the real deployment. |
| CEWiT | Agree |
| New H3C | We are fine with FL proposal on the two intra-subband interference with high priority. |
| Spreadtrum | Support this proposal. But the difference between interference in R18 dynamic/flexible TDD and interference studied in R14 and R16 should be further clarified. Also agree with Sony to clarify about intra-subband in dynamic/flexible TDD. |
| Panasonic | We are fine with the proposal. |
| Huawei, HiSilicon | In our view, the study on Gnb-to-Gnb adjacent-channel interference and UE-to-UE adjacent-channel interference should take the Rel-16 co-existence study as the starting point. |
| Lenovo | We prefer to study the handling of both inter-Gnb and inter-UE adjacent channel interference. |
| Nokia, NSB | We agree that co-channel intra-subband Gnb-to-Gnb and UE-to-UE cross-link interferences should be considered.  Regarding the FFS, adjacent channel interferences were considered during Rel-16 cross-link interference studies. In our view, the conclusions of previous studies remain valid for Rel-18 dynamic TDD, e.g., in FR1 macro-to-macro performance is significantly degraded if different TDD radio frames are used. Therefore, we suggest to not consider adjacent channel interference in this study, unless some of the baseline assumptions are modified for SBFD co-existence studies as compared to Rel-16 co-existence studies, in which case it could make sense to perform new co-existence also for dynamic TDD. |
| CMCC | Regarding the FFS, the adjacent channel interference has been studied by RAN4 in rel-16, and we don’t see the motivation to further discuss it in rel-18. |
| InterDigital | Support Proposal #2-1, where the co-channel intra-subband interference is prioritized. |
| Intel | We are fine with the proposal. For the main bullet, we suggest to add “dynamic/flexible TDD and SBFD” as intra-subband is mainly targeted for SBFD operation.  Initial FL Proposal #2-1  Following interference scenarios can be considered for study of dynamic/flexible TDD and SBFD ~~study~~:   * gNB-to-gNB co-channel ~~intra-subband~~ interference   + Note: For SBFD, this is limited to intra-subband interference * UE-to-UE co-channel ~~intra-subband~~ interference   + Note: For SBFD, this is limited to intra-subband interference * FFS: gNB-to-gNB adjacent-channel interference * FFS: UE- to-UE adjacent-channel interference   For adjacent channel interference, our understanding is that these should be studied in RAN4, not RAN1. |
| NEC | Generally OK but we think gNB-gNB adjacent channel is also important if we consider inter-operator case. |
| QC | Support to focus on co-channel interference scenarios to avoid duplicated study of Rel-16.  For our proposed SBHD scheme (FR1), where UL and DL is separated in different frequency resources to enable dynamic TDD in different cells, gNB-to-gNB and UE-to-UE co-channel inter-subband interference should be added. |
| Ericsson | Fully agree with vivo's comment, and thus we don't agree to de-prioritize adjacent channel interference, since we don't share the view from some companies that adjacent channel coexistence was fully evaluated in Rel-16 SI. There were some shortcomings of the Rel-16 SI such as impact of from legacy operator (static TDD) to dynamic TDD operator, unrealistic traffic models (full buffer), unrealistic indoor/outdoor user ratio, etc.  It is also not clear to us what is meant by intra-subband interference when considering coexistence of legacy operator (static TDD) with a dynamic TDD operator. In the former, there are no subbands. Strictly speaking, there are also no subbands in the latter; however, we understand that one can think of dynamic TDD as a special case of SBFD, so it can make sense to discuss subbands in that case.  Our suggestion is an update of Intel's proposal:  Initial FL Proposal #2-1  Following interference scenarios can be considered for study of dynamic/flexible TDD and SBFD ~~study~~:   * gNB-to-gNB co-channel ~~intra-subband~~ interference   + Note: For SBFD, this is limited to intra-subband interference * UE-to-UE co-channel ~~intra-subband~~ interference   + Note: For SBFD, this is limited to intra-subband interference * ~~FFS:~~ gNB-to-gNB adjacent-channel interference * ~~FFS:~~ UE- to-UE adjacent-channel interference   We don't agree that adjacent channel interference is to be studied only in RAN4. The SID states the following:   * Study the performance of the identified schemes as well as the impact on legacy operation assuming their co-existence in co-channel and adjacent channels (RAN1). |
| OPPO | We have the same question as Sony. What does “intra-subband” mean here? Does it refer to the concept in AI 9.3.2? If yes, it maybe better to decide on Proposal 3-1 first. |
| CATT1 | We would prefer to de-prioritize UE-UE interference scenario |
| Samsung | We are in principle fine with the intention of the proposal. UE-UE/gNB-gNB co-channel intra-subband interference can be discussed for the dynamic/flexible TDD study part in RAN1. We do not think that the FFS for UE-to-UE and gNB-to-gNB adjacent channel interference are necessary. We consider these part of the coexistence evaluation in RAN4. |
| NTT DOCOMO | We support. For adjacent-channel interference, it can be discussed in 9.3.2, and at least we would like to avoid overlapping discussion in 9.3.2 and 9.3.3. |
| Sharp | We support the proposal. |
| LG | We are okay for the proposal and tend to agree with Vivo and CMCC that the most critical reason why dynamic TDD was not deployed is CLI, especially gNB-to-gNB CLI since the power of gNB is much higher than that of UE. Therefore we think gNB-to-gNB co-channel intra-subband interference should be prioritized. And we also think adjacent channel interference part is up to RAN4. |
| Xiaomi | We are fine to focus on intra-subband interference to avoid the duplicated work. |
| WILUS | Support. It should be clarified whether to study adjacent channel interference in RAN1 or RAN4, and whether to study AI 9.3.2 or 9.3.3 if it is studied in RAN1. |
| ITRI | We are fine with the proposal. |
| TCL | In our view, SBFD and dynamic TDD are two different scenarios and CLI handling for each scenario may be different from each other. Therefore, we suggest to study the CLI handling in SBFD such as intra sub-band interference, and dynamic TDD separately. |
| MediaTek | We fully agree with Ericsson that adjacent channel interference should not be de-prioritized for the study. And the study and evaluation of adjacent channel interference can be conducted in RAN1. We hence support Ericsson’s proposal. |

**Summary of 1st Round Discussion**

Based on the 1st round discussion, we can summarize as below:

■ Study of gNB-to-gNB/UE-to-UE Co-channel interference

▶ Fine with FL's proposal (Discuss gNB-to-gNB/UE-to-UE co-channel interference under AI 9.3.3)

ZTE, CEWiT, New H3C, Spreadtrum, Panasonic, Nokia, NSB, InterDigital, NEC, Qualcomm, Samsung,

NTT DOCOMO, Sharp, LG Electronics, Xiaomi (to avoid the duplicated work), WILUS, ITRI

▶ Prefer to de-prioritize UE-UE interference scenario

CATT

▶ Suggest to study the CLI handling in SBFD such as intra sub-band interference, and dynamic TDD separately.

TCL

▶ Clarification question and comment

Q1) Clarify what it meant by intra-subband interference and why would legacy system, where subband does not exists, have intra-subband interference?

Sony, Spreadtrum, OPPO

C1) The difference between interference in R18 dynamic/flexible TDD and interference studied in R14 and R16 should be further clarified.

Spreadtrum

■ Study of adjacent channel interference in RAN1

▶ Supportive

Vivo (The adjacent channel interference handling is also critical for the study in order to make dynamic TDD successful in the real deployment.)

Lenovo (Study the handling of both inter-Gnb and inter-UE adjacent channel interference.)

NEC (Think gNB-gNB adjacent channel is also important if we consider inter-operator case.)

Ericsson (don't agree to de-prioritize adjacent channel interference, since we don't share the view from some companies that adjacent channel coexistence was fully evaluated in Rel-16 SI. Study in RAN1)

MediaTek

▶ Negative

Samsung (We do not think that the FFS for UE-to-UE and gNB-to-gNB adjacent channel interference are necessary. We consider these part of the coexistence evaluation in RAN4.)

LG Electronics (in RAN4)

CMCC (Don’t see the motivation to further discuss it in rel-18.)

Huawei, HiSilicon (The study on Gnb-to-Gnb adjacent-channel interference and UE-to-UE adjacent-channel interference should take the Rel-16 co-existence study as the starting point.)

Nokia, NSB (Suggest to not consider adjacent channel interference in this study, unless some of the baseline assumptions are modified for SBFD co-existence studies as compared to Rel-16 co-existence studies, in which case it could make sense to perform new co-existence also for dynamic TDD.)

▶ Need to clarify whether in RAN1 or RAN4

WILUS

Regarding co-channel interference scenario, it is observed from the comments:

* Most of companies are supportive position with initial FL Proposal #2-1.
* Single company suggests to de-prioritize UE-to-UE co-channel interference.
* Single company suggests to study CLI handling in SBFD and dynamic TDD separately
* Also, one company suggests modification to make clear the targeting interference scenario for dynamic/flexible TDD and SBFD

Also, so far, it is under discussion whether intra-subband scenario for SBFD is considered under AI 9.3.2 or AI 9.3.3.

Considering on the comment, we can make a modified FL Proposal #2-1 (1) as below:

Regarding adjacent channel interference scenario, it is observed from the comments:

* Four companies are supportive position considering on adjacent channel interference scenario and study in RAN1.
* Seven companies are negative position.

It seems two group of companies should have discussion whether adjacent-channel interference can be considered for study of dynamic/flexible TDD. Considering on the comment, we can make a modified FL Proposal #2-1 (2) as below:

**Updated FL Proposal #2-1 (1) for 2nd round discussion**

Following interference scenarios can be considered for study of dynamic/flexible TDD [and SBFD]:

* gNB-to-gNB co-channel interference
* UE-to-UE co-channel interference
* Note: For SBFD, this is limited to gNB-to-gNB intra-subband interference and UE-to-UE intra-subband interference

**Updated FL Proposal #2-1 (2) for 2nd round discussion**

Discuss whether following interference scenarios can be considered for study of dynamic/flexible TDD [and SBFD]:

* gNB-to-gNB adjacent-channel interference
* UE- to-UE adjacent-channel interference

### *2nd Round Discussion*

Updated FL Proposal #2-1 (1) for 2nd round discussion

Following interference scenarios can be considered for study of dynamic/flexible TDD [and SBFD]:

* gNB-to-gNB co-channel interference
* UE-to-UE co-channel interference
* Note: For SBFD, this is limited to gNB-to-gNB intra-subband interference and UE-to-UE intra-subband interference

**Companies are invited to provide views on the above proposal.**

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|  | **Company** |
| **Support** | NEC, Sony (NOTE on SBFD), Intel (including SBFD in the main bullet), QC (with edit on SBFD), TCL (with SBFD interference discussion in AI 9.3.2), Samsung (without SBFD part), ITRI, New H3C (with SBFD in AI 9.3.2), DOCOMO, Xiaomi (remove the note), vivo(including SBFD in the main bullet), Lenovo, Ericsson (remove SBFD and the note), Spreadtrum, Panasonic(remove SBFD and the note), LG, IDC (with clarification) |
| **Not support** |  |

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| --- | --- |
| **Company** | **Views** |
| NEC | SBFD part should be discussed in AI 9.3.2 thus better to be removed |
| Sony | It is preferable that subband aspects is studied in AI 9.3.2. |
| Intel | Given that a unified solution is preferred for dynamic/flexible TDD and SBFD, it is more reasonable to study co-channel interference including intra-subband interference under AI9.3.3.  We suggest to remove the [] in the main bullet as follows:  Following interference scenarios can be considered for study of dynamic/flexible TDD ~~[~~and SBFD~~]~~:   * gNB-to-gNB co-channel interference * UE-to-UE co-channel interference * Note: For SBFD, this is limited to gNB-to-gNB intra-subband interference and UE-to-UE intra-subband interference |
| QC | SBFD shall be studies in AI 9.3.2 without mixed with dynamic TDD. No need for the [and SBFD] and the Note |
| TCL | As we commented in the 1st round discussion that the interference mitigation solutions of dynamic TDD may be different from SBFD. Therefore, in our view the SBFD interference shall be discussed in AI 9.3.2 |
| Samsung | We are ok with the d-/f-TDD part of the FL proposal. We much prefer that any proposals related to SBFD are discussed under AI 9.3.2. Therefore, we can only agree to the FL proposal #2-1 (1) if the “[and SBFD]” is removed.  After identifying potential solutions in AI 9.3.2 and AI9.3.3, we can further discussion which AI is proper to study the solutions. |
| Apple | We do not support intra-sub-band CLI for SBFD (neither here nor in 9.3.2), it should be handled by configuration. Intra-sub-band CLI can be discussed only for dynamic TDD. |
| ZTE | Maybe it is better to remove the red text for now. |
| New H3C | We also prefer SBFD be discussed in AI 9.3.2. |
| NTT DOCOMO | We also think SBFD is studied in AI 9.3.2. |
| Xiaomi | No need to discuss SBFD related issue. |
| CATT | Prefer SBFD be discussed in AI 9.3.2. |
| vivo | Same view as Intel. |
| Ericsson | Prefer to remove [and SBFD] and the Note  SBFD will be studied in 9.3.2. |
| Huawei, HiSilicon | The [and SBFD] and the Note can be removed as long as there is group consensus that the co-channel intra-subband interference in SBFD is studied in AI 9.3.3. Otherwise, the suggestion from Intel is more clear. |
| Spreadtrum | Agree with Intel to consider a unified CLI handling for both SBFD and dynamic/flexible TDD. For SBFD, intra-subband CLI only exists in scenarios of cells with different subband configuration or co-channel co-existence case. But for dynamic/flexible TDD, co-channel CLI is the typical CLI, it is more reasonable to be studied under AI 9.3.3. |
| CMCC | We also support to remove the red part |
| Panasonic | The red part can be removed. SBFD is studied in AI 9.3.2. |
| MediaTek | Prefer SBFD be discussed in 9.3.2. |
| LG | It is our understanding that the unified CLI handling mechanism for SBFD and dynamic/flexible TDD should be considered, and that is the reason why SBFD is included. However, since we have separate AI 9.3.2 for SBFD, it is okay to remove SBFD part to prevent duplication of discussion which is the concern from other companies. |
| InterDigital | We can remove [and SBFD] and the Note, with confirming that the co-channel intra-subband CLI for SBFD is studied in AI 9.3.2. |

Updated FL Proposal #2-1 (2) for 2nd round discussion

Discuss whether following interference scenarios can be considered for study of dynamic/flexible TDD [and SBFD]:

* gNB-to-gNB adjacent-channel interference
* UE- to-UE adjacent-channel interference

**Companies are invited to provide views on the above proposal.**

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| --- | --- |
|  | **Company** |
| **Support** | NEC, Sony (clarification needed), TCL, CEWiT, New H3C(with SBFD in AI 9.3.2), DOCOMO, vivo, Lenovo, Ericsson (remove [and SBFD]) |
| **Not support** | Intel, QC, Samsung, Xiaomi, Spreadtrum, Nokia, NSB, LG, IDC |

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| **Company** | **Views** |
| NEC | SBFD part should be discussed in AI 9.3.2 thus better to be removed |
| Sony | There were suggestions that adjacent channel interference is studied in RAN4. Is the intention of the proposal to study adjacent channel interference in RAN1? |
| Intel | It is not clear to us whether this is needed. Based on the discussion in AI 9.3.1, study on adjacent channel interference may be conducted in RAN4, instead of RAN1. If this is confirmed, this proposal may not be needed. |
| QC | SBFD shall be studies in AI 9.3.2 without mixed with dynamic TDD. No need for the [and SBFD].  Support to focus on co-channel interference scenarios to avoid duplicated study of Rel-16 for dynamic TDD.  Adjacent-channel co-existence between SBFD and static TDD is addressed as case 4 in AI 9.3.1 and should not duplicate in AI 9.3.3. |
| TCL | SBFD shall be discussed in AI 9.3.2 |
| Samsung | The proposal is unclear to us since these two interference scenarios are considered in evaluation assumptions under AI9.3.1. If we understand correctly, the intention of this proposal is to study CLI handling for gNB-to-gNB adjacent-channel interference and UE-to-UE adjacent-channel interference. |
| Apple | We have a preference that adjacent-channel CLI is studied by RAN4 |
| ZTE | Agree with other companies, adjacent channel interference is one important aspect. We think the adjacent channel can be studied in RAN1.  Ok to remove the red text. |
| New H3C | We think SBFD should be discussed in AI 9.3.2. |
| Xiaomi | The adjacent channel interference had been evaluated in Rel-16 CLI WI. We don’t know what in addition is needed. |
| CATT | Prefer SBFD be discussed in AI 9.3.2. |
| vivo | As we comment in the first round, the fact that dynamic TDD cannot be deployed in the field is the adjacent channel interference between operators. The adjacent channel interference handling is key for the study in order to make dynamic TDD successful in the real deployment. Agree with Ericsson that adjacent channel interference is not good enough. In addition, the following objective is included in the scope of the SID, it is clear that adjacent channel CLI should be considered in Rel-18. Thus, we think these should be considered for study directly.  Study the performance of the identified schemes as well as the impact on legacy operation assuming their co-existence in co-channel and adjacent channels (RAN1). |
| Lenovo | Study of handling adjacent channel CLI has been listed in the SID, so we think it should be studied. |
| Ericsson | Adjacent channel interference was investigated in Rel-16 WI for dynamic/flexible TDD, but not for SBFD. Since there is a specific RAN1 objective in the SID for studying adjacent channel interference for SBFD, then there should be no discussion about whether or not it should be studied; it shall be studied.  *Study the performance of the identified schemes as well as the impact on legacy operation assuming their co-existence in co-channel and adjacent channels (RAN1).*  Hence, we prefer to remove ~~[and SBFD]~~ from the proposal. |
| Huawei, HiSilicon | Suggest to remove SBFD in the main bullet and discuss it in ether AI 9.3.1 or 9.3.2.  For dynamic/flexible TDD, the proposal is not strictly needed since there are different views on whether this should be studied in RAN1 or RAN4.  Considering that some work has already been done in RAN4 in Rel-16. If the group decide that this should be done in RAN1 again, there is a need to decide what particular change, e.g. traffic mode, interference modelling, should be made. |
| Spreadtrum | Agree with QC to remove SBFD. And we also think study on adjacent-channel interference should be conducted by RAN4. |
| CMCC | Whether or not to study adjacent channel CLI for SBFD in RAN1 should be discussed in AI 9.3.2.  In addition for dynamic TDD, the adjacent channel CLI has been evaluated in Rel-16, we don’t think the repeated work is needed. |
| Nokia, NSB | For dynamic/flexible TDD our preference is to not consider new adjacent channel interference studies to avoid repetition from Rel-16, unless new assumptions are considered. SBFD adjacent channel interference studies might draw different conclusions from Rel-16 studies and therefore we support them. This discussion should be treated in AI 9.3.2 |
| Panasonic | Similar view with Huawei. |
| MediaTek | Prefer SBFD be discussed in 9.3.2. |
| LG | We are aligned to the intention of the proposal, however it seems SS made a point. It would be better to limit the proposal for CLI handling for gNB-to-gNB and UE-to-UE adjacent-channel interference. |
| InterDigital | Study on adjacent channel interference can be led by RAN4. |

**Summary of 2nd Round Discussion**

Based on the 2nd round discussion, we can summarize as below:

(1)

It is observed that most of company agree with the intention of the Updated FL Proposal #2-1 (1) for 2nd round discussion.

