

[RAN94e-R18Prep-07] Evolution of Duplex Operation - Version 0.0.8
RAN

3GPP TSG RAN#94e RP-212667

Electronic Meeting, December 6 – 17, 2021

Agenda Item: 8A.1

Source: Samsung

Title: Moderator’s summary for discussion [RAN94e-R18Prep-07] Evolution of Duplex Operation

Document for: Information & Decision

The discussion in this thread covers topic #7 “Evolution of duplex operation” and email discussion deadline and NWM organization are based on the guidelines provided by the RAN Chair [RP-212657].

The goal of the email discussion is to focus on potential scope/areas for each potential WI or SI, with NO intention to update the set and the organization of the topics as endorsed in RP-212608

- Any further update/consolidation of the topics/structure is to be handled in RAN#94-e
- Aim to identify whether a topic should be a SI, or WI (including possibly a study phase for some scope(s))
- Aim to identify on the leading WG (including if any change compared with those in RP-212608) and the secondary WG(s)
- Aim to identify on the potential interaction with SA/CT
- Critical to keep all items under rigorous check; important to avoid “number counting” driven discussion, but focus on tangible commercial interests (near & longer terms)

1 Initial Round

1.1 General

Below is the final summary from last email discussion prior to RAN#93-e for duplex enhancement.

1. Rel-18 work plan:

- [Non-controversial] Study should be performed first.
- [Controversial] Planning of potential follow-up normative work. Continue discussion.

2. Duplex mode:

- [Non-controversial] TDD is included in the scope.
- [Controversial] Whether FDD will be included in the scope. Continue discussion.

3. Duplex enhancement at gNB only?:

- [Non-controversial] Duplex enhancement at gNB is included in the scope.
- [Controversial] Whether duplex enhancement at UE will be included in the scope. Continue discussion.

4. [Controversial] Duplex enhancement approaches:

- Continue discussion whether all of the three identified full duplex schemes (subband non-overlapping, subband overlapping, full overlapping) or a subset of them should be studied.
- Continue discussion about the need for CLI enhancement on dynamic/flexible TDD.

5. [Non-controversial] Interference management: Organize the study as follows.

- Study inter-gNB and inter-UE CLI and identify solutions to manage them [RAN1]
- Study RF requirements considering the self-interference and the inter-operator CLI at gNB [RAN4]
- Study co-channel and adjacent-channel co-existence with the legacy operation [RAN1/4]. Continue discussion how to organize interaction between RAN1 and RAN4.

6. [Controversial] Deployment scenarios: Continue discussion aiming to narrow down the deployment scenarios to be considered.

7. [Controversial] Frequency range: There was not much discussion on which frequency ranges have to be considered. Continue discussion on the frequency range to be considered.

The moderator proposes to focus on the work scope in the initial round of discussion. Whether the follow-up normative work can take place in Rel-18 can be discussed later after stabilizing the work scope.

Feedback Form 1:

1 – Spark NZ Ltd

Comments from Spark NZ.

TDD frame structures are mandated in local regulations. Often the period of spectrum assignment ranges from 10- 20 years. Operators in a TDD band must apply the same frame structure, should be time synchronised and frame aligned. Adjacent bands co existence is also based on known frame structures. Suppose a band has say 3 operators A,B,C respectively each with their own radio and core networks, operator B cannot unilaterally make changes to the frame structure unless A and C agree. Interference arising from in compatible frame structures such as the legacy frame structure and the new one could result in loss of performance and consequent litigation. Therefore changing the frame structure such as being discussed in this study have serious regulatory implications and can only be implemented if all operators in the same band and possibly adjacent bands agree.

Furthermore backwards compatibility with the legacy architecture is an issue and this must be proven before going too far in this study. The arguments made thus far are not convincing that adequate interference mitigation measures will be in place to account for the above concerns.

2 – Spark NZ Ltd

if we must proceed with a study with a limited scope it should only be a study item and NOT a work item until the feasibility is proven

3 – TELECOM ITALIA S.p.A.

The points raised by Spark is very important and need to be addressed. The different proposals do not seem to address the issue of inter-operator synchronization which is the REAL limiting factor in TDD operation. Therefore the work should focus on 1.5 interference management and "Continue discussion about the need for CLI enhancement on dynamic/flexible TDD".