In addition, regarding SBFD, companies suggest removing the red colored text ([SBFD], Note: )

In this sense, FL recommends as below:

**Further updated FL Proposal #2-1 (1) from 2nd round discussion**

Following interference scenarios can be considered for study of dynamic/flexible TDD ~~[and SBFD]~~:

* gNB-to-gNB co-channel interference
* UE-to-UE co-channel interference
* ~~Note: For SBFD, this is limited to gNB-to-gNB intra-subband interference and UE-to-UE intra-subband interference~~

(2)

Regarding the adjacent-channel interference, FL recommends as below:

**FL recommendation from 2nd round discussion**

Continue to discuss whether following interference scenarios can be considered in RAN1 for study of dynamic/flexible TDD or not

* gNB-to-gNB adjacent-channel interference
* UE- to-UE adjacent-channel interference

### *3rd Round Discussion*

**(1) Co-channel Interference**

In GTW session (5/16 Mon.), following was agreed:

**Agreement**

At least, following interference scenarios can be considered for study of dynamic/flexible TDD:

* gNB-to-gNB inter-cell co-channel interference
* UE-to-UE inter-cell co-channel interference

**(2) Adjacent-channel Interference**

Remaining discussion topic is whether or not adjacent-channel interference can be considered in RAN1 for study of dynamic/flexible TDD. As companies mentioned this issue is under discussion in AI 9.3.1. Therefore, it seems better to defer this discussion until agreement whether evaluation is performed for the adjacent-channel interference scenario is made in AI 9.3.1.

FL recommendation#2-2

If evaluation for adjacent-channel interference scenario for study of dynamic/flexible TDD is agreed as RAN1 scope in AI 9.3.1, this discussion will be continued in AI 9.3.3.

**Companies are invited to provide views on the above recommendation.**

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| --- | --- |
| **Companies** | **Views** |
|  |  |

## CLI handling for dynamic/flexible TDD

### *Submitted proposal*

|  |  |
| --- | --- |
| **ZTE [2]** | ***Proposal 4****: RAN1 discusses how to coordinate on interference cancellation/management for subband full duplex (AI 9.3.2) and dynamic/flexible TDD (*AI 9.3.3*) to avoid duplicated discussion.* |
| **Spreadtrum Communications [5]** | ***Observation 3:*** *Interferences in dynamic/flexible TDD scenarios is a subset of that in SBFD scenarios, a unified CLI mechanism for dynamic/flexible TDD and SBFD can be studied.* |
| **vivo [7]** | *Error: Reference source not found* |
| **Samsung [10]** | ***Observation 5:*** *SBFD is a potential CLI mitigation solution for urban macro and micro TDD deployments* |
| **Ericsson [16]** | ***Observation 1:*** *Dynamic/flexible TDD is a special case of subband full duplex (SBFD) where the UL subband size (0% or 100%) is different within and between operators.*  ***Proposal 1:*** *To study in a targeted way whether or not enhancements of dynamic/flexible TDD are beneficial, define a phased study approach based on a deployment with two SBFD operators with different UL subband sizes. Each phase introduces increasing sources of difference first between and then within each operator's network. In the final phase, full dynamic TDD is studied, which is equivalent to dynamic adjustment of the UL subband size between 0% and 100% of the carrier bandwidth.* |
| **Lenovo [23]** | ***Proposal 4:*** *The CLI handling for dynamic/flexible TDD can be reused as much as possible for CLI handling for full duplex. On the other hand, specific schemes are needed to handle the more complex CLI in full duplex.* |
| **CEWiT [28]** | ***Proposal 1:*** *Consider solutions proposed for CLI management in flexible TDD as the starting point for CLI management in SBFD enabled networks.* |

### *Summary*

CLI handling method are discussed in two agenda items (*AI 9.3.2* and *AI 9.3.3*). Based on this understanding, it is proposed to discuss how to coordinate on interference cancellation/management for the subband non-overlapping full duplex and dynamic/flexible TDD to avoid duplicated discussion [2].

Also, it is proposed that the unified solution for mitigate the CLI should be strived for both the subband non-overlapping full duplex and dynamic TDD because interferences in dynamic/flexible TDD scenarios is a subset of that in the subband non-overlapping full duplex [5][7]. And it is proposed that the CLI handling for dynamic/flexible TDD can be reused as much as possible for CLI handling for the subband non-overlapping full duplex [23]. In addition, it is proposed to consider solutions proposed for CLI management in flexible TDD as the starting point for CLI management in the subband non-overlapping full duplex enabled networks [28].

In summary, it can be considered that CLI handling method discussed for dynamic/flexible TDD can be a starting point of discussion of CLI handling for the subband non-overlapping full duplex.

### *1st Round Discussion*

Initial FL Question #3-1

How to coordinate on discussion of CLI handling for in the subband non-overlapping full duplex in AI 9.3.2 and for dynamic/flexible TDD AI 9.3.3?

**Companies are invited to provide views on the above question.**

|  |  |
| --- | --- |
| **Companies** | **Views** |
| ZTE | As discussed online today, the intra-subband interference can be studied in this AI.  The self-interference and inter-subband interference can be studied in AI 9.3.2. |
| Sony | Solutions that are common to subband and dynamic/flexible TDD should be studied in the subband agenda AI 9.3.2. Solutions that are purely for dynamic/flexible TDD is studied in this agenda, i.e. AI 9.3.3. |
| vivo | Same question is also asked in [109-e-R18-Duplex-03] Question 5.1. We think the unified solution for mitigate the CLI should be strived for both SBFD and dynamic TDD. So either AI 9.3.2 or AI 9.3.3 can handle CLI mitigation schemes which are applicable for both SBFD and dynamic/flexible TDD as long as one AI handles it for efficiency. |
| CEWiT | Interference scenarios in dynamic TDD will also be present in SBFD, but interference scenarios like inter-subband CLI, intra-cell UE-to-UE CLI etc. will be specific to only SBFD. Hence, in our opinion, the CLI handling schemes applicable for dynamic TDD will also be applicable to SBFD. Therefore, CLI handling schemes applicable for both dynamic TDD and SBFD should be studied in 9.3.3 whereas, CLI handling schemes specific to SBFD should be studied in 9.3.2. |
| New H3C | CLI related to subband should be discussed in AI9.3.2. CLI related to only dynamic/flexible TDD should be handled in AI 9.3.3 |
| Spreadtrum | We can focus on intra-subband interference handling here, at the same time evaluate whether the solution of interference in AI 9.3.2 is suitable for dynamic/flexible TDD or not. |
| Panasonic | It might not be straightforward to categorize whether a CLI handling scheme is related to SBFD or dynamic/flexible TDD. Different companies might have different understanding. Therefore, it is better to discuss all CLI handling related issues in one AI, either 9.3.2 or 9.3.3.(but not in both AIs). |
| Huawei, HiSilicon | As discussed on the GTW, co-channel intra-subband CLI can be discussed in this AI, while co-channel inter-subband CLI should be discussed under AI 9.3.2. |
| Lenovo | Our preference is to pursue CLI handling methods that can be expanded from one application to the other and possibly be specified in a unified framework for SFBD and dynamic/flexible TDD |
| Nokia, NSB | Our preference is that the interference types common to dynamic TDD and subband non-overlapping full duplex are discussed under AI 9.3.3. Therefore, we propose the following:  Interference types discussed under the dynamic/flexible TDD AI:   * gNB-to-gNB inter-cell co-channel intra-subband CLI * UE-to-UE inter-cell co-channel intra-subband CLI   Interference types discussed under the subband non-overlapping full duplex AI:   * gNB self-interference * UE-to-UE intra-cell co-channel inter-subband CLI * UE-to-UE inter-cell co-channel inter-subband CLI   gNB-to-gNB inter-cell co-channel inter-subband CLI |
| CMCC | Similar question is discussed in AI 9.3.2, from our perspective, inter-subband CLI can be studied in AI 9.3.2 and intra-subband CLI and be studied in AI 9.3.3 |
| Intel | Our view is that   * Intra-subband cochannel CLI can be studied under dynamic/flexible TDD AI 9.3.3,   Inter-subband cochannel CLI can be studied under SBFD AI 9.3.2. |
| NEC | First of all, we should have as much commonality as possible when designing the CLI handing schemes for SBFD and dynamic/flexible TDD. We propose to have baseline discussion in dynamic/flexible TDD AI and in SFBD AI, only additional enhancements are discussed. |
| QC | Support to discuss common solutions in one sub-agenda, e.g. AI 9.3.3 to avoid duplication, as well as dynamic TDD specific solutions e.g. the intra-subband interference handling in AI 9.3.3. |
| Ericsson | Agree with view from Sony:   * Solutions that are common to subband and dynamic/flexible TDD should be studied in the subband agenda AI 9.3.2. * Solutions that are purely for dynamic/flexible TDD is studied in this agenda, i.e. AI 9.3.3.   In our view most (if not all) solutions will be common. |
| Apple | Common solutions can be discussed in one of 9.3.2 and 9.3.3 (former is slightly preferred). |
| OPPO | From CLI perspective, dynamic/flexible TDD can be considered as a special case of subband non-overlapping full duplex, especially for its dynamic mode. Then our preference is that, CLI handling for dynamic/flexible TDD and subband non-overlapping full duplex are jointly discussed in one agenda, preferably AI9.3.2, with R16 CLI as a starting point. |
| CATT1 | We can accept the suggestion from Sony . |
| Samsung | As we commented in Initial FL Proposal #2-1, UE-UE/gNB-gNB co-channel intra-subband interference can be discussed in AI9.3.3, while UE-UE/gNB-gNB co-channel inter-subband interference can be discussed in AI9.3.2. The identified schemes for CLI handling in AI9.3.2 and AI9.3.3 may or may not same. If the same CLI handling is identified, then we prefer to discuss the CLI handling in a single AI, as RAN1 discussions evolve. |
| NTT DOCOMO | We agree with FL summary, so that we can start with CLI discussion for dynamic/flexible TDD and it can be a starting point for the CLI for SBFD, since we may assume common solutions for inter-subband CLI (9.3.2) and intra-subband CLI (9.3.3) and would like to avoid overlapping discussion. |
| Sharp | Nokia’s formulation is preferred. |
| LG | Unified solution for CLI handling is preferred.  It is our understanding the dynamic/flexible TDD has very similar aspect with SBFD especially in terms of CLI. It is our understanding that is the reason why some of companies think the dynamic/flexible TDD as the special case of SBFD. In that sense, unified solution for SBFD and dynamic/flexible TDD should be considered to avoid duplicate discussion. |
| Xiaomi | We also share the view that intra-subband interference should be handled here while other interference should be handled in other agenda |
| WILUS | Agree with FL. SBFD-specific CLI handling (e.g., inter subband CLI) can be studied in AI 9.3.2, and CLI handling for other scenarios (e.g., intra subband CLI) can be studied in AI 9.3.3. |
| ITRI | Co-channel intra-subband interference can be studied in this AI.  Co-channel inter-subband interference can be studied in AI 9.3.2. |
| TCL | Support the FL proposal. In our view, CLI handling for SBFD and dynamic TDD should be studied separately. |
| MediaTek | To manage the load in each agenda item, for SBFD and dynamic/flexible TDD, inter-UE CLI can be discussed in 9.3.2 and inter-gNB CLI in 9.3.3 |

**Summary of 1st Round Discussion**

Based on the 1st round discussion, we can summarize as below:

■ Cross Link Interference Scenarios

The co-channel CLI scenario including intra-subband interference scenario can be considered under AI 9.3.3.

And, the self-interference scenario and inter-subband CLI scenario can be considered under AI 9.3.2.

ZTE, CEWiT, Spreadtrum, Huawei, HiSilicon, Nokia, NSB, CMCC, Intel, NEC, Qualcomm, Sharp, Xiaomi,

WILUS, ITRI

■ Study of Cross Link Interference Handling scheme

▶ Approach 1:

Solutions that are common to subband and dynamic/flexible TDD should be studied in the subband agenda AI 9.3.2. Solutions that are purely for dynamic/flexible TDD is studied in this agenda, i.e. AI 9.3.3.

Sony, Ericsson, Apple (slightly preferred), OPPO (preferably AI9.3.2), CATT

▶ Approach 2:

Common solutions in one sub-agenda, e.g. AI 9.3.3

vivo, CEWiT, Lenovo, WILUS

NEC (baseline discussion in dynamic/flexible TDD AI, only additional enhancements are discussed in SFBD AI)

Qualcomm (common solutions in one sub-agenda, e.g. AI 9.3.3 to avoid duplication, as well as dynamic TDD specific solutions e.g. the intra-subband interference handling in AI 9.3.3.)

NTT DOCOMO (can start with CLI discussion for dynamic/flexible TDD and it can be a starting point for the CLI for SBFD)

▶ Better to discuss all CLI handling related issues in one AI, either 9.3.2 or 9.3.3.

Panasonic, Samsung, LG Electronics

Issues for this discussion can be categorized two points (i.e., Cross Link Interference Scenarios, and Study of Cross Link Interference Handling scheme)

Regarding the CLI scenarios, companies are supportive position regarding following approach:

* The co-channel CLI scenario including intra-subband interference scenario can be considered under AI 9.3.3.
* And, the self-interference scenario and inter-subband CLI scenario can be considered under AI 9.3.2.

Hence, we can make a proposal for agreement as Initial FL Proposal #3-1.

Regarding study of CLI handling scheme, two approaches can be identified:

* Approach 1:
  + Common solutions for SBFD and dynamic/flexible TDD should be studied under AI 9.3.2.
  + Solutions that are purely for dynamic/flexible TDD is studied under AI 9.3.3.
* Approach 2:
  + Common solutions in one sub-agenda, e.g. AI 9.3.3

But, so far, it is hard to decide one approach among two candidate because companies understating seems different, and the understanding regarding common solution is not clear. So, it needs to be discussed which solution can be commonly applied for both SBFD and dynamic/flexible TDD (e.g., L1/L2 based measurement and reporting, beam based CLI handling, power control, etc.), which specific solution should be studied for each duplex scheme (e.g., subband wise measurement for SBFD, SRS-RSRP measurement for intra-subband CLI scenarios, etc.). In summary, it seems better to make understanding more clear, then to select one approach which is more reasonable. In this sense, we provide single question to ask companies understanding regarding CLI handling solution which can be applicable for both SBFD and dynamic/flexible TDD, and duplex scheme specific CLI handling solution.

**Initial FL Proposal #3-1 for 2nd round discussion**

The co-channel CLI scenario interference scenario can be considered under AI 9.3.3.

* gNB-to-gNB inter-cell co-channel CLI (including intra-subband)
* UE-to-UE inter-cell co-channel CLI (including intra-subband)

The self-interference scenario and inter-subband CLI scenario can be considered under AI 9.3.2.

* gNB self-interference
* UE-to-UE intra-cell co-channel inter-subband CLI
* UE-to-UE inter-cell co-channel inter-subband CLI

**Initial FL Question #3-2 for 2nd round discussion**

Companies are encouraged to provide companies understanding regarding following two sub-bullets:

* CLI handling solution which can be applicable for both SBFD and dynamic/flexible TDD,
* Duplex scheme specific CLI handling solution for each duplex scheme.

### *2nd Round Discussion*

Initial FL Proposal #3-1 for 2nd round discussion

The co-channel CLI scenario interference scenario can be considered under AI 9.3.3.

* gNB-to-gNB inter-cell co-channel CLI (including intra-subband)
* UE-to-UE inter-cell co-channel CLI (including intra-subband)

The self-interference scenario and inter-subband CLI scenario can be considered under AI 9.3.2.

* gNB self-interference
* UE-to-UE intra-cell co-channel inter-subband CLI
* UE-to-UE inter-cell co-channel inter-subband CLI

**Companies are invited to provide views on the above proposal.**

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|  | **Company** |
| **Support** | NEC, Intel, QC, TCL, Samsung, CEWiT, ITRI, New H3C, DOCOMO, Xiaomi (remove the second bullet), vivo, Lenovo, Spreadtrum, Nokia, NSB (with an additional bullet for 9.3.2), Panasonic, LG, IDC |
| **Not support** | Sony, Ericsson |

|  |  |
| --- | --- |
| **Company** | **Views** |
| Sony | When we have subband configured, there will bound to be inter-subband interference in addition to intra-subband interference.  That is, if we were to run a simulation with subbands, the simulator would include *inter-subband and intra-subband interferences*. Wouldn’t it be easier to discuss these interferences under AI 9.3.2 as part of a discussion for inter-subband interferences (or subband interferences in general)? It seems like extra work to try to extract only inter-subband results out for T-doc discussion in AI 9.3.2 discussion and intra-subband results for T-doc discussion in AI 9.3.3.  Hence, we prefer that all subband interferences (including intra-subband) are studied in AI 9.3.2 (to avoid double work). |
| Intel | As mentioned above, our understanding is that the potential solutions for CLI handling as mentioned by companies can be commonly applied for both intra-subband cochannel interference for SBFD and cochannel interference for dynamic/flexible TDD. In this case, it is more appropriate to study/evaluate the potential solutions in AI 9.3.3 in order to avoid duplicated work.  It may be good to consider this as a conclusion, rather than a proposal. |
| QC | We can follow suggestion from Skeleton where AI 9.3.3 captures the potential inter-gNB and inter-UE CLI handling schemes that are specific for dynamic TDD and schemes that are common for both SBFD and dynamic/flexible TDD.  AI 9.3.2 captures the potential inter-gNB and inter-UE CLI handling schemes that are specific for SBFD. |
| Samsung | Inter-gNB inter-subband interference should be studied in AI 9.3.2. |
| Apple | There seems some overlap between this proposal and P2-1 (probably 2-1). Under this proposal, source of CLI interference should be clarified (dynamic TDD vs SBFD). |
| ZTE | Generally, we are ok with this separation. |
| New H3C | The separation is OK, then the second item should be moved to AI 9.3.2. |
| Xiaomi | No need to have the second bullet |
| CATT | Ok with this plan. |
| Ericsson | Agree with QC; we can follow the structure of the TR skeleton:   * SBFD-specific gNB-gNB and UE-UE CLI mitigation schemes: 9.3.2 * gNB-gNB and UE-UE CLI mitigation schemes common to SBFD/dTDD: 9.3.3 |
| Huawei, HiSilicon | We are fine with the proposal. Inter-subband inter-gNB and Inter-UE CLI and gNB self-interference are specific interference in SBFD, and the handling schemes should be studied in AI 9.3.2. |
| Spreadtrum | We are generally fine with this proposal. However, we think scenarios here should be consistent with the interference scenarios mentioned in Updated FL Proposal #2-1. If co-channel CLI (including intra-subband) is included here, SBFD should be included in the interference scenarios in Updated FL Proposal #2-1. |
| CMCC | We are generally fine with this proposal |
| Nokia, NSB | Agree with the suggested split. However, the gNB-to-gNB inter-cell co-channel inter-subband CLI should be also mentioned to be studied as part of AI 9.3.2. Thus, the proposal should be:  The co-channel CLI scenario interference scenario can be considered under AI 9.3.3.   * gNB-to-gNB inter-cell co-channel CLI (including intra-subband) * UE-to-UE inter-cell co-channel CLI (including intra-subband)   The self-interference scenario and inter-subband CLI scenario can be considered under AI 9.3.2.   * gNB self-interference * UE-to-UE intra-cell co-channel inter-subband CLI * UE-to-UE inter-cell co-channel inter-subband CLI * gNB-to-gNB inter-cell co-channel inter-subband CLI |
| Panasonic | We are fine with the proposal. |
| MediaTek | Sub-band related aspects can be studied in 9.3.2. |
| LG | Support the proposal and we also think conclusion would be proper. |

Initial FL Question #3-2 for 2nd round discussion

Companies are encouraged to provide companies understanding regarding following two sub-bullets:

* CLI handling solution which can be applicable for both SBFD and dynamic/flexible TDD,
* Duplex scheme specific CLI handling solution for each duplex scheme.

**Companies are invited to provide views on the above proposal.**

|  |  |
| --- | --- |
| **Company** | **Views** |
| NEC | Based on FL’s comment, duplex schemes may refer to different measurement of CLI in our understanding. If this is the case, we propose the following modifications.   * ~~Duplex scheme s~~Specific CLI measurement and CLI handling solution ~~for each duplex scheme~~.   From our understanding most of the CLI handling schemes (like L1/L2 based CLI measurement and reporting solution, beamforming enhancements, sensing based solutions) have commonality between SBFD and dynamic and hence can be studied under AI 9.3.3  While, SBFD specific CLI measurement/handling enhancements can involve CLI resource configuration aspects, gNB procedures for self-interference mitigation, etc.  However, the number and range of such solutions can be significant and we don’t think it would be feasible to make a decision at this stage on how to segregate the solutions. It would be preferable to agree on guidelines for classifying solutions between AI 9.3.2 and AI 9.3.3 and allow the companies to decide how to classify their solutions for the next meeting. |
| Sony | We do share similar views with NEC that there are likely going to be a big list of potential enhancements. Is the intention here list them all out and decide which ones go to AI 9.3.2 and AI 9.3.3? I would thought it would be easier if the companies decide these themselves and submit the T-doc accordingly after the guidelines are clear. |
| Intel | This depends on interference characteristic. In our view   * For intra-subband cochannel interference for SBFD and cochannel interference for dynamic TDD, CLI handling solution which can be applicable for both SBFD and dynamic/flexible TDD. * For inter-subband cochannel interference for SBFD, it can be applicable for SBFD only. |
| QC | We can follow suggestion from Skeleton where AI 9.3.3 captures the potential inter-gNB and inter-UE CLI handling schemes that are specific for dynamic TDD and schemes that are common for both SBFD and dynamic/flexible TDD.  AI 9.3.2 captures the potential inter-gNB and inter-UE CLI handling schemes that are specific for SBFD. |
| TCL | We share similar views with Intel |
| Samsung | It makes most sense to us that any CLI measurement (incl. the L1-based solutions) and mitigation scheme which is motivated by d-/f-TDD, e.g., can be used without SBFD, is discussed under AI 9.3.3. If such a scheme can also be useful and/or provide gains in the context of SBFD, e.g., common, then we can capture this in AI 9.3.3 as well. For any inter-gNB or inter-UE CLI measurement and mitigation scheme motivated by SBFD, e.g., not meaningful in the context of d-/f-TDD, that should be discussed under AI 9.3.2. |
| CEWiT | Any intra sub-band CLI can be discussed under AI 9.3.3. Inter sub-band CLI and self-interference related schemes can be discussed under 9.3.2. |
| ZTE | It may be too early to discuss whether solutions can be applied to duplex or dynamic TDD before knowing the detailed solutions. |
| NTT DOCOMO | We shar similar views with Qualcomm. And we may/will have a list of candidate solutions, and we may discuss which one is for common/duplex scheme specific solutions for the next meetings. |
| Xiaomi | We don’t know what is the “Duplex scheme specific CLI handling solution” means. We basically have the feeling that intra-subband CLI should be handled here which is unified for dynamic TDD and SBFD, while inter-subband CLI and self-interference handling should be for SBFD specifically. |
| CATT | We should prioritize the discussion of CLI handling solution which can be applicable for both SBFD and dynamic/flexible TDD |
| vivo | Similar view as Intel, for same interference scenarios, common solution is preferred. For SBFD specific interference scenarios, e.g., inter-band interference and self-interference, CLI handling solution may be applicable for SBFD only. |
| Ericsson | Agree with QC; we can follow the structure of the TR skeleton:   * SBFD-specific gNB-gNB and UE-UE CLI mitigation schemes: 9.3.2 * gNB-gNB and UE-UE CLI mitigation schemes common to SBFD/dTDD: 9.3.3 |
| Huawei, HiSilicon | We share the similar view with Intel and suggest to clarify this since duplex scheme specific CLI handling is a bit unclear. |
| Spreadtrum | We agree with Intel and QC. |
| CMCC | It is better to follow the structure of the TR skeleton |
| Nokia, NSB | Based on our reply above and the proposed TR skeleton, our view is that CLI handling solutions that apply for both dynamic TDD and SBFD should be considered under AI 9.3.3. Specific CLI handling solutions for SBFD (inter-subband CLI related) should be considered in AI 9.3.2 |
| LG | Our preference is the first sub-bullet, i.e., unified CLI handling mechanism, however it should be carefully considered to prevent duplication of discussion, which is the complicated part that in which AI we should discuss CLI handling. For the second sub-bullet, it seems rather limiting the CLI handling mechanism considering similar part of SBFD and dynamic/flexible TDD, which also may lead duplication. It seems only matter of decision rather than the technical problem, we are open to discuss. |

**Summary of 2nd Round Discussion**

Based on the 2nd round discussion, we can summarize as below:

(1)

It is observed that most of company agree with the intention of Initial FL Proposal #3-1 for 2nd round discussion.

In addition, ‘Further updated FL Proposal #2-1 (1) from 2nd round discussion’ is identical with first part of Initial Proposal #3-1 for 2nd round discussion. It seems better to avoid making duplicated proposal.

In this sense, FL recommends as below:

Updated Initial FL Conclusion #3-1 from 2nd round discussion

The self-interference scenario and inter-subband CLI scenario can be considered under AI 9.3.2.

* gNB self-interference
* UE-to-UE intra-cell co-channel inter-subband CLI
* UE-to-UE inter-cell co-channel inter-subband CLI

(2)

Initial FL Conclusion #3-2 from 2nd round discussion

* For discussion under AI 9.3.3, suggestions from Skeleton are followed.
* Note: AI 9.3.3 captures the potential inter-gNB and inter-UE CLI handling schemes that are specific for dynamic TDD and schemes that are common for both SBFD and dynamic/flexible TDD.
* Note: AI 9.3.2 captures the potential inter-gNB and inter-UE CLI handling schemes that are specific for SBFD.
* A list of candidate solutions for CLI handling for potential enhancement on dynamic/flexible TDD is identified in RAN1#109-e meeting, then discussion to identify which scheme is for common or duplex scheme specific solutions will be started from RAN1#110 meeting.

### *3rd Round Discussion*

Initial FL Conclusion #3-1 from 2nd round discussion

The self-interference scenario and inter-subband CLI scenario ~~can be considered under AI 9.3.2.~~ are not considered under AI 9.3.3 (Potential enhancements on dynamic/flexible TDD).

* gNB self-interference
* UE-to-UE intra-cell co-channel inter-subband CLI
* UE-to-UE inter-cell co-channel inter-subband CLI

**Companies are invited to provide views on the above conclusion.**

|  |  |
| --- | --- |
|  | **Company** |
| **Support** |  |
| **Not support** |  |

|  |  |
| --- | --- |
| **Company** | **Views** |
|  |  |

How to distinguish CLI handling schemes for dynamic/flexible TDD and SBFD

In GTW session (5/16 Mon.), following guideline for future meeting was made:

**Guideline for future meetings**

* Note: AI 9.3.3 handles the potential inter-gNB and inter-UE CLI handling schemes that are specific for dynamic TDD and schemes that are common for both SBFD and dynamic/flexible TDD.
* Note: AI 9.3.2 handles the potential inter-gNB and inter-UE CLI handling schemes that are specific for SBFD.

According to the Guideline for future meeting, **FL recommends for companies to provide observation or statement whether or not proposed CLI handling scheme can be commonly applied for both SBFD and dynamic/flexible TDD when CLI handling schemes are proposed.**

**Companies are invited to provide views on the above recommendation.**

|  |  |
| --- | --- |
| **Company** | **Views** |
|  |  |

## Inter-cell gNB-to-gNB CLI

### *Submitted proposal*

|  |  |
| --- | --- |
| **Huawei, HiSilicon [1]** | ***Observation 1:*** *IRC receiver is essential to suppress the cross link interference while minimizing the impact on the downlink performance of the Macro cells.*  ***Proposal 1:*** *Potential enhancements on the interference covariance matrix estimation for the IRC receiver should be studied in Rel-18 dynamic/flexible TDD enhancement.*  ***Proposal 2:*** *Study the feasibility and performance of advanced IRC receivers based on muting resources for interference covariance matrix estimation considering different interference characteristics.*  ***Proposal 3:*** *Study the feasibility and performance of Tx beamforming based on gNB-to-gNB interference channel estimation.* |
| **ZTE [2]** | ***Proposal 5****: Take the Rel-16 UE-UE CLI and RIM as a starting point for Rel-18 enhancements on dynamic/flexible TDD.*  ***Proposal 6****: Rel-16 RIM Framework-1 can be considered as baseline for gNB-gNB interference management for Rel-18 dynamic/flexible TDD.*  ***Proposal 7****: The existing DL RS (e.g., SSB, CSI-RS) can be reused as measurement RS for gNB-gNB CLI for Rel-18 dynamic/flexible TDD.*   * *FFS: determination of receiving timing of the victim.*   ***Proposal 8****: UL rate matching/cancellation mechanism can be defined for more accurate gNB-gNB measurement.* |
| **Spreadtrum Communications [5]** | ***Observation 1:*** *Enhancements on dynamic/flexible TDD can focus on inter-gNB CLI mitigation with high priority and further signaling design, to better support this existing feature to be implemented.*  ***Proposal1:*** *Focus on the following aspects of dynamic/flexible TDD enhancement*   * *CLI analysis* * *CLI handling (gNB/UE)*   ***Proposal2:*** *gNB-to-gNB CLI management should be firstly studied and UE-to-UE CLI measurement/reporting can also be enhanced.* |
| **CATT [6]** | ***Proposal 2:*** *TRP-to-TRP CLI handling is prioritized for Rel-18 duplex enhancement.*  ***Proposal 3:*** *Prioritize TRP-to-TRP CLI handling scheme which are applicable to both subband non-overlapping full duplex and dynamic/flexible TDD.*  ***Proposal 4:*** *Deprioritize advanced receiver based interference cancellation solution in CLI handling study.*  ***Proposal 5:*** *Consider power based interference measurement at gNB side in Rel-18.* |
| **xiaomi [9]** | ***Proposal 2:*** *The Rel-18 study on dynamic/flexible TDD should focus on the following aspects:*   * *Inter-gNB CLI* * *Further enhancement on the inter-UE CLI*   ***Proposal 4:*** *Network listening based interference measurement can be further studied.*  ***Proposal 5:*** *The candidate solutions for CLI handling studied in Rel-14 duplex can be the baseline for further investigation in Rel-18.* |
| **Samsung [10]** | ***Observation 1:*** *gNB-to-gNB interference dominates co- and adjacent channel CLI in TDD urban macro deployments*  ***Observation 4:*** *TDD base stations can measure DL signals received from neighbor cells of the same or different operator using implementation techniques*  ***Observation 7:*** *The existing R16 RIM-RS type 1 or 2 are not suitable for purpose of intra-operator gNB-to-gNB (DL-to-UL) CLI measurements in NR mid-band small deployments*  ***Proposal 1:*** *RAN1 to study and evaluate the benefits of a new DL reference signal design to support intra-operator gNB-to-gNB (DL-to-UL) CLI measurements*  ***Proposal 2:*** *RAN1 to study and evaluate the benefits of providing desired/prohibited beam indications using Xn-AP to support intra-operator gNB-to-gNB (DL-to-UL) CLI mitigation* |
| **SHARP Corporation [13]** | ***Proposal 1:*** *RAN1 further study how to handle TRP-to-TRP/UE-to-UE intra-cell intra-subband CLI under dynamic/flexible TDD.*  ***Proposal 2:*** *RAN1 further study how to handle gNB-to-gNB/UE-to-UE inter-cell intra-subband CLI under dynamic/flexible TDD.* |
| **CMCC [18]** | ***Proposal 2:*** *For inter-gNB CLI handling, the following aspects can be further studied:*   * *How to handle the timing misalignment between the received UL transmission of target UE and the CLI interference from aggressor gNB? e.g., set via information n-TimingAdvanceOffset.* * *To enable advanced beamforming algorithms to suppress the gNB-gNB CLI, how to measure the effective channel () between aggressor gNB and victim gNB?*   + *Potential resources muting schemes in UL transmission or more accurate gNB-gNB CLI measurement.* * *Inter-gNB coordination in time-domain, frequency-domain, spatial-domain, and power domain.*   + *Backhaul signalling enhancement to support inter-vendor cooperation.* |
| **Nokia, Nokia Shanghai Bell [20]** | ***Proposal 3:*** *For studying inter-cell CLI for traditional TDD, we suggest focusing on gNB-to-gNB CLI mitigation. This is motivated by the higher gNB transmit powers and antenna gains as compared to that of UEs.*  ***Observation 5:*** *The UL performance of the small cells with dynamic TDD is severely impacted by the strong gNB-to-gNB CLI from the macro layer with DL-heavy TDD configuration. At least 20 dB UL SINR improvement is needed to achieve decent UL performance in slots with gNB-to-gNB CLI.*  ***Observation 6:*** *The victim gNB is heavily impacted by the strongest CLI aggressor cell (normally the closest macro gNB), while the other aggressor cells provides much weaker CLI contributions. Enhancements to mitigate the CLI from the strongest aggressor cell are therefore sufficient to achieve good performance benefits.*  ***Proposal 4:*** *Enhanced gNB receivers should be considered as a possible solution for CLI mitigation, potentially assisted through information exchange of the CLI aggressor characteristics over the Xn interface (or the F1 interface in case of gNB-split architectures). Detailed solution is FFS.*  ***Proposal 5:*** *The potential benefits of boosting the UE Tx power in slots that are subject to high CLI should be further investigated as a potential method to boost UL received SINR at the victim cell. Detailed solution is FFS.*  ***Proposal 6:*** *The potential benefits of reducing the Tx power of the aggressor cell to reduce the CLI impact on the victim cell should be further studied, including potential coordination mechanisms between aggressor and victim cells (e.g. via the Xn or F1 interface) to orchestrate this. Detailed solution is FFS.* |
| **Lenovo [23]** | ***Proposal 3:*** *Consider using dedicated resources for inter-gNB CLI measurement as one potential area for inter-gNB CLI mitigation in dynamic/flexible TDD.* |
| **LG Electronics [24]** | **BS-to-BS CLI handling methods**  ***Proposal 2:*** *BS-to-BS CLI handling in Rel-14 NR SI and evaluation results of UE-to-UE CLI handling in Rel-16 should be a starting point of discussion for CLI handling.*  ***Proposal 3:*** *If necessary, discuss how to enable measurement for BS-to-BS CLI handing.* |
| **MediaTek Inc. [27]** | ***Observation 1:*** *Advanced receivers at the gNB can help to address the inter-gNB CLI but they require the exchange of interference parameters between gNBs.*  ***Observation 2:*** *Proactive mitigation schemes at the gNB can help to avoid the inter-gNB CLI but they require the exchange of coordination information between gNBs.*  ***Observation 3:*** *Proactive mitigation schemes may be more feasible for same operator scenario due to the need for coordination between gNBs.*  ***Observation 4:*** *Power control at the gNB may have a negative impact on DL performance.*  ***Observation 5:*** *Analog beam coordination between gNBs can be the most practical approach for inter-gNB CLI handling.*  ***Observation 6:*** *Measurement of inter-gNB CLI in NR duplex operation can be based on existing RSs, such as CSI-RS.*  ***Proposal 1:*** *Advanced receiver-based interference mitigation schemes could be considered in RAN1 to address the inter-gNB CLI.*  ***Proposal 2:*** *Proactive-based interference mitigation schemes such as DL power control and analog beamforming could be considered in RAN1 for same operator inter-gNB CLI handling.* |
| **Intel Corporation [29]** | ***Observation 1***  *• For inter-operator dynamic TDD operation, gNB-to-gNB CLI may be more pronounced due to asynchronous network.*  ***Observation 2***  *• Additional UE-to-UE and gNB-to-gNB CLI can be observed in case of NOFD with TDD operation.*  ***Proposal 1***  *• RAN1 to further study the potential benefit and specification impact for gNB-to-gNB CLI mitigation.* |
| **Qualcomm Incorporated [30]** | ***Observation 4:*** *SBHD can enable dynamic TDD and mitigate the impact of inter-gNB CLI.*  ***Observation 8:*** *In FR2, Dynamic TDD with misaligned slots format is possible where CLI could be mitigated with proper beam-pair selection and lower Tx power.*  ***Observation 12:*** *In Rel-16 RIM framework, this no support for beam-based interference detection and mitigation which may be needed for reducing inter-gNB CLI in dynamic/flexible TDD.*  ***Observation 13:*** *Rel-16 RIM-RS is used for conveying information about presence of ducting phenomenon and sufficiency of the applied interference mitigation. It was not intended for enabling inter-gNB CLI channel measurement.*  ***Proposal 6:*** *Support of inter-gNB coordination schemes for inter-gNB CLI mitigation in dynamic/flexible TDD to identify compatible inter-gNB beam pairs, which is enabled by inter-gNB CLI measurement and reporting per candidate DL/UL beam pair.*  ***Proposal 7:*** *Support of inter-gNB CLI channel measurement and reporting to neighbouring gNBs for enabling Tx/Rx beamforming or nulling.* |
| **NEC [11]** | ***Proposal 2:***  *■ For gNB-to-gNB CLI measurement,*  *- The measurement matric should be defined first, such as CLI sensitivity level.*  *- Study the resource configuration and RS sequence properties for IM resources to optimally handle TRP-TRP interference measurement.*  ***Proposal 3:***  *■ Following points need to be studied further for gNB-gNB interference mitigation using inter-gNB signaling*  *- CLI RS configuration needs to be implicitly or explicitly shared between gNBs for interference measurement*  *- Information exchange should allow victim gNB to identify the aggressor gNBs/TRPs identity from CLI RS measurement*  *- Assistance information sharing between gNBs to mitigate the interference observed by the victim gNB*  ***Proposal 4:***  *■ Unified design for CLI RS for gNB-to-gNB and UE-to-UE measurement should be considered to reduce the RS overhead.*  ***Proposal 5:***  *■ Sensing based scheme can be studied to avoid the CLI.*  ***Proposal 6:***  *■ Mechanisms to progressively mitigate interference based on measurement or report of measurement results should be studied.* |
| **NTT DOCOMO, INC. [19]** | ***Proposal 2:*** *Study on how much PSD difference is expected at gNB for FR1 and FR2, and if the difference is critical for the duplex operation, CLI handling at gNB is considered.* |