Note that flexible TDD operation (if feasible) is a real urgent market need, which should be addressed urgently by 3GPP, while evolution of duplex operation is more a long term objective

4 – China Mobile Com. Corporation

We would better not to preclude the possibility of a follow-up WI at the beginning. From operator perspective, we prefer a follow-up normative work in Rel-18 and the work scope can be restricted to subband non-overlapping full duplex schemes to make it realistic to complete the WI.

Another alternative can be considered as our second preference, i.e., a comprehensive and thorough investigation in the study item without follow-up WI on all potential full duplex schemes including subband non-overlapping full duplex and full overlapping full duplex.

5 – Intel Corporation (UK) Ltd

[Intel]

On duplex evolution, careful studies are necessary, especially in RAN4, to establish feasibility and to determine reasonable assumptions on different levels of isolation. In this regard, studies in RAN4 should be prioritized, relatively timed (as against following RAN1 studies), and budgeted accordingly. This includes even the case of sub-band non-overlapping case, for which, e.g., RAN4 studies should first help establish the appropriate assumptions on filtering at gNB and UE transceivers. The overall set of SI objectives should be defined accordingly with clear guidance on the dependence on outcome of RAN4 feasibility studies.

6 – Nokia Corporation

In our view it is important to carefully study this area. Therefore, we expect that study will take the entire release if complex flexible/full duplex solutions are included to the study. If the study focuses on enhancements for flexible DL/UL allocations in TDD only (i.e. enabling dynamic TDD in practical deployments), shorter study with follow-up WI would be possible.

Detailed scope definition is needed for the study since good collaboration between RAN1 and RAN4 is critical to succeed in the study. At the moment the scope description above is too generic. In our view it is important to explicitly identify and define in the SID scope what are especially important aspects to study. For instance, in our view it is important to carefully study what are limiting factors for the performance. For instance, if RF performance, requirements and self-interference aspects are limiting factors for the performance, CLI related enhancements will not help the performance in those cases. Therefore, especially RAN4 studies on RF co-channel and adjacent channel performance aspects, self-interference issues and related constraints for feasible deployment scenarios need to be studied in the early phase of the study item.

Thus, the study should start with the following task: Study and identify target deployment scenario(s) and assumptions including frequency ranges for the Phase 1 and Phase 2 studies [RAN1, RAN4]. As part of this first task RAN4 should also validate targeted deployment scenarios against BS and UE RF requirements. After this phase enhancement studies for targeting deployment scenarios could start.

7 – Nokia Corporation

Nokia comments continue:

Like commented Telecom Italia also in our view in the enhancement studies, it would be important to first focus on studies of enhancements for short term deployment needs and thereby to study how to enhance TDD flexibility in practical deployments. For this purpose, the following RAN4 and RAN1 studies should be conducted.

- Study and identify solutions for gNB-2-gNB Cross Link Co-channel Interference mitigation [RAN1]
 - o Solutions discussed in Rel-14 SI on NR (TR 38.802) to be used as starting point
- Study further Cross Link inter-cell co-channel UE-2-UE interference mitigation enhancements [RAN1]
 - o E.g. de-prioritized cases in Rel-16 and additional network signaling

More complex duplex operation enhancements should be studied in the second phase of the studies. In the second phase of these enhancement studies the following aspects should be studied:

- Study system performance of flexible/full duplex TDD when legacy UEs are operating on the same and adjacent TDD channel. Study impacts of flexible/full duplex TDD on legacy UE performance and operations [RAN1, RAN4]
- Study UE RF in-band requirement enhancements [RAN4]
- Study system level impacts and new potential solutions for UE-2-UE Cross Link intra-cell co-channel interference mitigation if gains exist over already standardized mechanisms [RAN1]
- Study self interference issues and their impacts on gNB performance and needs for gNB requirement enhancements [RAN4]
- Study self interference issues and their impacts on UE performance and needs for UE requirement enhancements [RAN4]

8 – China Unicom

From operator's point of view, we also strongly suggest to the scenario that gNBs configured with different TDD frame structures has high priority, considering both intra-operator and inter-operator (adjacent frequency). This is a practical and urgent deployment scenario for 5G commercial network.

For work plan, at this stage work item should not be precluded. At least the normative work related to some high priority and limited specification impact parts should not be precluded.

9 – ZTE Corporation

We are generally fine to first focus on the scope in the initial round of discussion. However, we should keep in mind that this is the first SI studying full duplex thoroughly for NR, which may require lots of effort from working groups to study the potential requirements, scenarios, potential solutions and potential gain, especially for RAN1 and RAN4. Thus, a SI spanning all the release seems to be more appropriate.

10 – KDDI Corporation

We have the same view as CMCC's first preference that we should not preclude following normative work. Given the situation that careful studies are necessary, in order to include study and following work in a limited TU, we should focus on the most feasible full duplex scheme i.e., sub-band based non-overlapping and limit duplex mode to TDD only.

11 – Samsung Electronics Co.

We think that it is in reach to aim for a R18 SI followed by a R18 WI on duplex enhancements.

12 – Fujitsu Limited

Fine to focus on the work scope in the initial round of discussion.

13 – MediaTek Inc.

Based on current scoping, the study is at least a cross-RAN1//4 work. Considering the potential impacts on NR system in both intra-operator and inter-operator scenarios, we don't see the possibility to complete the whole study and normative works within Rel-18 time frame, even with good collaboration between RAN1 and RAN4. We think entire Rel-18 time frame is needed to make sure thorough study covering every aspect, especially for RAN4 aspects.

14 – HUAWEI TECHNOLOGIES Co. Ltd.

AS commented by Telecom Italia, there is real urgent market needs for dynamic/flexible TDD. Such market needs should be carefully addressed in this duplex evolution item. Inter-gNB CLI handling for dynamic/flexible TDD in Rel-15/16/17 is not standardized except intended TDD configuration signaling between gNBs, and the available solution is not sufficient to enable efficient dynamic/flexible TDD for factory applications. So, for interference management, enhancement in cross link interference management should be considered for the dynamic/flexible TDD scenario.

15 – Telia Company AB

The work should focus on studying and finding practical solutions for inter-operator 5G TDD networks related interference management. We support work on "Continue discussion about the need for CLI enhancement on dynamic/flexible TDD".

16 – Sony Europe B.V.

Rel-18 work plan: A follow-up WI is preferred, with realistic features preferably minimising any RF requirements at the UE.

Duplex mode: Focus on TDD since there is likely to be a lot of bandwidth in FR2.

Duplex enhancement at gNB/UE: For Rel-18, we should focus on gNB enhancement thereby minimising any RF or hardware enhancements at the UE.

Duplex Enhancement approaches: For Study Item, we can consider all 3 duplex schemes but for the follow up WI, we specify only for non-overlapping sub-band.

17 – Motorola Mobility UK Ltd.

We would like RAN to limit the work scope to more promising and feasible scenarios so that normative work can take place in Rel-18.

18 – Apple France

We prefer the R18 performs starts as a study item on objectives that majority agree on, i.e. full-duplex operation in TDD band at non-overlapping sub-bands at gNB only.

19 – Verizon UK Ltd

We are supportive of a SI first and open to a follow up WI if the feasibility is proven.

20 – Ericsson LM

Full duplex operation has impacts on many aspects of the system that need careful study. It is better to focus only on a study item in Rel-18 and make sure that all aspects are thoroughly studied before starting any discussions on a potential work item. It is important to consider the following for the study in Rel-18 on full duplex operation,

- Early and substantial involvement of RAN4 to ensure that practical implementation aspects are properly considered.
- Evaluation of system level performance and co-existence in a variety of scenarios using realistic and feasible models and assumptions to accurately capture potential real-world gains and the scenarios in which such gains may be seen.
- The scope of the study should be defined carefully to focus on more realistic cases such as full duplex with different frequency resources and to avoid repeating work done in previous study and work items, e.g., on cross-link interference mitigation.

21 – LG Uplus

We should step on WI stage within Rel-18 timeline after SI with sufficiently small area is done. The scope of SI need to be carefully focused on practical cases such as only gNB side impact and non-overlapped sub-band to prevent device complexity increase and regulation impact from near band. We think only study about all the cases over whole Rel-18 timeline without commercialization verification cannot get good shape of Rel-19 WI. XDD is really key feature for UL improvement which is a major bottle neck of NR SA as many companies agree.

22 – Qualcomm Korea

Careful study on the feasibility of the full duplex scheme(s) is necessary before discussing whether the follow-up normative work can take place in Rel-18. It is premature to discuss normative work without understanding details of various requirements, potential enhancement solutions, etc. that can be established through the Rel-18 study item.

1.2 Duplex mode

Taking into account the outcome of the last email discussion prior to RAN#93-e, the moderator proposal is as follows.