### *Summary*

In Rel-14 SI, gNB-to-gNB CLI handling scheme were studied. Followings are list of gNB-to-gNB CLI handling method studied in Rel-14 SI.

* List of Rel-14 NR SI:
  + - Advanced receiver (IC/IS), hybrid dynamic/static UL/DL resource assignment, scheduling coordination, beam coordination, link adaptation, power control, sensing, cell/TRP clustering, co-channel multiple connectivity, dynamic TDD type definition, load/link-based resource/scheduling adaptation

In Rel-16 CLI handling and RIM WI, gNB-to-gNB CLI handling was not specified and it was left up to network implementation. In Rel-18 Duplex Evolution SI, it is proposed to study gNB-to-gNB CLI handling, and the study with higher priority than enhancement of UE-to-UE CLI handling. Also, companies propose that gNB-to-gNB CLI handling in Rel-14 SI should be a starting point/baseline of discussion [1][2][6][9][24].

Several kinds of gNB-to-gNB CLI handling method such as gNB-to-gNB CLI measurement, Tx beamforming, Power control, Timing Alignment, Backhaul signaling enhancement, Advanced receiver, RIM are proposed as below:

* gNB-to-gNB CLI measurement
  + - The existing DL RS (e.g., SSB, CSI-RS) can be reused as measurement RS for gNB-to-gNB CLI [2]
    - UL rate matching/cancellation mechanism for more accurate gNB-to-gNB measurement [2]
    - Network listening based interference measurement [9]
    - New DL reference signal design to support intra-operator gNB-to-gNB CLI measurement [10]
    - Measure the effective channel between aggressor gNB and victim gNB [18]
    - Dedicated resources for inter-gNB CLI measurement [23]
    - How to enable measure for gNB-to-gNB CLI handling [24]
    - The measurement matric should be defined, such as CLI sensitivity level [11]
    - Resource configuration and RS sequence properties for IM resources to optimally handle TRP-TRP interference measurement [11]
    - Unified design for CLI RS for gNB-to-gNB and UE-to-UE measurement [11]
    - Sensing based scheme to avoid the CLI [11]
* Tx beamforming
  + - Feasibility and performance of Tx beamforming based on gNB-to-gNB interference channel estimation [1]
    - desired/prohibited beam indication using Xn-AP to support intra-operator gNB-to-gNB CLI mitigation [10]
    - advanced beamforming algorithm to suppress the gNB-to-gNB CLI [10]
    - Analog beamforming [27]
    - inter-gNB beam pairs [30]
* Power control
  + - Boosting the UE Tx power in slot that are subject to high CLI [20]
    - Reducing the Tx power of the aggressor cell to reduce the CLI impact on the victim cell [20]
    - DL power control [27]
    - low Tx power [30]
* Timing alignment
  + - Timing misalignment between the received UL transmsision of target UE and CLI interference from aggressor gNB [18]
* Backhaul signaling enhancement
  + - Inter-gNB coordination in time-domain, frequency domain, spatial-domain and power domain [18]
    - Potentially assisted through information exchange of the CLI aggressor characteristics over the Xn interface [20]
    - Inter-gNB CLI measurement and reporting to neighbouring gNBs [30]
    - CLI RS configuration implicitly or explicitly shared between gNBs for interference measurement [11]
* Advanced Receiver
  + - Advanced IRC receivers and muting resource for interference covariance matrix estimation [1]
    - Enhanced gNB receiver should be considered as a possible solution for CLI mitigation [20]
    - Advanced receiver-based interference mitigation scheme [27]
    - Deprioritize advanced receiver based interference cancellation solution [6]
* RIM
  + - Rel-16 RIM Framework-1 as baseline for gNB-to-gNB interference management [2]
    - R16 RIM-RS type 1 or 2 are not suitable for purpose of intra-operator gNB-to-gNB CLI measurement [10]

In order to avoid repeated discussion, it needs to make clear which issues can be discussed in Rel-18 Duplex Evolution SI, and it needs to be identified which methods addressed in Rel-14 SI can be re-open for discussion in Rel-18.

In addition, in order to avoid duplicate discussion of gNB-to-gNB CLI handling in both AI 9.3.2 and AI 9.3.3, it need to be identified which schemes should be studied for potential enhancement on dynamic/flexible TDD.

### *1st Round Discussion*

Initial FL Proposal #4-1

For study of potential enhancement on dynamic/flexible TDD, enhancement of gNB-to-gNB CLI handling is considered.

* At least gNB-to-gNB CLI measurement and Tx beamforming are studied.
* FFS: Power control, Advanced Receiver, RIM based solution

**Companies are invited to provide views on the above proposal. Also, companies are encouraged to provide views which schemes should be studied for dynamic/flexible TDD in agenda item 9.3.3.**

|  |  |
| --- | --- |
| **Companies** | **Views** |
| ZTE | At this stage, it is better if we can list all the possible directions and have some initial discussion on them first before precluding them. Companies are encouraged to provide more details. |
| Sony | We share similar view with ZTE. It would be good to at least have a 1st discussion no all the schemes listed above and then decide on a subset of them for Rel-18 Duplex Evo SI. |
| vivo | We think power control based solution should be straightforward, no need to have FFS on it. |
| CEWiT | We agree with the proposal.  We feel that Rel. 16 RIM based solution can be considered for measurement and reporting since the framework is already in place and only enhancements will be required to fit it in this scenario. |
| New H3C | We have the same view with ZTE. At this time, we need collect all of possible research directions. |
| Spreadtrum | Support FL’s proposal. And we also think the enhancement on information exchange between gNBs should be taken into account. |
| Panasonic | Same view as ZTE. |
| Huawei, HiSilicon | We share similar view with ZTE. There is no need to do prioritization among technical solutions at the moment. Companies can propose different solutions and the potential benefit and specification impact for each solution can be further studied. From our point of view, at least the Advanced Receiver, and Tx beamforming should be studied. |
| Lenovo | We are fine with the proposal. |
| Nokia, NSB | We prefer to not preclude any of the potential enhancements at this early stage of the SI. We support that the study should at least consider power control schemes, coordinated scheduling & Tx beamforming and advance receivers. This includes as well means to perform gNB-to-gNB CLI measurements and the required enhacenments on the backhaul signaling. |
| CMCC | Similar view as ZTE |
| InterDigital | Support the FL proposal in principle. But, we are also open to discuss some solutions first, before having prioritization. |
| Intel | We are generally fine with the proposal. We tend to agree with other companies that it is generally more inclusive during SI phase.  We suggest the following update  For study of potential enhancement on dynamic/flexible TDD, enhancement of gNB-to-gNB CLI handling is considered.   * At least gNB-to-gNB CLI measurement and reporting, and Tx/Rx beamforming are studied. * FFS: Power control, Advanced Receiver, RIM based solution |
| NEC | In SI stage, we could be open to discuss different schemes. In addition, power control might not be a precise term in the case where gNB adjusts its Tx power, maybe we can use power adjustment instead. |
| QC | At this stage, we believe all solutions for inter-gNB CLI handling suggested by companies should be listed for further study. The proposal should open to all the enhancements:  For study of potential enhancement on dynamic/flexible TDD, enhancement of gNB-to-gNB CLI handling is considered.   * gNB-to-gNB CLI measurement and Tx/Rx beamforming, DL/UL beam pair for FR2, separated UL/DL subband.   Power control, Timing alignment, Backhaul signaling, Advanced Receiver, RIM based solution.  Note: any other scheme for inter-gNB CLI handling shall not be excluded. |
| Ericsson | We are supportive of the direction of the FL proposal to try to narrow the scope to avoid repetition of discussion from Rel-15/16. The SID is quite clear on this:  *Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.*  We share the view from some companies that gNB-gNB CLI mitigation approaches for SBFD and dynamic/flexible TDD should be common, but the proposal only mentions dynamic/flexible TDD.  Also "Tx beamforming" seems a bit vague. Isn't this something that gNBs would do purely by implementation?  We think "Advanced receiver" should be clarified. Advanced compared to what? |
| OPPO | Support the proposal. |
| CATT1 | We support gNB-to-gNB CLI measurement, further clarification regarding tx beamforming is needed about what exact this means. |
| Samsung | No need for main bullet, which is clearly stated in SID objective “Study inter-gNB and inter-UE CLI handling and identify solutions to manage them (RAN1)”  For the first sub-bullet, Tx beamforming is too wide and more details should be added. Tx beamforming based gNB-gNB CLI handling can be classified into the following two categories. It needs to clarify which one is intended in the proposal;   * *Tx beamforming without beam information exchange across gNB’s interface*. In this category, RAN1 needs to study 1) how to configure the resource to measure gNB-gNB CLI, 2) how to block UL transmission on the measurement resource, 3) how to set receive beamforming to measure gNB-gNB CLI, etc. * *Tx beamforming with beam information exchange across gNB’s interface*. In this category, RAN1 needs to study what kind of beam information is exchanged across gNB. For example, beam disabling information for aggressor gNB.   Overall, we are not certain that it helps us to make progress if we try to narrow down a list of potential enhancements in this meeting. For example, there is no need to single out gNB-to-gNB CLI measurements as potential enhancement for d/f-TDD and leave out other potential enhancements as FFS. This appears arbitrary. It should be left to company proposals to identify and show performance of promising techniques before attempting to reach a RAN1 agreement which ones are to be further considered. |
| NTT DOCOMO | We are fine with the proposal, and we also fine to wait the outcome of evaluation to decide whether gNB-to-gNB CLI is necessary or not. |
| Sharp | We have similar view with ZTE although we are fine with the proposal. |
| LG | According to summary, it is our understanding that the intention of the proposal is to re-open some of the methods addressed in Rel-14 SI. If it is correct understanding, we think the list of Rel-14 SI should be given for the proposal. Therefore we would like to add one option to QC’s version as follows:  For study of potential enhancement on dynamic/flexible TDD, enhancement of gNB-to-gNB CLI handling is considered.   * gNB-to-gNB CLI measurement and Tx/Rx beamforming, DL/UL beam pair for FR2, separated UL/DL subband, sensing.   Power control, Timing alignment, Backhaul signaling, Advanced Receiver, RIM based solution.  Note: any other scheme for inter-gNB CLI handling shall not be excluded.  Last but not least, issues can be raised up again however duplication of discussion in Rel-14 CLI should be avoided, as Ericson pointed out. |
| Xiaomi | Maybe a bit early to discuss this. The first step should be performing evaluation especially for the scenarios that is not captured in the TR, such as HetNet scenario. Depending on the evaluation, we can study the potential solutions. The Rel-14 solutions can be sure be the starting point. |
| ITRI | Same view as ZTE. |
| MediaTek | We also think it is too early to discuss this proposal. |

**Summary of 1st round discussion**

Based on the 1st round discussion, we can summarize as below:

* Fine with the FL's proposal
  + Spreadtrum, Lenovo, Ericsson, Oppo, NTT DOCOMO (wait the outcome of evaluation to decide whether gNB-to-gNB CLI is necessary or not)
* List all the possible directions
  + ZTE, Sony, New H3C, Panasonic, CMCC, InterDigital, Intel, NEC, Sharp, ITRI, LG Electronics, Xiaomi
* Technical solutions
  + Huawei/HiSilicon (Advanced Receiver, Tx beamforming)
  + vivo (power control based solution)
  + CEWiT (Rel.16 RIM based solution)
  + Nokia/NSB (power control schemes, coordinated scheduling & Tx beamforming and advance receivers, the required enhancement on the backhaul signaling)
  + Qualcomm (DL/UL beam pair for FR2, separated UL/DL subband, Timing alignment, Backhaul signaling),
  + Samsung (Tx beamforming without beam information exchange across gNB’s interface, Tx beamforming with beam information exchange across gNB’s interface)

Companies are thinking that it be better not to preclude or prioritize among technical solutions proposed by companies at this early stage of the SI. Companies can propose different solutions and the potential benefit and specification impact for each solution can be further studied. In this sense, proposed technical solutions are included in updated FL Proposal #4-1 as below:

**Updated FL Proposal #4-1 for 2nd round discussion**

For study of potential enhancement on dynamic/flexible TDD, followings are considered as candidates of potential enhancement method of gNB-to-gNB CLI handling, where further prioritization/down-scoping of candidate schemes for study can be done in the future meetings:

* gNB-to-gNB CLI measurement and reporting
* Coordinated scheduling (e.g., separated UL/DL subband)
* Beamforming based solution (e.g., Tx/Rx beamforming, DL/UL beam pair for FR2, Tx beamforming without beam information exchange across gNB’s interface, Tx beamforming with beam information exchange across gNB’s interface)
* Advanced Receiver (e.g., IRC receiver)
* Timing alignment
* Power control based solution
* Rel.16 RIM based solution
* The required enhancement on the backhaul signaling
* Note: Any other scheme(s) for inter-gNB CLI handling is/are not be precluded.
* Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.

### *2nd Round Discussion*

Updated FL Proposal #4-1 for 2nd round discussion

For study of potential enhancement on dynamic/flexible TDD, followings are considered as candidates of potential enhancement method of gNB-to-gNB CLI handling, where further prioritization/down-scoping of candidate schemes for study can be done in the future meetings:

* gNB-to-gNB CLI measurement and reporting
* Coordinated scheduling (e.g., separated UL/DL subband)
* Beamforming based solution (e.g., Tx/Rx beamforming, DL/UL beam pair for FR2, Tx beamforming without beam information exchange across gNB’s interface, Tx beamforming with beam information exchange across gNB’s interface)
* Advanced Receiver (e.g., IRC receiver)
* Timing alignment
* Power control based solution
* Rel.16 RIM based solution
* The required enhancement on the backhaul signaling
* Note: Any other scheme(s) for inter-gNB CLI handling is/are not be precluded.
* Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.