- Conclude that TDD is included in the scope.
- Company views are invited on whether FDD will be included in the scope.

Feedback Form 2:

1 – OPPO

OPPO does not support to include FDD in the scope, due to following reasons:

- Regional regulations.
- UE implementation feasibility/complexity.
- feature overlapping with other potential RAN enhancements, such as flexible spectrum (between DL and UL).
- Likely limited TUs available in Rel-18 for duplex enhancement.

2 – Spark NZ Ltd

Comments from Spark NZ.

Pls refer to the comments above in General. we have serious reservations about the feasibility and deployment of the various duplex evolution approaches being discussed.

3 – Spark NZ Ltd

The above comments also apply to FDD bands

4 – China Telecommunications

From China Telecom’s view, we prefer to study duplex evolution for FDD as well. The FDD paired spectrum also has useful scenarios in operators’ deployment and some of FDD low band LTE spectrum will likely to begin to be re-farmed for NR usage. However, it does not offer any means to effectively allocate the UL DL resource split to adapt the traffic with asymmetric and ratio changing DL/UL service until now.

It is not impossible to apply for the change of regulations in the future due to the proved gain in FDD and the controllable interferences. We haven’t seen much UE complexity to support transmission direction change in FDD spectrum without supporting full duplex. The difference from flexible spectrum integration is allowing transmission direction change and providing flexible UL DL even with one paired UL DL spectrum.

If companies have strong concern for duplex evolution of FDD spectrum, we can agree to study TDD with priority.

5 – vivo Communication Technology

We prefer to limit the Rel-18 study to TDD only.

6 – TELECOM ITALIA S.p.A.

see general comment

7 – China Mobile Com. Corporation

We do not support to include FDD in the scope with the following reasons.

- Compared with subband non-overlapping duplex operation in TDD band, it is hard to justify the latency/coverage gain, since FDD band is already full duplex mode and enough uplink time resources are already available.
- Full-duplex operation in FDD may raise regulatory concerns.
- Limited TUs

8 – Intel Corporation (UK) Ltd**Intel**

We support limiting the study to TDD only. As discussed during the Rel-18 WS and RAN #93-e, FDD should not be included due to regulatory constraints for supporting “TDD in FDD” (limiting the applicability in the first place), significant impact to UE side, impact to legacy UEs, and rather limited motivation in the first place.

9 – Spreadtrum Communications

R18 should not include FDD, considering regional regulations and limited TU. In addition, we want to clarify that unlicensed band is not considered in R18 as well.

10 – Beijing Xiaomi Electronics

We prefer to focus on TDD only in Rel-18. Same reasoning as CMCC.

11 – NTT DOCOMO INC.

For the sub-band scheme, we think focusing on TDD bands would be sufficient with considering the bandwidth of FDD bands that are generally too narrow especially for the sub-band non-overlapping operation. And the motivation/benefit to support full duplex in FDD is not so strong considering that there are available UL resources every slot.

12 – Nokia Corporation

In our view Rel-18 study should focus on TDD only.

13 – NEC Corporation

NEC does not support to include FDD in the scope as considering the UE RF requirement implementation feasibility/complexity.

14 – Panasonic Corporation

Our understanding is FDD requires the study to collect regional regulations. In addition, UE is required to have additional receiver in (current) UL band or additional transceiver in (current) DL band. Instead of to study them, understanding the urgent need for TDD for inter-operator synchronization scenario, our proposal is to focus TDD in Rel.17.

<p>15 – ZTE Corporation</p> <p>We are open to include FDD in the scope. However, if majority companies prefer not to have it in Rel-18, we could go with the majority view.</p>
<p>16 – KDDI Corporation</p> <p>We prefer to focus on TDD only in Rel-18.</p>
<p>17 – Samsung Electronics Co.</p> <p>We support including only the TDD spectrum in the SI on duplex evolution. Considering the low commercial interest due to small bandwidth size and lower spectrum range for FDD FR1, different from TDD FR1 inter-operator interference scenarios, and the more limited benefits of potential use cases to use the FDD DL in the FDD UL channel, we see no strong motivation to include FDD spectrum enhancements.</p>
<p>18 – Fujitsu Limited</p> <p>We prefer to focus on TDD only.</p>
<p>19 – MediaTek Inc.</p> <p>Considering regulation restriction and target system benefits, Rel-18 study should include TDD only and we don't the needs to include FDD.</p>
<p>20 – SHARP Corporation</p> <p>We think uplink coverage is an important motivation for this study. For FDD, continuous uplink time resources are always available. Therefore, no issue exists.</p>
<p>21 – VODAFONE Group Plc</p> <p>Focus on TDD only is OK.</p>
<p>22 – CEWiT</p> <p>For Rel. 18, we can focus only on TDD bands since regional regulatory aspects need to be considered to study full duplexing in FDD bands. Considering the limited time, we should prioritize study in TDD bands in Rel. 18.</p>
<p>23 – HUAWEI TECHNOLOGIES Co. Ltd.</p> <p>We prefer to focus this item on TDD spectrum. There may be some long-term interests for FDD spectrum, and it can be considered in later releases taking into account the outcome of the study for TDD spectrum.</p>
<p>24 – Telia Company AB</p> <p>Priority in TDD, no objection to FDD studies.</p>
<p>25 – Futurewei Technologies</p> <p>We prefer to have TDD only in Rel. 18 due to the limited time.</p>

26 – Sony Europe B.V.

We agree to consider only TDD.

FDD can already perform full duplex and it isn't clear what the gain would be to further allow full duplex within the DL and UL bands. FDD can be considered in later releases.

27 – InterDigital

We prefer to focus on TDD only in Rel-18, at least considering the limited TUs and the strong motivation on managing UL resources efficiently, while FDD always has available UL resources.

28 – CATT

The current commercial demand mainly focuses on UL coverage, latency and throughput enhancement in TDD mode with limited UL duty cycle, which is also the main motivation of study for full duplex. Furthermore, deploying full duplex on paired spectrum might bring regulatory issues. So we don't prefer to include FDD in R18 full duplex scope.

29 – Motorola Mobility UK Ltd.

We prefer to limit the Rel-18 scope to TDD only.

30 – Apple France

Some of the objectives that proponents of the full-duplex operation in TDD envision, like uplink latency reduction, are already achievable in a paired spectrum. In addition, as mentioned by couple of other companies, there may be regulatory concerns associated with full-duplex operation in FDD. So we prefer TDD only

31 – Ericsson LM

It would be better to first focus on studying the key problems that need to be addressed for the technology to work. The study should focus on TDD bands especially considering that one of the main issues cited for the study is coverage improvements in TDD bands with DL-heavy DL-UL ratios. As pointed out by others, there will likely be additional regulatory and coexistence issues in FDD bands as well.

32 – LG Uplus

Within Rel-18, we should focus on TDD band only.

33 – Qualcomm Korea

We don't support Duplex enhancement in FDD. In our views, full duplex in FDD spectrum is not necessary because the biggest two motivation to deploy full duplex is to reduce latency and enhance UL coverage, which are already supported in FDD. In addition, there are regularity issues. We think that focusing on TDD only would increase the chances to conclude the SI without getting de-railed with regulatory time sinks that looking into full duplex for FDD would bring about.

34 – China Unicom

We prefer to focus on TDD mode only in Rel-18.

1.3 Duplex enhancement at gNB only?

Taking into account the outcome of the last email discussion prior to RAN#93-e, the moderator proposal is as follows.

- Conclude that duplex enhancement at gNB is included in the scope.
- Company views are invited on whether duplex enhancement at UE will be included in the scope.

Feedback Form 3:

1 – OPPO

OPPO does not support to consider Rel-18 duplex enhancement on UE side, due to following reasons:

- Full duplex on Uu-interface could have fundamental impacts to transmitter/receiver operations. It is better to open the spec to these new fundamental impacts step-by-step, even with validation from real deployment/field-trial. So starting from gNB-only enhancement could help to build a healthy long-term development of duplex enhancement.
- Potential UE hardware limitations (e.g., subject to UE size) at this time may anyway keep UE not being able to sufficiently enjoy the benefit of UE-side full duplex.
- Likely limited TUs available in Rel-18 for duplex enhancement.

2 – Spark NZ Ltd

The complete potential of duplex evolution can only be realised if it is implemented at both the gNB and UE. Whilst it may be possible at some large cost in signal processing to mitigate interference (self and adjacent cells at the gNB , certainly at the UE side the signal processing to mitigate self interference will impact on battery life, the isolation needed may also require separate Tx and Rx antennas. Given the form factor of UEs this will be an welcome requirement.

Intercell interference at teh base station can only be fully mitigated if the channel state informations of the interfering paths are known. This in turn means inter gNB co ordination links of un known capacity must be in place adding to latency and transport network complexity.