**Companies are invited to provide views on the above proposal.**

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| --- | --- |
|  | **Company** |
| **Support** | NEC, Sony, Intel (some clarification), QC, TCL, Samsung (only with clarifications), CEWiT, ITRI, New H3C, DOCOMO, Xiaomi, vivo, Lenovo,Spreadtrum, Nokia, NSB (with minor suggestion), Panasonic, SK Telecom, LG, IDC |
| **Not support** | Ericsson |

|  |  |
| --- | --- |
| **Company** | **Views** |
| NEC | Sensing based mechanism can be added as a candidate method for gNB-to-gNB CLI handling |
| Intel | In our view, almost all the solutions can also be applicable for CLI handling for SBFD. For instance, “Coordinated scheduling (e.g., separated UL/DL subband)” is specifically targeted for SBFD. We suggest to add “SBFD” in the main bullet to avoid duplicated work/discussions.  We are generally fine with the listed solutions: Some suggestions or clarification:   * Timing alignment (e.g., timing-synchronization assistance information exchange) * ~~The required~~ Enhancement on the backhaul signaling |
| QC | Suggest adding OTA signalling in the sub-bullet: “The required enhancement on the backhaul/OTA signaling”. |
| TCL | Support the QC added sub-bullet |
| Samsung | Like QC, we think that the possibility of solutions based on OTA signaling should be included. We also think that the RIM sub-bullet needs to be clarified: “Solutions based on Rel-16 RIM incl. possible enhancements to the RIM signaling design” |
| ZTE | Ok with QC’s addition on OTA. |
| New H3C | We are fine with the proposal and also QC’s proposal. |
| Xiaomi | We are fine with NEC and QC’s proposal |
| Ericsson | We question what is the purpose of generating a long list of schemes from two perspectives:   1. It is a repeat of previous discussion which the SID states should be avoided (see below table from Section 10 of TR 38.802 Section 10 (NR Study Item)) 2. There is a note that says other schemes are not precluded   Hence, in our view, what schemes are considered should instead be a result of company contributions, since nothing is precluded anyway – if there is strong support for a given scheme, that will naturally be prioritized.   |  |  | | --- | --- | | IM techniques | | | Advanced receiver (IC/IS) | eMMSE-IRC | | Interference cancellation | | Packet exchange for interference cancellation) | | MMSE-IRC | | IS/IC receiver | | Reduced complexity maximum likelihood (RML) receiver | | Hybrid dynamic/static UL/DL resource assignment | Distributed hybrid dynamic/static UL/DL resource assignment - For Macro deployment, intra-site coordination is a considered. | | Switching/adaptation between semi-static and dynamic operations | | Scheduling coordination | | | | | | Beam coordination | | | | | | Link adaptation | | | | Power control | | | | | | Sensing | | | | | | | | | | Cell/TRP clustering | | | OTA signaling | | | | Co-channel multiple connectivity | | | Dynamic TDD Type Definition | | | Load/link-based resource/scheduling adaptation | | |
| Huawei, HiSilicon | We are fine with the proposal. |
| Spreadtrum | We think there are some duplicated work between “Tx beamforming with beam information exchange” and “enhancement on the backhaul signaling”. But it’s OK at this stage. |
| CMCC | Fine with the proposal. |
| Nokia, NSB | As an example of coordinated scheduling separated UL/DL subband is mentioned. In our view, this is specific for SBFD and it should be studied in AI 9.3.2 |
| Panasonic | We are generally ok with the proposal. |
| MediaTek | We are fine with FL, NEC, and QC’s proposals. |
| SK Telecom | We are fin with the proposal. |
| LG | We also think sensing based mechanism can be added. And a minor editorial suggestion:  Note: Any other scheme(s) for inter-gNB CLI handling is/are not ~~be~~ precluded. |

**Summary of 2nd round discussion**

Based on the 2nd round discussion, we can summarize as below:

It is observed that Updated FL Proposal #4-1 for 2nd round discussion is supported by most of companies in general.

In addition, modifications were proposed as below:

* Intel (Adding “SBFD’ in the main bullet)
* Intel (Adding specific scheme (e.g., timing-synchronization assistance information exchange)
* Samsung (Suggestion: incl. possible enhancements to the RIM signaling design)
* Intel (modification suggestion: ~~The required~~ Enhancement on the backhaul signaling)
* Qualcomm (Adding OTA), Samsung, ZTE, New H3C
* NEC (Adding Sensing based mechanism)

**Further Updated FL Proposal #4-1 from 2nd round discussion**

For study of potential enhancement on dynamic/flexible TDD, followings are considered as candidates of potential enhancement method of gNB-to-gNB CLI handling, where further prioritization/down-scoping of candidate schemes for study can be done in the future meetings:

* gNB-to-gNB CLI measurement and reporting
* Coordinated scheduling (e.g., separated UL/DL subband)
* Beamforming based solution (e.g., Tx/Rx beamforming, DL/UL beam pair for FR2, Tx beamforming without beam information exchange across gNB’s interface, Tx beamforming with beam information exchange across gNB’s interface)
* Advanced Receiver (e.g., IRC receiver)
* Timing alignment (e.g., timing-synchronization assistance information exchange)
* Power control based solution
* Enhancement on solution based on Rel-16 RIM (e.g., possible enhancements to the RIM signaling design)
* Enhancement on the backhaul/OTA signaling
* Note: Any other scheme(s) for inter-gNB CLI handling is/are not be precluded.
* Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.

### *3rd Round Discussion*

Further Updated FL Proposal #4-1 from 2nd round discussion

For study of potential enhancement on dynamic/flexible TDD, followings are considered as candidates of potential enhancement method of gNB-to-gNB CLI handling, where further prioritization/down-scoping of candidate schemes for study can be done in the future meetings:

* gNB-to-gNB CLI measurement and reporting
* Coordinated scheduling (e.g., separated UL/DL subband)
* Beamforming based solution (e.g., Tx/Rx beamforming, DL/UL beam pair for FR2, Tx beamforming without beam information exchange across gNB’s interface, Tx beamforming with beam information exchange across gNB’s interface)
* Advanced Receiver (e.g., IRC receiver)
* Timing alignment (e.g., timing-synchronization assistance information exchange)
* Power control based solution
* Enhancement on solution based on Rel-16 RIM (e.g., possible enhancements to the RIM signaling design)
* Enhancement on the backhaul/OTA signaling
* Note: Any other scheme(s) for inter-gNB CLI handling is/are not be precluded.
* Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.

**Companies are invited to provide views on the above proposal.**

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|  | **Company** |
| **Support** |  |
| **Not support** |  |

|  |  |
| --- | --- |
| **Company** | **Views** |
|  |  |

## Inter-cell UE-to-UE CLI

### *Submitted proposal*

|  |  |
| --- | --- |
| **Huawei, HiSilicon [1]** | ***Observation 4:*** *The overhead of**UE-to-UE CLI measurement can be reduced by aperiodic measurement, and layer 1 based UE-UE CLI report could improve the accuracy of measurement.*  ***Proposal 4:*** *Study the feasibility and performance of UE-to-UE CLI measurement based on muting resources, aperiodic UE-to-UE CLI measurement and layer 1 based UE-UE CLI report.* |
| **ZTE [2]** | ***Proposal 5****: Take the Rel-16 UE-UE CLI and RIM as a starting point for Rel-18 enhancements on dynamic/flexible TDD.*  ***Proposal 9****: Timing alignment solution on measurement RS transmission for UE-UE CLI should be considered in Rel-18.* |
| **TCL Communication Ltd. [4]** | ***Proposal 2:*** *A specific cell area of a neighbor cell, where the UE existence may create negligible or insignificant CLI in a given cell can be consider as a beneficial cell area.*  ***Proposal 3:*** *Study CLI management in dynamic TDD based on the neigbour cells UEs existance in the beneficial cell areas.* |
| **Spreadtrum Communications [5]** | ***Proposal1:*** *Focus on the following aspects of dynamic/flexible TDD enhancement*   * *CLI analysis* * *CLI handling (gNB/UE)* |
| **CATT [6]** | ***Proposal 1:*** *UE-to-UE CLI handling enhancement is deprioritized for dynamic/flexible TDD in R18.* |
| **vivo [7]** | *Error: Reference source not found* |
| **xiaomi [9]** | ***Proposal 3:*** *Dynamic UE CLI measurement can be further studied to acquire instantaneous interference level.* |
| **Samsung [10]** | ***Observation 6:*** *The existing R16 CLI features can be re-used for intra-cell and inter-cell CLI measurements and associated UE-based measurement reporting* |
| **NEC [11]** | ***Proposal 4:***  *■ Unified design for CLI RS for gNB-to-gNB and UE-to-UE measurement should be considered to reduce the RS overhead.* |
| **OPPO [12]** | ***Observation 1:*** *R16 inter-UE CLI handling remains applicable.* |
| **Panasonic [15]** | ***Proposal 2:*** *For CLI measurement and reporting, further discuss the following enhancements:*  *• L1 report, instead of or on top of L3 report, to aid scheduling decision*  *• How to include spatial domain information to facilitate efficient UE pairing to avoid UE-UE interference* |
| **CMCC [18]** | ***Proposal 1:*** *For inter-UE CLI handling, the following enhancements can be considered:*   * *Support L1 CLI measurement and report to better reflect the interference variation, and aperiodic LI CLI measurement and report can also be considered to reduce the overhead.* * *Enhance the backhaul signaling to exchange necessary information, e.g., CLI SRS configuration, to support inter-vendor inter-gNB cooperation.* |
| **NTT DOCOMO, INC. [19]** | ***Observation 1:*** *RSSI measurement is a baseline of CLI measurement for subband non-overlapping full duplex, since the frequency bandwidth of aggressor signals and that of victim signals are not fully overlapped.*  ***Proposal 1:*** *For the enhancement of UE-UE CLI for subband non-overlapping full duplex, following aspects needs to be studied.*   * *Introduction of spatial domain information for CLI measurement* * *Introduction of multiple frequency resource configurations for CLI measurement* |
| **Nokia, Nokia Shanghai Bell [20]** | ***Observation 2:*** *Solutions for Rel-16 co-channel CLI focused on UE-to-UE CLI problems, where new UE-to-UE CLI measurements (and corresponding reporting) were standarized. Solutions to mitigate gNB-to-gNB CLI were not standardized in Rel-16.*  ***Observation 3:*** *For having a completely standardized solution for UE SRS-RSRP measurements, gNBs should be able to exchange their cells/UEs SRS configurations over the Xn/F1 interface. This is missing from current NR specifications.* |
| **Lenovo [23]** | ***Proposal 1:*** *Any potential area for further enhancements of CLI mitigation shall take the Rel-16 enhancement as baseline, and provide noticeable performance gain.*  ***Proposal 2:*** *Consider more dynamic interference measurement and reporting as one potential area for further enhancements for inter-UE CLI mitigation in dynamic/flexible TDD.* |
| **CEWiT [28]** | ***Observation 2:*** *Factors like synchronization errors between gNBs, smaller CP length in higher numerologies, higher propagation delay between the UEs causes the misalignment to go beyond CP duration while measuring the CLI on SRS as both the UEs are not time synchronized.*  ***Proposal 2:*** *Study enhancements to improve CLI measurement accuracy.*  ***Observation 3:*** *The aggressor UE can transmit the SRS at a different numerology as compared to the numerology at which the victim UE is receiving. This discrepancy in the transmitted and received SRS numerologies will affect the accuracy of CLI RSRP measurement.*  ***Proposal 3:*** *Study methods to overcome the impact of aggressor and victim UEs operating at different numerologies on CLI measurement.*  ***Observation 4:*** *The victim UE might receive only a part of the transmitted SRS by the aggressor UE for measurement of CLI RSRP where the reference points for SRS sequence generation and filling are different at victim and aggressor UEs.*  ***Proposal 4:*** *Study the impact of partial reception of SRS with different reference points for sequence generation and filling at victim and aggressor UEs for CLI measurement on CLI measurement accuracy.*  ***Observation 5:*** *CLI varies with dynamic scheduling in flexible TDD scenario.*  ***Proposal 5:*** *Mechanism for dynamic reporting of CLI is supported.* |
| **Intel Corporation [29]** | ***Observation 2***  *• Additional UE-to-UE and gNB-to-gNB CLI can be observed in case of NOFD with TDD operation.*  ***Proposal 2***  *• RAN1 to further study L1 CLI measurement and reporting at UE for dynamic TDD operation.* |
| **Qualcomm Incorporated [30]** | ***Observation 9:*** *Rel-16 CLI reporting is based on L3 which has limited flexibility and slow adaptability*  *• This leads to increased latency in CLI reporting which is not suitable for fast adaptation to mitigate CLI*  *• L1/L2 report can be obtained by gNB-DU with lower latency, in turn it can better reflect current CLI*  *• L1 report can be sent on-demand enabling fast L1 beam adaptation*  ***Observation 10:*** *In Rel-16 CLI framework, there is no dedicated signalling or configuration of QCL-D for CLI measurement, hence not suitable for enabling CLI-aware beam management*  ***Observation 11:*** *Rel-16 CLI framework does not support subband CLI reporting, i.e., reporting CLI for one or more subbands in the measurement bandwidth. In SBFD, CLI leakage to adjacent subbands is not uniform over the measurement bandwidth and may require subband CLI reporting.*  ***Proposal 3:*** *Support L1/L2 based CLI reporting to increase flexibility and reduce reporting latency compared to Rel-16 L3 based framework.*  ***Proposal 4:*** *Support UE Rx beam (QCL-D) configuration and indication per CLI measurement resource for enabling CLI-aware beam management.*  ***Proposal 5:*** *Support subband-based CLI reporting to provide accurate CLI reporting in dynamic TDD in which CLI could be non-uniform across the DL.* |
| **InterDigital, Inc. [14]** | ***Observation 2.*** *CLI estimation and reporting at a potential victim UE based on distinguishing aggressor UEs can be used for enhancing CLI mitigation at the UE and further optimal scheduling at the gNB.*  ***Observation 4.*** *Joint beam management between victim UE and gNB taking into account beams from aggressor UE can be beneficial in dynamic beam selection for CLI mitigation.*  ***Observation 5.*** *A beam failure instance due to CLI may occur even when the signal received from gNB is not physically blocked, where the degradation in the DL radio link is mainly due to the interference from an aggressor UE.*  ***Proposal 1.*** *Consider supporting means of CLI measurement and reporting at the potential victim UE that includes distinguishing aggressor UEs.*  ***Proposal 3.*** *Consider enhancements in joint beam management between gNB, victim UE, and aggressor UE for optimal beam selection or beam avoidance at the victim UE or aggressor UE, respectively.*  ***Proposal 4.*** *Consider enhancements in beam failure detection and recovery, in case the beam failure is caused by CLI from one or more aggressor UEs.* |

### *Summary*

In Rel-16, L3 based UE-to-UE CLI-RSSI and SRS-RSRP measurement and reporting are introduced, which may have limitation of flexibility. For fast reflection of measured CLI to resource assignment, enhancement of UE-to-UE CLI handling is proposed.

* CLI measurement/reporting
  + L1 based UE-to-UE CLI measurement/report [1][15][18][29][30]
  + Aperiodic UE-to-UE CLI measurement [1]
  + Dynamic UE CLI measurement [9][28]
  + Different numerologies on CLI measurement [28]

Also, for further enhancement of UE-to-UE CLI handling, followings are proposed.

* UE power control [7]
* Spatial domain information [15][19][30]
* Joint beam management between gNB, victim UE, and aggressor UE [14]
* Reference signal and Resource [11][28][30]
  + Unified design for CLI RS for gNB-to-gNB and UE-to-UE measurement [11]
  + Partial reception of SRS [28]
  + Subband-based CLI reporting [30]

On the other hand, deprioritization of enhancement of UE-to-UE CLI handling is proposed [6]. Also, it is mentioned that existing R16 CLI feature can be re-used for intra-cell and inter-cell CLI measurement and association UE based measurement reporting [10], and R16 inter-UE CLI handling remains applicable [12].

### *1st Round Discussion*

Initial FL Proposal #5-1

For study of potential enhancement on dynamic/flexible TDD, enhancement of UE-to-UE CLI handling is considered.

* At least L1 based UE-to-UE CLI measurement and reporting is studied.