Therefore we have serious reservations on teh duplex evolution at either gNB or UE side

3 – Spark NZ Ltd

Typo above:
unwelcome requirement

4 – AT&T

We are ok with limiting the scope to gNB only in Rel-18.

5 – China Telecommunications

We prefer full duplex at UE is not considered at first study phase, due to UE complexity, feasibility, power consumption, and cost to implement full duplex.

6 – vivo Communication Technology

In our view, enhanced duplexing at the UE side is premature from commercial device perspective due to implementation constraint. Rel-18 study shall focus on gNB side only.

7 – China Mobile Com. Corporation

We think the UE hardware impact should be minimized, although UE behavior may be enhanced for Rel-18 UE. It is well-known that it is much harder for UEs to implement full-duplex due to the constraints on size, power and processing capabilities. Therefore, duplex enhancement at UE should be avoided in Rel-18.

8 – Intel Corporation (UK) Ltd**Intel**

We support limiting the study to duplex enhancements at the gNB side only.

In the context of practical deployments and commercial solutions, the feasibility of full duplex at the UE remains to be ascertained considering limited resources and form factor at the UE side to realize proper isolation. Thus, duplex enhancements at the UE should NOT be considered within the scope of Rel-18 studies. *However, it should be noted that this does not preclude the study of UE side enhancements to enables the full duplex side operation at the gNB side.*

9 – Intel Corporation (UK) Ltd**Intel**

We support the proposal from the moderator.

We would like to emphasize that the consideration of dynamic/flexible TDD in multi-cellular deployments should be one of the first steps since they form a necessary component to support of enhanced duplex operations. Further, dynamic/flexible TDD operation, under similar assumptions on NW coordination, should be the baseline for evaluation of potential gains from any enhanced duplexing scheme.

On other full duplex schemes, both should not be in scope for Rel-18 studies. Just handling the case of sub-band non-overlapping requires considerable investigations by RAN4 and RAN1. Adding the “overlapping” cases would not be reasonable at this stage, especially when practically achievable levels of isolation at the gNB for real-world multi-cellular deployments remain unclear and the impact to UE implementation is likely significant.

10 – Intel Corporation (UK) Ltd**Intel**

Please ignore comment #9 (it was for Section 1.4).

11 – Spreadtrum Communications

It is better have a step-by-step evolution. We don't support duplex enhancement at UE in R18, considering UE implementation complexity, feasibility, and form factor.

12 – Beijing Xiaomi Electronics

We support to limit the duplex enhancement at gNB side. From our perspective, it is a very challenging work if full duplex is supported at UE side, not only on the hardware but also the uncontrollable workload. We prefer a more smooth way on the study of duplex enhancement.

13 – NTT DOCOMO INC.

We support Rel-18 covers only gNB full duplex operation with considering UE device size, e.g., difficulty for self-interference isolation.

14 – Nokia Corporation

In our view it is important to study both gNB and UE enhancements to understand real performance benefits and limiting factors. Also, legacy UE impacts need to be studied carefully. In the future work item phase step-by-step approach can be considered but this decision should be done only after actual technical studies and related findings.

15 – NEC Corporation

We think Rel-18 can focus on full duplex at gNB side only, and half duplex operation should be assumed at UE. And duplex enhancement at UE could not be included in the scope.

16 – Panasonic Corporation

Our view is not to include UE side in order to manage UE complexity with reasonable level.

17 – LG Electronics Inc.

Taking into account work load and specification impact, we think duplex enhancement at gNB only is a reasonable choice for Rel-18 SI.

In addition, we think because full duplex has been introduced for IAB backhaul in Rel-17, same/similar enhancement of duplex operation studied in Rel-18 can be applied for IAB.

18 – ZTE Corporation

Firstly, it seems to be common understanding that duplex enhancements at gNB should be included in the scope.

Secondly, regarding the duplex enhancement at UE side, we would prefer to include it in the scope. We understand that some companies may have concern on the UE complexity. However, theoretically speaking, further including duplex enhancements on UE side can further improve the system performance, but we can further analyse and evaluate these aspects. To mitigate companies' concern on the UE complexity, we can take UE implementation complexity into account when conduct the analysis and evaluation of duplex enhancements on UE side.

19 – KDDI Corporation

We support to limit the duplex enhancement at gNB side only in Rel-18.

20 – Samsung Electronics Co.

We support including gNB-side duplex enhancements only, e.g., the gNB implements support for full-duplex operation but UEs remain half-duplex. On the UE side, SIC capability for FR1 modems is not easy to implement due to device form-factor, RF architecture, and antenna paths. We consider UE full-duplex support presently not in immediate reach for FR1 and therefore see no need to include it into the R18 SI. We propose to consider UE-side duplex enhancement only in Rel-19 or later.

21 – Fujitsu Limited

We support to focus on full duplex enhancement at gNB only.

22 – MediaTek Inc.

For full duplex, no matter whether all full duplex schemes are included or not, Rel-18 should be limited to gNB full duplex operation only, considering UE form factor not able to provide sufficient interference isolation for full duplex operation.

23 – SHARP Corporation

In our view, the key factor is increasing uplink time resource for TDD deployment (e.g., wideband carrier with legacy TDD framework with narrow uplink bandwidth for coverage extension). From scheduling perspective, in a time occasion where DL and UL signals can be transmitted, the network can schedule DL transmission for one UE and schedule UL transmission for another UE. Therefore, our view is that UE side full duplex is not a key factor for duplex enhancement.

24 – VODAFONE Group Plc

This should be limited to new duplex mode operation at the gNB (but we must also address the consequential interference issues at the UEs).

25 – CEWIT

We support the study of duplex enhancement at gNB only with half duplex UEs. Further, the duplexing used at the gNB can be transparent to the UE so that legacy half duplex UEs can also be accommodated. Duplex enhancement at the UE will require advanced hardware and RF implementation to suppress self interference which is currently challenging considering the limitation of device size and complexity.

26 – HUAWEI TECHNOLOGIES Co. Ltd.

We support to limit the scope to gNB-side full duplex for full duplex scenarios in this release, and UE-side full duplex enhancement may be considered in the future releases, as, according to our view, UE-side full duplex is not mature enough.

We would like to point that that, no UE-side full duplex enhancement in Rel-18 does not mean there is no UE-side enhancement in Rel-18 to support gNB-side full duplex. We expect that some UE-side CLI enhancement is needed in order to support gNB-side full duplex.

27 – Telia Company AB

Both gNB and UE duplex enhancements should be identified and studied to get common baseline understanding the possibilities for future improvements but also to identify limiting factors.

28 – Futurewei Technologies

We prefer to limit the scope to gNB full duplex for Rel. 18 and identify the impact on UE behavior and performance.

29 – Sony Europe B.V.

For Rel-18, we agree to focus full duplex enhancement only at the gNB. This is to avoid complexity at the UE to avoid self-interference at least for Rel-18.

30 – InterDigital

At least in the first study phase, it is desired to limit the scope to the duplex enhancement at gNB only. But, it needs to make sure enhancements on UE side by assuming such a duplex operation at gNB should be thoroughly studied.

31 – CATT

Considering UE form factor limitation, there is a great challenge for RF isolation at current stage. Thus Rel-18 should only focus on full duplex at gNB side. Full duplex is a long term work and step by step study is more feasible. Full duplex operation at UE side could be considered in future releases.

32 – Motorola Mobility UK Ltd.

Considering potential feasibility issues in UE implementation, we prefer to limit the Rel-18 scope to gNB only.

33 – Apple France

Yes. Given the scope is already large, and the complexities associated with full-duplex operation at UE (like limited form factor, processing capabilities, etc) full-duplex operation at UE shall NOT be supported. Besides, a step-by-step enhancement is more realistic where gradually all open aspects of full-duplex operation at gNB, serving legacy half-duplex UEs, is studied. We should note that even under the assumption of HD UE and full-duplex operation at gNB only, RAN1/RAN4 still need to cooperate in identifying solutions for improved gNB FD operation, managing UE-to-UE CLI, etc. Such a work scope will be much larger if we jump to FD operation at both UE and gNB.

34 – Ericsson LM

Restricting the UE to half-duplex for the Rel-18 study is a sensible approach. However, the study should leave flexibility to consider whether tighter UE performance requirements are needed or beneficial. For example, if a UE only transmits in the center PRBs of a carrier during downlink slots, it may be needed to check whether existing emissions/ACS requirements on UEs are then sufficient to ensure co-existence to/from neighbor carriers or some tightening may be needed or useful to facilitate/improve full duplex operation.