**Companies are invited to provide views on the above proposal. Also, companies are encouraged to provide views which schemes should be studied for dynamic/flexible TDD in agenda item 9.3.3.**

|  |  |
| --- | --- |
| **Companies** | **Views** |
| ZTE | At this stage, it is better if we can list all the possible directions and have some initial discussion on them first before precluding them. |
| Sony | Similar comment as gNB-gNB CLI (for Proposal#4-1 above). We can have a 1st discussion on the listed schemes and select a subset of them. |
| vivo | UL power control schemes should also be studied. |
| CEWiT | We support the proposal.  However, we also feel that enhancements related to CLI measurement accuracy should also be studied. Our contribution [28] discusses the factors/cases that impacts the measurement accuracy.  In general, we feel that the following broad categories can be considered for study and schemes can be discussed under it.  - Study of CLI handling schemes at aggressor UE (e.g., Tx beam related) - Study of CLI handling schemes for improvement of measurement accuracy. |
| New H3C | We have the same view with ZTE. At this time, we need collect all of possible research directions. |
| Spreadtrum | Support FL’s proposal. |
| Panasonic | Same view as ZTE. |
| Huawei, HiSilicon | Fine with the proposal and open to other enhancements as well. |
| Lenovo | We are fine with the proposal. |
| Nokia, NSB | Support FL’s proposal. |
| CMCC | Fine, other enhancements are also open for us |
| InterDigital | Support the FL proposal. |
| Intel | We are fine with the proposal. |
| NEC | We also have similar view as ZTE, some of the proposed issues/solutions need to be discussed before excluding them from study. |
| QC | At this stage, we believe all solutions for inter-UE CLI handling suggested by companies should be listed for further study. The proposal should open to all the enhancements:  For study of potential enhancement on dynamic/flexible TDD, enhancement of UE-to-UE CLI handling is considered.   * L1/L2 based UE-to-UE CLI measurement and reporting is studied. * Spatial domain enhancements, e.g UE Rx beam (QCL-D) configuration and indication per CLI measurement resource, and preferred/restricted Tx/Rx beams * UE UL power control and gNB DL power adjustment * Timing adjustment * Note: any other scheme for inter-UE CLI handling shall not be excluded. |
| Ericsson | Support FL's proposal  We agree to narrow the scope to avoid repetition of discussion from Rel-15/16. The SID is quite clear on this:  *Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.* |
| Apple | The proposal shall make a clear differentiation on the applicability of solutions to victim vs aggressor UEs. We are open to discuss possible solutions/enhancements for the aggressor UE to avoid UE-to-UE CLI. But to victim UE in DL reception, given that all legacy UEs potentially lie in that category, no enhancement is envisioned. |
| OPPO | Support the proposal. |
| CATT1 | We share similar view with ZTE. We think in general this can be de-prioritized. |
| Samsung | As we commented in FL proposal #4-1, the main bullet is not needed.  From our side, we see benefits in further study of L1 based UE-to-UE UL CLI measurement and reporting. For CLI handling, enhancements to UE power control and joint beam management can be considered. We are not sure if a unified design for CLI RS for both gNB-to-gNB and UE-to-UE measurement is always possible. For purpose of transmitting CLI-RS in DL resources, a unified design such as based on NZP CSI-RS resource sets & associated CSI reporting configurations is desirable, For purpose of gNB-to-gNB measurements, the effective link budget achievable with RE-level CLI RS may not be sufficient. An approach based on enhancements of RIM-RS may be more promising.  For the further discussion, potential discussion points should be captured in FFS. For example, “FFS: UL power control, beam managements, new reference signals and resources” |
| NTT DOCOMO | We are fine with the proposal. On the other hands, it seems premature to mention one potential solution (L1 based CLI) in this stage. |
| Sharp | We have similar view with ZTE although we are fine with the proposal. |
| LG | Similar view with QC and SS. It seems too early for precluding options. Similar to comment on proposal 4-1, duplication of discussion should be avoided. |
| Xiaomi | Same comment with proposal 4-1 |
| ITRI | Support FL’s proposal. |
| TCL | Support the FL proposal |
| MediaTek | We think it is too early to preclude or to pick some potential solutions but not the others. At this state, companies should be encouraged to present and compare results of potential solutions based on evaluation methods and deployment scenarios. Down selection of potential solutions can be discussed after that. |

**Summary of 1st round discussion**

Based on the 1st round discussion, we can summarize as below:

* Fine with the FL's proposal
  + Spreadtrum, Huawei, HiSilicon, Lenovo, Nokia, NSB, InterDigital, Intel, Ericsson, OPPO, NTT DOCOMO, ITRI, TCL
* List all the possible directions
  + ZTE, New H3C, Panasonic, Huawei, HiSilicon, CMCC, NEC, Qualcomm, CATT, NTT, DOCOMO, Sharp, LG Electronics
* Technical solutions
  + Vivo (UL power control schemes)
  + CEWiT (UE Tx beamforming Related Schemes (e.g., Tx beam related), Improvement of measurement accuracy)
  + Qualcomm (Spatial domain enhancement, Power control, Timing adjustment)
  + Samsung (Beamforming, Measurement Resource)

Same as discussion in section 3.3, companies are thinking that it be better not to preclude or prioritize among technical solutions proposed by companies at this early stage of the SI. Companies can propose different solutions and the potential benefit and specification impact for each solution can be further studied. In this sense, proposed technical solutions are included in updated FL Proposal #5-1 as below:

**Updated FL Proposal #5-1 for 2nd round discussion**

For study of potential enhancement on dynamic/flexible TDD, followings are considered as candidates of potential enhancement method of UE-to-UE CLI handling, where further prioritization/down-scoping of candidate schemes for study can be done in the future meetings:

* Improvement of measurement accuracy, e.g. L1/L2 based UE-to-UE CLI measurement and reporting.
* Spatial domain enhancements, e.g. UE Rx beam (QCL-D) configuration and indication per CLI measurement resource, and preferred/restricted Tx/Rx beams, Joint beam management
* UE UL power control and gNB DL power adjustment
* Timing adjustment
* Measurement Resource, e.g. a unified design for CLI RS for both gNB-to-gNB and UE-to-UE measurement
* Note: Any other scheme(s) for inter-UE CLI handling is/are not be precluded.
* Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.

### *2nd Round Discussion*

Updated FL Proposal #5-1 for 2nd round discussion

For study of potential enhancement on dynamic/flexible TDD, followings are considered as candidates of potential enhancement method of UE-to-UE CLI handling, where further prioritization/down-scoping of candidate schemes for study can be done in the future meetings:

* Improvement of measurement accuracy, e.g. L1/L2 based UE-to-UE CLI measurement and reporting.
* Spatial domain enhancements, e.g. UE Rx beam (QCL-D) configuration and indication per CLI measurement resource, and preferred/restricted Tx/Rx beams, Joint beam management
* UE UL power control and gNB DL power adjustment
* Timing adjustment
* Measurement Resource, e.g. a unified design for CLI RS for both gNB-to-gNB and UE-to-UE measurement
* Note: Any other scheme(s) for inter-UE CLI handling is/are not be precluded.
* Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.

**Companies are invited to provide views on the above proposal.**

|  |  |
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|  | **Company** |
| **Support** | NEC, Sony, Intel (see comments), QC, TCL, Samsung (with modifications), CEWiT, ITRI, New H3C, DOCOMO, Xiaomi, vivo, Lenovo, Spreadtrum, Nokia, NSB (with minor suggestion), Panasonic, SK Telecom, LG, IDC |
| **Not support** | Ericsson |

|  |  |
| --- | --- |
| **Company** | **Views** |
| NEC | Sensing based mechanism can be added as a candidate method for UE-to-UE CLI handling |
| Intel | As mentioned above, we suggest to add “SBFD” in the main bullet to avoid duplicated work/discussions.  It is not clear to us exactly which aspects are included in “Timing adjustment”? It would be good to clarify the issue further in context of UE to UE CLI mitigation. Otherwise, the scope remains rather vague. |
| QC | Suggest editing “Improvement of CLI measurement latency and flexibility”  Suggest including “subband CLI reporting” in the list.  Subband CLI reporting is clearly needed for SBFD; however, it may also need for dynamic TDD: use case 1: when UL Tx BW is allocated with a partial BW on cell 1, and DL Rx BW is a whole BW on cell 2; use case 2: for SBHD operation across cells where different cells have different UL and DL subbands in half duplex mode. |
| Samsung | Suggest editing: “Improvement of measurement accuracy…”  “Improvements to CLI measurement reporting latency and overhead”  Suggest editing “Timing adjustment”  “Transmission and reception timing”  Suggest editing: “Measurement resource, …”  “Measurement resource and resource set configuration(s) … for CLI-RS” |
| ZTE | OK |
| New H3C | Same as Intel, ‘Timing adjustment’ is no clear for us. |
| Xiaomi | We are fine with NEC’s addition. |
| Ericsson | We have a similar view as for Proposal #4-1. We don't see the value in listing so many schemes that have been studied before, especially when the list also says "other schemes not precluded."  In our view, what schemes are considered should instead be a result of company contributions, since nothing is precluded anyway – if there is strong support for a given scheme, that will naturally be prioritized. We preferred the proposal from the 1st round, since it was clear from company contributions that L1/L2 based CLI measurement/reporting was mentioned by many companies. |
| Huawei, HiSilicon | We are fine with proposal |
| CMCC | Fine with the proposal. |
| Nokia, NSB | gNB DL power reduction is listed as a mechanism to reduce inter-UE CLI. In our view, this mechanism helps in handling inter-gNB CLI. |
| Panasonic | We are generally ok with the proposal. |
| MediaTek | OK |
| SK Telecom | We are fine with proposal. |
| LG | Adding latency and flexibility seems limiting other enhancements to us. Since there is a note “any other schemes are not precluded”, we are okay with the proposal. Same minor editorial comment is:  Note: Any other scheme(s) for inter-UE CLI handling is/are not ~~be~~ precluded. |
| InterDigital | OK |

**Summary of 2nd round discussion**

Based on the 2nd round discussion, we can summarize as below:

It is observed that Updated FL Proposal #5-1 for 2nd round discussion is supported by most of companies in general.

In addition, modifications were proposed as below:

* Intel (add “SBFD” in the main bullet to avoid duplicated work/discussions.)
* Qualcomm (“Improvement of CLI measurement latency and flexibility”)
* Samsung (“Improvement of measurement accuracy…”  “Improvements to CLI measurement reporting latency and overhead”)
* Intel, New H3C (‘Timing adjustment’ is no clear)
* Samsung (“Timing adjustment”  “Transmission and reception timing”)
* NEC (Sensing based mechanism can be added as a candidate method for UE-to-UE CLI handling), Xiaomi
* Samsung (“Measurement resource, …”  “Measurement resource and resource set configuration(s) … for CLI-RS”)
* Qualcomm (Suggest including “subband CLI reporting” in the list.)

@ Intel, New H3C

In Rel-16, there was a discussion about transmission timing of aggressor UE and reception timing of victim UE for CLI-measurement (including CLI-RSSI and SRS-RSRP). In the discussion, it was concluded that transmission timing of aggressor UE is not changed, and reception timing of victim UE is up to UE implementation. In addition, it was agreed that network may configure an offset value for adjustment of reception timing of victim UE. But, the UE implementation and offset value for timing adjustment seems not good for ensuring accurate CLI measurement.

For accurate CLI measurement, at least reception ‘timing adjustment’ seems to be enhanced. In this sense, companies propose enhancement of timing adjustment.

Samsung’s suggestion for editing (‘Transmission and reception timing’) seems better than ‘Timing adjustment’.

@ Qualcomm

It is understood that enhancement of subband CLI measurement / reporting is not clear because subband CLI measurement/report has been specified in Rel-16 CLI handling WI. For example, it is specified that UE shall assume that the actual CLI-RSSI resource bandwidth is within the active DL BWP and UE can be configured a set of PRBs which is not a whole BW.

@ Samsung

Regarding comment for ‘Measurement resource’, it seems to use general terminology for identifying scope of candidate scheme.

**Further Updated FL Proposal #5-1 from 2nd round discussion**

For study of potential enhancement on dynamic/flexible TDD, followings are considered as candidates of potential enhancement method of UE-to-UE CLI handling, where further prioritization/down-scoping of candidate schemes for study can be done in the future meetings:

* Improvements to CLI measurement/reporting latency, flexibility and overhead, e.g. L1/L2 based UE-to-UE CLI measurement and reporting.
* Spatial domain enhancements, e.g. UE Rx beam (QCL-D) configuration and indication per CLI measurement resource, and preferred/restricted Tx/Rx beams, Joint beam management
* UE UL power control and gNB DL power adjustment
* Transmission and reception timing
* Measurement Resource, e.g. a unified design for CLI RS for both gNB-to-gNB and UE-to-UE measurement
* Sensing based mechanism
* Note: Any other scheme(s) for inter-UE CLI handling is/are not be precluded.
* Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.

### *3rd Round Discussion*

Further Updated FL Proposal #5-1 from 2nd round discussion

For study of potential enhancement on dynamic/flexible TDD, followings are considered as candidates of potential enhancement method of UE-to-UE CLI handling, where further prioritization/down-scoping of candidate schemes for study can be done in the future meetings:

* Improvements to CLI measurement/reporting latency, flexibility and overhead, e.g. L1/L2 based UE-to-UE CLI measurement and reporting.
* Spatial domain enhancements, e.g. UE Rx beam (QCL-D) configuration and indication per CLI measurement resource, and preferred/restricted Tx/Rx beams, Joint beam management
* UE UL power control and gNB DL power adjustment
* Transmission and reception timing
* Measurement Resource, e.g. a unified design for CLI RS for both gNB-to-gNB and UE-to-UE measurement
* Sensing based mechanism
* Note: Any other scheme(s) for inter-UE CLI handling is/are not be precluded.
* Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.

**Companies are invited to provide views on the above proposal.**

|  |  |
| --- | --- |
|  | **Company** |
| **Support** |  |
| **Not support** |  |

|  |  |
| --- | --- |
| **Company** | **Views** |
|  |  |

## Information Exchange

### *Submitted proposal*

|  |  |
| --- | --- |
| **Samsung [10]** | ***Proposal 2:*** *RAN1 to study and evaluate the benefits of providing desired/prohibited beam indications using Xn-AP to support intra-operator gNB-to-gNB (DL-to-UL) CLI mitigation* |
| **OPPO [12]** | ***Proposal 1:*** *For inter-gNB CLI handling, especially for inter-operator gNB CLI, mechanism on interference measurement and resource configuration exchange should be studied.* |
| **CMCC [18]** | ***Proposal 1:*** *For inter-UE CLI handling, the following enhancements can be considered:*   * *Support L1 CLI measurement and report to better reflect the interference variation, and aperiodic LI CLI measurement and report can also be considered to reduce the overhead.* * *Enhance the backhaul signaling to exchange necessary information, e.g., CLI SRS configuration, to support inter-vendor inter-gNB cooperation.* |
| **Nokia, Nokia Shanghai Bell [20]** | ***Observation 4:*** *Exchange of the ”Intended TDD DL-UL Configuration” over the XnAP and F1AP was standardized in Rel-16, basically to allow a gNB to announce the TDD radio frame configuration that a cell intends to use. No additional Xn/F1 signalling is standardized to facilitate TDD radio frame coordination between cells.*  ***Proposal 2:*** *For having a completely standardized solution of UE SRS-RSRP measurements, exchange of cells/UEs SRS configuration over the Xn/F1 interface shall be standardized.* |
| **LG Electronics [24]** | **Inter-operator Interference Handling**  ***Proposal 4:*** If information exchange between inter-operators are not assumed, technical schemes to support dynamic TDD can be studied, and candidate solutions for interference handling (e.g., uplink band suppression, sensing, etc.) can be discussed. |

### *Summary*

For supporting inter-UE/gNB-to-gNB CLI handling or for having a completely standardized solution of UE SRS-RSRP measurement, exchange of information is proposed [10][18][20].

* For intra-opeator gNB-to-gNB CLI mitigation, Beam indication using Xn-AP [10]
* For inter-UE CLI handling, enhancement of backhaul signaling to exchange necessary information [18]
* For having a completely standardized solution of UE SRS-RSRP measurement, exchange of cells/UEs SRS configuration over the Xn/F1 interface [20]

Also, for inter-operator gNB CLI, mechanism on interference measurement and resource configuration exchange are proposed. [12]

### *1st Round Discussion*

Initial FL Question #6-1

Whether enhancement of information exchange is necessary or not for study of potential enhancement on dynamic/flexible TDD.

**Companies are invited to provide views on the above question.**

|  |  |
| --- | --- |
| **Companies** | **Views** |
| ZTE | We are open to consider this direction. |
| Sony | We can decide this once we decide on the CLI schemes in Proposal#4-1 and Proposal#5-1. |
| vivo | We are open for the enhancement of information exchange, the potential performance gain based on the enhancement should also consider the feasibility, e.g. capacity and latency of x2 or F1 interface. |
| CEWiT | We support the study of information exchange between gNBs. Without information exchange, the schemes for handling CLI cannot be considered as fully standardised. |
| New H3C | We are open to discuss about it. |
| Spreadtrum | It is an efficient way to handle inter-gNB CLI if the information of other gNB is known. So we prefer to study the enhancement of information exchange between gNBs. |
| Huawei, HiSilicon | The potential information exchange can be studied in the respective enhancements on dynamic/flexible TDD. As one example, gNB-to-gNB CLI measurement resources and report can be exchanged between gNBs for interference suppression/mitigation at the transmitter and receiver. |
| Lenovo | For e.g., beam level solutions and CLI measurement, the enhancement of information exchange between gNBs seems necessary. |
| Nokia, NSB | In our view, enhancement of information exchange is necessary for assisting in the mitigation of gNB-to-gNB and UE-to-UE CLI. Details can be FFS. |
| CMCC | From our point of view, the mainly interested and realistic scenario for dynamic/flexible TDD deployment is to apply different TDD frame structures for outdoor macro network and indoor hotspot in the same frequency carrier to fit the different UL/DL traffic statistic ratios. In this scenario, it is highly probable that the macro gNBs and indoor gNBs are from different vendors, so enhancement of backhaul signaling to exchange necessary information is needed to handle the gNB-gNB CLI in this scenario. |
| InterDigital | We support further investigation on the enhancements of information exchange. |
| Intel | In our view, if intra-subband cochannel CLI is studied under dynamic/flexible TDD in AI 9.3.3, it would be more appropriate to consider extension of the existing network coordination mechanisms as defined in Rel-16. In particular, configuration of UL or DL subband for SBFD operation may be exchanged among gNBs for gNB-to-gNB CLI mitigation. |
| NEC | In our understanding, information exchange for gNB-gNB CLI handling should be supported if we like to make dynamic/flexible TDD efficient. Maybe we can list some potential types of information as FFS points such as CLI RS configuration, beam related configuration, UL/DL configuration, etc. |
| QC | Support to study information exchange enhancement for both inter-gNB and inter-UE CLI handling. |
| Ericsson | Share a similar view as Sony. First the CLI schemes to study should be identified. Then they can be studied to assess their potential benefits. Whether or not they require information exchange, and whether or not that is practical, e.g., between operators, can be deferred until later. We feel it is out of scope in this RAN1-led study item to be discussing potential changes/enhancements of Xn/F1 interfaces. |
| Apple | OK to exchange information between gNBs. For UE to UE, such exchange of information shall be transparent to victim UE |
| OPPO | It is too early to make such decision. The answer should be solution-specific. |
| CATT1 | This discussion can be deferred. |
| Samsung | RAN1 should study if information exchange between gNBs using the existing network interfaces, e.g., Xn-AP can provide benefit. In our view, candidates are beam related information such as desired/prohibited beam indication (R17 eIAB), TDD Tx On/Off related information, measurement resource related configurations, etc. |
| NTT DOCOMO | We support to study the enhancement of information exchange, since exchanging special domain information or additional time domain information (e.g. additional TDD pattern if defined) can be one of the potential enhancements for CLI. |
| LG | We think information exchange is needed for CLI handling at least inter-vendor deployment is not precluded. However, as pointed out by several companies, the contents of the information and even whether information exchange is needed or not depends on the CLI handling scheme. Therefore identifying the information to be exchanged depending on CLI handling scheme is needed.  The contents of information to be exchanged should be carefully considered according to the assumption of backhaul link (i.e., ideal or non-ideal). |
| ITRI | We support the study of information exchange between gNBs. |
| TCL | In our view, the study of enhancement of information exchange is necessary, to reduce the backhaul or OTA signalling in dynamic TDD. |
| MediaTek | We think information exchange could be beneficial to some CLI handling schemes and we support the study of information exchange for inter-gNBs and inter-UEs. |

**Summary of 1st Round Discussion**

Based on the 1st round discussion, we can summarize as below:

● Option 1: Study of information exchange between gNBs

Support: ZTE, CeWiT, New H3C, Spreadtrum, InterDigital, Qualcomm, Apple, ITRI, TCL, NOKIA/NSB,

vivo (potential peformance gain based on the enhancement),

Huawei/HiSilicon (exchange between gNBs for interference suppression/mitigation),

Lenovo (e.g., beam level solution and CLI measurement),

CMCC (handle the gNB-gNB CLI in the scenario, where outdoor macro network and indoor hotspot in the same frequency carrier),

Intel (extension of the existing network coordination mechanism for intra-subband co-channel CLI),

NEC (CLI RS configuration, beam related configuation, UL/DL configuration, etc.),

Samsung (Beam related information, measurement resource related configuration),

NTT DOCOMO (exchanging special domain information or additional time domain information),

OPPO (solution specific),

LG Electronics (Identifying the information to be exchange depending on CLI handling scheme, take an assumption of backhaul link into account)

● Option 2: Decide information exchange once deciding on the CLI schemes

Sony

● Option 3: Defer this discussion

CATT (Discussion can be deferred)

● Option 4: Not study in RAN1

Ericsson (out of scope in RAN1-led study item)

It is mentioned as clear majority view that enhancement of information exchange between gNBs can be studied taking CLI scheme into account. Also, it seems that option 2 and 3 is not much different from option 1.

In addition, in Rel-18 Duplex Evolution study item, RAN1 can study the enhancement of information exchange between gNBs. In WI, RAN3 should be mainly led to design Xn/F1 interface.

From the above observation, we propose as below:

**FL proposal#6-1 for 2nd round discussion**

The enhancement of information exchange between gNBs is studied in Rel-18 Duplex Evolution Study Item

* Identify the information to be exchange depending on CLI handling scheme

### *2nd Round Discussion*

FL proposal#6-1 for 2nd round discussion

The enhancement of information exchange between gNBs is studied in Rel-18 Duplex Evolution Study Item

* Identify the information to be exchange depending on CLI handling scheme

**Companies are invited to provide views on the above proposal.**

|  |  |
| --- | --- |
|  | **Company** |
| **Support** | NEC, Sony, Intel, QC, TCL, Samsung (with modifications), CEWiT, ITRI, ZTE, New H3C, DOCOMO, Xiaomi, vivo, Lenovo, Spreadtrum, CMCC, Nokia, NSB, Panasonic, LG, IDC |
| **Not support** | Ericsson |

|  |  |
| --- | --- |
| **Company** | **Views** |
| NEC | ‘exchange’  ‘exchanged’ |
| Samsung | We support the intention of the FL proposal #6-1. But we think the wording can be improved.  We propose: “RAN1 study, identify and evaluate the potential benefits of enhancements to inter-gNB signaling in support of CLI mitigation.” |
| CATT | We think this required involvement of RAN3 which is currently not in the scope of the WID |
| Ericsson | Agree with view from CATT. It is out-of-scope to consider inter-gNB signaling; this is the purview of RAN3.  Instead of the above proposal, we suggest the following modification which simply captures whether or not a considered scheme requires inter-gNB signaling.  For gNB-gNB CLI mitigation schemes considered in the Rel-18 Duplex Evolution Study item, identify whether or not they require inter-gNB signaling |
| CMCC | We think some candidate solutions can be studied in RAN1 for providing some information to the follow up WI if any. |
| MediaTek | We are fine with Samsung’s revision. |

**Summary of 2nd Round Discussion**

Most of company support the FL proposal#6-1 for 2nd round discussion.

Also, typo mentioned by NEC is fixe**d**.

**Updated FL proposal#6-1 from 2nd round discussion**

The enhancement of information exchange between gNBs is studied in Rel-18 Duplex Evolution Study Item

* Identify the information to be exchanged depending on CLI handling scheme

### *3rd Round Discussion*

Regarding the comment from CATT and Ericsson, RAN3 should be involved for specifying inter-gNB signalling. But, for the signalling, RAN1 needs to provide/recommend regarding the information to RAN3. In this aspect, RAN1 work is necessary. Also, in Study Item, RAN1 may study which signalling needs to be enhanced, and may identify the signalling.

Regarding Samsung’s suggestion for modification, thanks for suggestion. The proposal also seems fine. But, the wording ‘evaluate the potential benefits of enhancements’ seems unclear because it is not clear whether/how to evaluate the signalling in RAN1.

In 2nd round discussion, it is observed that most of companies are supporting FL proposal#6-1, hence this proposal seems relatively stable. So, FL kindly recommends for companies to provide views only if companies have a strong concern.

Updated FL proposal#6-1 from 2nd round discussion

The enhancement of information exchange between gNBs is studied in Rel-18 Duplex Evolution Study Item

* Identify the information to be exchanged depending on CLI handling scheme

**Companies are invited to provide views on the above proposal.**

|  |  |
| --- | --- |
|  | **Company** |
| **Support** |  |
| **Not support** |  |

|  |  |
| --- | --- |
| **Company** | **Views** |
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# Others

## TDD configuration, Resource allocation

### *Submitted proposal*

|  |  |
| --- | --- |
| **New H3C Technologies Co., Ltd. [3]** | ***Observation 1:*** *GP shall be reserved for the purpose of HF UE even the gNB works in the FD mode.*  ***Proposal 1:*** *Extend the functionality of flexible symbol for supporting FD, and the frame structure configuration mechanism in legacy TDD can be reused.*  ***Proposal 2:*** *support the configurations of a number of dedicated symbols as FD symbols, the dedicated FD symbols should be consecutive in a period of the frame structure.* |
| **Spreadtrum Communications [5]** | ***Observation 2:*** *When the legacy gNB uses DL dominant TDD UL-DL configuration and Rel-18 duplex gNB uses UL dominant TDD UL-DL configuration, there is no impact to the legacy gNB, only impact to legacy UE should be considered.* |
| **Sony [8]** | ***Observation 1:*** *FD-TDD can be supported for legacy UEs by scheduling DL & UL transmissions for different UEs within the same Flexible OFDM symbols but in different frequency resources.*  ***Observation 2:*** *Reconfiguring slot format with heavy FL symbols for support of FD-TDD would have major impacts on legacy operations.*  ***Observation 3:*** *To enable Rel-18 UEs to fully utilize FD-TDD from the network perspective, allow UE to overwrite DL OFDM symbols to UL OFDM symbols and vice-versa.*  ***Proposal 1:*** *Allow gNB to indicate in the DL & UL grants whether semi-static/SFI indicated DL and UL OFDM symbols can be overwritten for UL and DL transmissions respectively.* |
| **NEC [11]** | ***Proposal 1:*** *Enhancement for the flexible symbols allocation can be studied, such as:*  *■ Methods to achieve different UE interpretation different slot format for flexible symbols can be studied.*  *■ LBT scheme can be applied to determine the flexible symbols used for DL or UL transmission.* |
| **Panasonic [15]** | ***Proposal 1:*** *Per-subband slot format should be considered to enable flexible resource allocation over different subbands at least from gNB perspective. Further discuss whether UE can be configured with multiple per-subband slot formats for a cell.* |
| **ITRI [21]** | ***Observation 1:*** *A slot configuration period and a number of downlink symbols, uplink symbols, and flexible symbols in each slot of the slot configuration period is determined from tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated and is common to each configured BWP.*  ***Observation 2:*** *For a set of symbols of a slot that are indicated as downlink/uplink by tdd-UL-DL-ConfigurationCommon, or tdd-UL-DL-ConfigurationDedicated, the UE does not expect to detect a DCI format 2\_0 with an SFI-index field value indicating the set of symbols of the slot as uplink/downlink, respectively, or as flexible.*  ***Observation 3:*** *A UE has a flexible resource configured by higher layer, and*  *• if a PDCCH/PDSCH/CSI-RS configured by higher layer in the flexible resource, the UE does not receive the PDCCH/PDSCH/CSI-RS, respectively, if the UE detects a DCI format 2\_0 indicating the flexible resource as flexible resource.*  *• if a DL PRS configured by higher layer in the flexible resource, the UE receives the DL PRS, if the UE detects a DCI format 2\_0 indicating the flexible resource as flexible resource.*  *• if a SRS/UCCH/PUSCH/PRAH configured by higher layer in the flexible resource, the UE does not transmit the SRS/UCCH/PUSCH/PRAH, respectively, if the UE detects a DCI format 2\_0 indicating the flexible resource as flexible resource.*  ***Proposal 1:*** *Considering gNB’s full duplex structure, study a mechanism to achieve more than one potential transmission states at a time at the UE side could be supported.* |
| **LG Electronics [24]** | ***Proposal 1:*** *It should be prioritized to identify the issues that cannot be supported by the Rel-15 TDD configuration.* |
| **WILUS Inc. [25]** | ***Proposal 1:*** *RAN1 to study semi-static sub-band format configuration based on semi-static TDD slot format configuration.*  *‐ RAN1 to study cell-specific and/or UE-specific sub-band format configuration.*  ***Proposal 2:*** *RAN1 to study whether/how to support dynamic sub-band format indication.*  ***Proposal 3:*** *RAN1 to study the UE behavior for following cases on semi-static flexible sub-band.*  *‐ PDCCH monitoring in configured CORESET symbols.*  *‐ DCI-indicated DL reception or UL transmission.*  *‐ Higher layer configured DL reception or UL transmission.* |
| **ASUSTeK [26]** | ***Observation 1:*** *A new scenario that UE would expect either UL or DL could happen on a symbol arises for subband non-overlapping duplex.*  ***Proposal 1:*** *RAN1 further investigates whether existing symbol type, e.g. “F”, or a new symbol type is required to support subband non-overlapping duplex.*  ***Observation 2:*** *Legacy SFI assume a wideband transmission direction while subband non-overlapping duplex may require subband transmission direction(s).*  ***Proposal 2:*** *RAN1 further investigates whether subband transmission direction(s) is achieved by proper scheduling or frequency resource related information in DCI format 2\_0 is required in addition to signaled slot format.* |
| **Qualcomm Incorporated [30]** | ***Observation 5:*** *SBHD-based dynamic enables flexible adaption of slots direction based on traffic which leads to reduced latency and improved UL coverage.* |

### *Summary*

It is proposed that enhancement for the flexible symbols allocation can be studied [11]. In addition, in many contributions, methods for enhancement for supporting the subband non-overlapping full duplex are proposed. But, clarification seems to be necessary whether AI 9.3.3 is appropriate for discussion on these proposals.

### *1st Round Discussion*

**Companies are encouraged to provide views which issues regarding TDD configuration and resource allocation can be studied for potential enhancement on dynamic/flexible TDD in agenda item 9.3.3.**

|  |  |
| --- | --- |
| **Companies** | **Views** |
| New H3C | We need study/consider extending DL/UL slot format to support FD slots configuration and resource allocation for semi-static/dynamic FD configuration. |
| Panasonic | We have the same observation as FL. Many tdocs in this AI have discussed enhancement of slot format to support subband non-overlapping full duplex. It needs to be clarified how to organize the discussion in AI 9.3.2 and AI 9.3.3, respectively. |
| Huawei, HiSilicon | In our view, TDD configuration for FD-TDD/SBFD should be considered in AI 9.3.2. As for the flexible/dynamic TDD, the UL dominant TDD configuration can be achieved with legacy TDD configuration method. As gNB is half duplex (same with Rel-15) in flexible/dynamic TDD, the resource allocation/ flexible symbols allocation/ flexible symbols interpretation between UEs can be supported by the Rel-15 TDD configuration/ directional collision handling. |
| Nokia, NSB | In our view, supporting dynamic TDD is possible with existing mechanisms, i.e., semi-static TDD configuration with flexible symbols + dynamic DCI-based signalling. Enhancements for supporting sub-band full duplex should be discussed under agenda item 9.3.2. |
| NEC | We agree with FL that TDD configuration should be investigated in this AI as a baseline solution and then some necessary extension can be studied in 9.3.2. |
| QC | Support in principles. However, a lot of proposals in the summary above from different companies are for SBFD, not for dynamic TDD.  Need to further study whether and what potential enhancement needed for dynamic TDD. E.g. SBHD-based dynamic TDD (FR1), which enables flexible adaptation of slots direction based on traffic and it leads to reduced latency and improved UL coverage. |
| Ericsson | We share the same view as Nokia. The current specifications already support flexible/dynamic TDD, hence we do not see a need for ehancements. |
| Apple | We share same view as Nokia/NSB and Ericsson |
| OPPO | We do not see a need to enhance existing TDD configuration for dynamic/flexible TDD. |
| CATT1 | We need to better coordinate and organize the discussion of 9.3.2 and 9.3.3 to improve efficiency of the discussion. |
| Samsung | No. In our view, this would result in duplicated discussions with potentially different resulting solution for SBFD and d-/f-TDD. If there is benefit to enhancements of existing transmission/reception UE behavior, e.g., in slots/symbols configured as F, then these should be considered for SBFD and d-/f-TDD jointly. We see d-/f-TDD as a special case of SBFD operation. With SBFD, a frequency subband smaller than the UE channel BW can be configured for UL transmissions in a time-domain resource. With d-/f-TDD, this frequency subband where UL is possible comprises the entire UE channel BW. There is no need to artificially introduce a distinction where none needs to be.  We also note that existing R15 TDD provides much flexibility in terms of configuration the transmission direction of a symbol/slot and indicate this to the UE. For example, UE-specific UL/DL TDD configuration can configure # of DL symbols and # of UL symbols in each slots for the subset of resources determined as F in the common UL/DL TDD configuration. Dynamic SFI can indicate symbol direction on semi-static flexible symbol, by using the pre-determined DL/UL slot format table. The DL/UL slot format table already includes various slot format with one switching point and two switching point. A bigger existing limitation is that only FG 5-1 support is mandatory for the UE, but FG 5-1a (UE-specific RRC UL-DL frame configuration) and FG 3-6 (SFI) are optional UE features (and not usually implemented). Before developing new transmission/reception UE behavior, it may be best to mandate existing and available features for UEs with enhanced support of flexible TDD configuration.  We have similar views on any proposed changes to resource allocation and DL/UL collision handling which are well defined in Rel-15 and Rel-16. Critical problems should be described before studying the enhancements.  Indication of UL/DL resources is also under discussion in [109-e-R18-Duplex-03] (Issue #2) and corresponding FL proposals in Section 3.2 are up for consideration there. To avoid duplication of the same RAN1 discussion, we propose to not further include Section 4 TDD configuration in Round 2 of [109-e-R18-Duplex-04]. |
| NTT DOCOMO | We think TDD configuration for SBFD should be discussed in 9.3.2. And also we share the same view as NOKIA and Ericsson. |
| WILUS | We share the similar view with FL. It should be clarified whether to address SBFD in AI 9.3.3. Studies for enhancements on TDD configuration and resource allocation other than SBFD, current specification already provides enough flexibility. |
| ITRI | It needs to be clarified how to organize the discussion in AI 9.3.2 and AI 9.3.3, respectively. |

**Summary of 1st Round Discussion**

Based on the 1st round discussion, we can summarize as below:

***■ Issue#1:*** *Enhancement of slot format to support subband non-overlapping full duplex needs to be clarified how to organize the discussion in AI 9.3.2 and AI 9.3.3, respectively*

Support: Panasonic, CATT, WILUS, ITRI

**■ Issue#2:** Configuration for supporting sub-band full duplex should be discussed under AI 9.3.2

Support: Huawei/HiSilicon, NOKIA, NEC, Qualcomm, NTT DOCOMO

***■ Issue#3***

***● Option1:*** *Supporting dynamic TDD is possible with existing mechanism.*

Support: Huawei/HiSilicon, NOKIA, Ericsson (no need for enhancement), Apple, OPPO, Samsung, NTT DOCOMO, WILUS

***● Option2:*** *Need to further study whether and what potential enhancement needed for dynamic TDD (e.g., SBHD-based dynamic TDD (FR1))*

Support: Qualcomm

It is mentioned that enhancement of slot format to support subband non-overlapping full duplex needs to be clarified how to organize the discussion in AI 9.3.2 and AI 9.3.3, respectively, and configuration for supporting sub-band full duplex should be discussed under AI 9.3.2. From the observation, **FL recommends that enhancement for supporting the subband non-overlapping full duplex which are proposed under AI 9.3.3 is submitted and discussed under AI 9.3.2.** Also, we can conclude as below:

**Possible conclusion for 2nd round discussion**

Configuration for supporting sub-band full duplex is discussed under AI 9.3.2.

In addition, it is mentioned as majority view that supporting dynamic TDD is possible with existing mechanism. And one company wants to further study whether and what potential enhancement needed for dynamic TDD (e.g., SBHD-based dynamic TDD (FR1)). **FL recommends to continue 2nd round discussion, and especially focus on the discussion whether enhancement such as SBHD-based dynamic TDD (FR1) is needed or not for dynamic TDD.**

**Initial FL Question #7-1 for 2nd round discussion**

Companies are encouraged to provide a view whether enhancement such as SBHD-based dynamic TDD (FR1) is needed or not for dynamic TDD, and to provide a view whether enhancement such as SBHD-based dynamic TDD (FR1) should be discussed in AI 9.3.3.

### *2nd Round Discussion*

Possible conclusion for 2nd round discussion

Configuration for supporting sub-band full duplex is discussed under AI 9.3.2.

**Companies are invited to provide views on the above proposal.**

|  |  |
| --- | --- |
|  | **Company** |
| **Support** | NEC, Sony, Intel, QC, TCL, ITRI, New H3C, DOCOMO, vivo, Spreadtrum, Nokia, NSB, Panasonic, LG |
| **Not support** | Samsung, Ericsson |

|  |  |
| --- | --- |
| **Company** | **Views** |
| Samsung | We don’t think such a “formal” conclusion is needed. We consider this obvious. |
| Ericsson | Agree with Samsung |

Initial FL Question #7-1 for 2nd round discussion

Companies are encouraged to provide a view whether enhancement such as SBHD-based dynamic TDD (FR1) is needed or not for dynamic TDD, and to provide a view whether enhancement such as SBHD-based dynamic TDD (FR1) should be discussed in AI 9.3.3.

**Companies are invited to provide views on the above proposal.**

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|  | **Company** |
| **Support** | NEC, QC, TCL New H3C, LG |
| **Not support** | Ericsson |

|  |  |
| --- | --- |
| **Company** | **Views** |
| NEC | Open to discussion |
| Sony | Does SBHD means SubBand Half Duplex? What does this mean? What’s the point of having subband and do only half duplex? |
| Intel | It is not clear the purpose of introducing half duplex for SB operation. In our view, it is out of scope for study. |
| QC | As discussed in our Tdoc **# R1-2205032**, to enable dynamic TDD deployment in FR1 macro cell deployment with flexile adaptation of slot format based on traffic, we considered subband half-duplex (SBHD) deployment.  In asynchronous slots, where the cells have different traffic direction, the frequency resources of this slot could be split into DL subband and UL subband as show in Error: Reference source not found. This subband split provides frequency isolation between aggressor and victim gNBs with help to mitigate inter-gNB CLI      In the scenario where all slots are considered flexible subband as show below, it provides flexibility to adapt to traffic demand and addresses new hybrid topologies where use cases dictate use of different slot structures.  The ability to select direction based on traffic profile help **reducing blocking delay and improving latency**. Also, the availabity of fore UL TX opportunities for cell-edge UEs helps **improving UL coverage**. Finally, this deployment can be achieved by utilizes existing radio HW. This can prove subband operation as a viable approach to mitigate cross-link interference at cost of some of the resources.    Figure 4‑1: SBHD slots structure across cells  Initial link budget analysis that SB-based dynamic TDD is feasible for macro-cell deployment. In addition, adjacent channel coexistence can be handled by aligning the traffic direction of the edge subband with legacy statitc TDD operator.  Qualcomm has validated a [demonstration](https://www.youtube.com/watch?v=dTEah2hpt5k&list=PLADNcabi-P9ZbhXUkF-wlj9Hf1WzuaF-u) of 5G NR test network supporting subband half-duplex which enables Dynamic TDD and allows for more flexible service multiplexing as well as improve latency and coverage. |
| TCL | We are open to discuss SBHD further |
|  | We consider SBHD a gNB implementation solution supported by existing spec functionality (where joint BB scheduling is possible). It is in some sense one particular way of using d-TDD, e.g., not scheduling all available UL (or DL) resources, but it is also a particular way of operating SBFD, e.g., not using DL SBs in one cell, and not using the UL SB in the other cell. This shows that inherently, there is much flexibility when introducing an FDM component to the TDM component of the R15 d-TDD NR design.  We should discuss the system-level performance trade-off’s when using SBHD as a gNB scheduling strategy. There may be cases where SBHD penalizes cell SE (from scheduling restrictions) and other cases where the use of SBHD is more meaningful. From QC’s figures, there is no intra-subband interference (both gNB-gNB and UE-to-UE). In this sense, the interference scenarios with SBHD are a subset of those with SBFD. We prefer to discuss SBHD in AI9.3.2 if needed. |
| New H3C | OK for us. SBHD can be considered as a special case of SBFD. So, for further discussion. We’d better make is clear: Will AI 9.3.2 or AI 9.3.3 consider this? |
| DOCOMO | We are open for the discussion. On the other hands, we are not clear the difference between SBFD and SBHD-based dynamic TDD. The main difference is Same (for SBFD) / different (for SBHD-based dynamic TDD) DL/UL time and frequency re-source partition pattern for multiple cells ? |
| CATT | The question maybe better to form as where (9.3.2 or 9.3.3) to discuss SBHD.  Currently it is too early to decide if SBHD is ‘needed’ or not for dynamic TDD |
| vivo | Open to discuss. We think the benefits need further clarification. The cost of mitigating interference is reduced resource utilization. |
| Ericsson | Similar confusion as DOCOMO. It is not clear to us what is the difference between SBHD and SBFD. We find it strange that this scheme is referred to as dynamic TDD. |
| Huawei, HiSilicon | In our view, SBHD-based dynamic TDD (FR1) is a special case of SBFD. SBHD-based dynamic TDD (FR1) can be realized by implementation if SBFD is supported by the gNB, and should be discussed in AI 9.3.2.  In addition, as also pointed out other companies, this schemes seems inefficient since the gNB can only operates with DL or UL transmissions on only part of the spectrum resources. |
| Spreadtrum | We are open for the discussion. But we also think it is a special case of dynamic/flexible TDD and it can be implemented by gNB scheduling. It is more of a CLI handling method than a new scheme. |
| Nokia, NSB | In our view, SBHD is a particular case of SBFD in which cells are configured to only schedule one direction/subband per slot. Like SBFD, SBHD creates new types of interference, e.g., gNB-to-gNB co-channel inter-band CLI, which are not in the scope of dynamic TDD. Therefore, we propose that SBHD should be discussed in AI 9.3.2. |
| LG | We are okay for the proposal and discuss further on SBHD. It is our understanding that dynamic/flexible TDD is already can be configured via cell specific RRC, UE specific RRC and SFI. Considering the detailed concept and configuration methods of sub-band will be introduced in discussion on SBFD, i.e., AI 9.3.2, we can reuse them in dynamic/flexible TDD, however introducing it in this AI seems not desirable to us since it could lead confusion and potentially duplicated discussion. |

**Summary of 2nd Round Discussion**

Based on the 2nd round discussion, we can summarize as below:

**(1) Configuration for supporting sub-band full duplex proposed under AI9.3.3**

It is observed that most of company agree with the intention of the possible conclusion for 2nd round discussion. One company is thinking that the conclusion is not necessary. Either conclusion or recommendation or anything else is fine if companies are commonly thinking no more discussion about configuration for supporting sub-band full duplex proposed under AI9.3.3

**(2) Subband-based dynamic TDD proposed Qualcomm**

From the QC's explanation, it is observed that the main benefit of ‘subband-based dynamic TDD’ seems to reduce inter-cell co-channel gNB-to-gNB CLI / inter-cell co-channel UE-to-UE CLI by means of time/frequency resource separation among cells with co-channel. If network want to enjoy the benefit of separation of time/frequency resource among cells, information exchange among network seems to be necessary. If correctly understood, this topic seems to be sorted as an enhancement of information exchange among cells (e.g., **enhancement of intended TDD configuration for supporting subband-based dynamic TDD**), and **this could be identified as a potential discussion topic at section 3.3 ‘Inter-cell gNB-to-gNB CLI’ and/or section 3.5 ‘Information Exchange’ in the documentation of discussion summary for AI 9.3.3, if necessary.**

At the same time, it seems inter-cell inter-subband gNB-to-gNB CLI / inter-cell inter-subband UE-to-UE CLI scenarios should be solved if these types of CLI potentially affect detection of desired signal. If correctly understood, **subband-based dynamic TDD can be discussed as a special case of SBFB specific CLI handling, if necessary.**

**From above summary of 2nd round discussion, FL recommends as below:**

**FL recommendation from 2nd round discussion**

* No more discussion about ‘TDD configuration, Resource allocation’ in section 4 of documentation for discussion summary in AI 9.3.3
* Whether discussion Enhancement of intended TDD configuration for supporting subband-based dynamic is necessary or not can be treated in section 3.3 ‘Inter-cell gNB-to-gNB CLI’ and/or section 3.5 ‘Information exchange’ in this documentation.
* Subband-based dynamic TDD can be discussed as a special case of SBFB specific CLI handling, if necessary.

### *3rd Round Discussion*

FL recommendation from 2nd round discussion

* No more discussion about ‘TDD configuration, Resource allocation’ in section 4 of documentation for discussion summary in AI 9.3.3
* Whether discussion Enhancement of intended TDD configuration for supporting subband-based dynamic is necessary or not can be treated in section 3.3 ‘Inter-cell gNB-to-gNB CLI’ and/or section 3.5 ‘Information exchange’ in this documentation.
* Subband-based dynamic TDD can be discussed as a special case of SBF~~B~~D specific CLI handling, if necessary.

**Companies are invited to provide views on the above recommendation.**

|  |  |
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|  | **Company** |
| **Support** |  |
| **Not support** |  |

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| --- | --- |
| **Company** | **Views** |
|  |  |

# FL Proposals for GTW session and Email Approval

## 2nd Round Discussion

**1) Deployment scenario**

FL recommendation from 2nd round discussion

* For discussion in AI 9.3.3, consider the deployment scenarios for dynamic/flexible TDD which are agreed for evaluation purpose under AI 9.3.1.
* Under AI 9.3.3., no more discussion about the deployment scenario for potential enhancement on dynamic/flexible TDD

**2) Interference Scenario**

Further updated FL Proposal #2-1 (1) from 2nd round discussion

Following interference scenarios can be considered for study of dynamic/flexible TDD ~~[and SBFD]~~:

* gNB-to-gNB co-channel interference
* UE-to-UE co-channel interference
* ~~Note: For SBFD, this is limited to gNB-to-gNB intra-subband interference and UE-to-UE intra-subband interference~~

Updated Initial FL Conclusion #3-1 from 2nd round discussion

The self-interference scenario and inter-subband CLI scenario can be considered under AI 9.3.2.

* gNB self-interference
* UE-to-UE intra-cell co-channel inter-subband CLI
* UE-to-UE inter-cell co-channel inter-subband CLI

**3) How to distinguish CLI handling schemes for dynamic/flexible TDD and SBFD**

Initial FL Conclusion #3-2 from 2nd round discussion

* For discussion under AI 9.3.3, suggestions from Skeleton are followed.
* Note: AI 9.3.3 captures the potential inter-gNB and inter-UE CLI handling schemes that are specific for dynamic TDD and schemes that are common for both SBFD and dynamic/flexible TDD.
* Note: AI 9.3.2 captures the potential inter-gNB and inter-UE CLI handling schemes that are specific for SBFD.
* A list of candidate solutions for CLI handling for potential enhancement on dynamic/flexible TDD is identified in RAN1#109-e meeting, then discussion to identify which scheme is for common or duplex scheme specific solutions will be started from RAN1#110 meeting.

**4) gNB-to-gNB CLI handling scheme**

Further Updated FL Proposal #4-1 from 2nd round discussion

For study of potential enhancement on dynamic/flexible TDD, followings are considered as candidates of potential enhancement method of gNB-to-gNB CLI handling, where further prioritization/down-scoping of candidate schemes for study can be done in the future meetings:

* gNB-to-gNB CLI measurement and reporting
* Coordinated scheduling (e.g., separated UL/DL subband)
* Beamforming based solution (e.g., Tx/Rx beamforming, DL/UL beam pair for FR2, Tx beamforming without beam information exchange across gNB’s interface, Tx beamforming with beam information exchange across gNB’s interface)
* Advanced Receiver (e.g., IRC receiver)
* Timing alignment (e.g., timing-synchronization assistance information exchange)
* Power control based solution
* Enhancement on solution based on Rel-16 RIM (e.g., possible enhancements to the RIM signaling design)
* Enhancement on the backhaul/OTA signaling
* Note: Any other scheme(s) for inter-gNB CLI handling is/are not be precluded.
* Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.

**5) UE-to-UE CLI handling scheme**

Further Updated FL Proposal #5-1 from 2nd round discussion

For study of potential enhancement on dynamic/flexible TDD, followings are considered as candidates of potential enhancement method of UE-to-UE CLI handling, where further prioritization/down-scoping of candidate schemes for study can be done in the future meetings:

* Improvements to CLI measurement/reporting latency, flexibility and overhead, e.g. L1/L2 based UE-to-UE CLI measurement and reporting.
* Spatial domain enhancements, e.g. UE Rx beam (QCL-D) configuration and indication per CLI measurement resource, and preferred/restricted Tx/Rx beams, Joint beam management
* UE UL power control and gNB DL power adjustment
* Transmission and reception timing
* Measurement Resource, e.g. a unified design for CLI RS for both gNB-to-gNB and UE-to-UE measurement
* Sensing based mechanism
* Note: Any other scheme(s) for inter-UE CLI handling is/are not be precluded.
* Note: For potential enhancements on dynamic/flexible TDD, utilize the outcome of discussion in Rel-15 and Rel-16 while avoiding the repetition of the same discussion.

**6) Enhancement of Information Exchange among gNBs for CLI handling**

Updated FL proposal#6-1 from 2nd round discussion

The enhancement of information exchange between gNBs is studied in Rel-18 Duplex Evolution Study Item

* Identify the information to be exchanged depending on CLI handling scheme

**7) TDD configuration, Resource allocation**

FL recommendation from 2nd round discussion

* No more discussion about ‘TDD configuration, Resource allocation’ in section 4 of documentation for discussion summary in AI 9.3.3
* Whether discussion Enhancement of intended TDD configuration for supporting subband-based dynamic is necessary or not can be treated in section 3.3 ‘Inter-cell gNB-to-gNB CLI’ and/or section 3.5 ‘Information exchange’ in this documentation.
* Subband-based dynamic TDD can be discussed as a special case of SBFB specific CLI handling, if necessary.

## 3rd Round Discussion

# Contact Person

Please provide the information of the contact person for the purpose of discussion facilitation

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
| CEWiT | Priyanka Dey | priyanka@cewit.org.in |
| New H3C | Lei Kong | kong.lei@h3c.com |
| Spreadtrum | Shuai Zhang | Shuai.Zhang6@unisoc.com |
| Panasonic | Quan Kuang | quan.kuang@eu.panasonic.com |
| Nokia/NSB | Quang Nhan | nhat-quang.nhan@nokia.com |
| CMCC | Tuo Yang | yangtuo@chinamobile.com |
| InterDigital | Jonghyun Park | jonghyun.park@interdigital.com |
| Intel | Gary Xiong | gang.xiong@intel.com |
| NEC | Pravjyot Singh Deogun | pravjyot.deogun@emea.nec.com |
| QC | Emily (Qian) Zhang | [qiaz@qti.qualcomm.com](mailto:qiaz@qti.qualcomm.com) |
| Samsung | Marian Rudolf  Kyungjun Choi | m.rudolf@partner.samsung.com  kyungj.choi@samsung.com |
| NTT DOCOMO | Daisuke Kurita | kuritad@nttdocomo.com |
| Sharp | Tomoki Yoshimura | yoshimurat@sharplabs.com |
| LG | Jaenam Shim | jaenam.shim@lge.com |
| Xiaomi | Yajun Zhu | zhuyajun@xiaomi.com |
| WILUS | David (Geunyoung) Seok | david.seok@wilusgroup.com |
| ITRI | Jen-Hsien Chen | itriA40175@itri.org.tw |
| Sony | Shin Horng Wong | Shinhorng.wong@sony.com |
| TCL | Shahid Jan | [shahid.jan@tcl.com](mailto:shahid.jan@tcl.com) |
| Apple | Ali Fakoorian | sfakoorian@apple.com |
| vivo | Na Li | Lina5g@vivo.com |
| Lenovo | Yuantao Zhang | zhangyt18@lenovo.com |
| SK Telecom | Sanghoon Cho | seanc.cho@sk.com |

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2. R1-2203205 Discussion of enhancements on dynamic/flexible TDD ZTE
3. R1-2203216 Discussion for potential enhancements on dynamic/flexible TDD New H3C Technologies Co., Ltd.
4. R1-2203221 Potential enhancement on dynamic/flexible TDD TCL Communication Ltd.
5. R1-2203329 Discussion on potential enhancements on dynamic/flexible TDD Spreadtrum Communications
6. R1-2203460 Discussion on potential enhancements on dynamic/flexible TDD CATT
7. R1-2203559 Potential enhancements on dynamic/flexible TDD vivo
8. R1-2203733 Enhancements to dynamic/flexible TDD for Full Duplex operation Sony
9. R1-2203816 Discussion on potential enhancements on dynamic TDD xiaomi
10. R1-2203905 Dynamic and flexible TDD for duplex evalution Samsung
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