35 – LG Uplus

We have the same opinion with Samsung. The burden on UE implementation is not preferred within Rel-18 timeline.

36 – Qualcomm Korea

Duplex mode enhancement should start first with a full duplex gNB. However, this shouldn't limit us to discuss/study the feasibility of full duplex mode at the UE. For example, a CPE device is feasible to provide sufficient space for accommodating multiple panels in FR2 with enough beam/panel isolation to enable simultaneous Tx/Rx, and without concern on the battery life if wall power is used. In addition, a large guard band between the UL and DL subbands can facilitate the full duplex UE operation if needed. Therefore, we propose to at least study the feasibility of full duplex at the UE.

37 – China Unicom

We support to include full duplex at gNB side only in Rel-18. Since at UE side, the issues of complexity, device design, cost and size will be much more serious due to self-interference cancellation. Furthermore,

the impact on UE behavior and performance should be in the scope. And necessary UE-to-UE CLI enhancements could be necessary to support full duplex at gNB-side.

1.4 Duplex enhancement approaches

In the last email discussion prior to RAN#93-e, the followings were observed.

- Among the identified full duplex schemes, there was strong support to include only the subband non-overlapping scheme in the scope, while there still were views to consider the other two schemes.
- There was request to have enhancements for dynamic/flexible TDD, which is supported in the current NR specifications, so that it could be deployed in commercial networks.

Taking into account the above status, the moderator proposal is as follows.

- Conclude that the enhancement on dynamic/flexible TDD is in the scope and will be discussed as a part of the interference management.
- Conclude that the subband non-overlapping scheme is included in the scope.
- Company views are invited on whether the other full duplex schemes, i.e., the subband overlapping and full overlapping schemes will be included in the scope.

Feedback Form 4:

1 – OPPO

Among full duplex schemes in Rel-18, OPPO supports subband non-overlapping scheme only, because

- As mentioned earlier in above feedback forms, OPPO prefers to have a step-by-step evolution for duplex enhancement, with cautious validation/review per each step to see what would be the key issues observed in the past and expected in future steps. Directly going to sub-band overlapping and full-overlapping seems too aggressive from our view.
- To consider three full-duplex schemes in one single release may have risk of growing three forks in WG discussion and reach multiple solutions, where the level of dependency/unity of these solutions is hard to predict and control. We believe a more feasible/safe way is to start with one simplest scheme, and to make the future enhancement stacked on the existing scheme.

Regarding to dynamic/flexible TDD, it does relate to interference mitigation. But we are a bit hesitated to include it in the scope, because

- We are not so sure how it relates to a simultaneous Tx/Rx of DL/UL (even just from gNB perspective), which is the key issue of this duplex study. To include dynamic/flexible TDD seems to distract the original intended focus.
- This dynamic/flexible TDD enhancement may need UE behavior impacts. Then combining dynamic/flexible TDD with full-duplex may result in difficult debates in WGs whether the enhancement should follow gNB-only guidance (if RANP agrees Rel-18 duplex is for gNB-only). Reversely, an enhancement limitation to gNB-only may also put unnecessary restriction back to dynamic/flexible TDD.

We would like to hear more views on this scope addition.

2 – Spark NZ Ltd

Comments from Spark NZ

we agree partially with Oppo. a step by step approach to confirm the validity and feasibility is the best. Sub band non overlapping scheme may be used to test: self interference, adjacent cell interference, adjacent operator interference, adjacent band interference, gNB and UE impacts etc.

3 – AT&T

We believe the subband overlapping and full overlapping schemes should be included in the scope at least of the study phase. Many of the various RF architecture, TDD configuration, and self-interference and cross-link interference modeling aspects will be common for the non-overlapping and overlapping cases. So it seems beneficial for 3GPP to try and analyze these schemes jointly. Of course the feasibility and practicality of certain scenarios may dictate which are emphasized in the normative phase, but there is no need to make assumptions at this stage in our view.

4 – China Telecommunications

With likely limited TUs, the study can focus on one full-duplex scheme with 1st priority. We are open to study subband overlapping or full overlapping duplex operation with 2nd priority in some scenarios if TU permits.

5 – vivo Communication Technology

From our understanding, sub-band non-overlapping would be most feasible approach from both implementation and actual deployment perspective. And sub-band non-overlapping can provide good system benefit for latency reduction and UL coverage perspective. For the overlapping case, it is not clear how the interference between different operators on adjacent channel can be managed, there are also gNB CLI issues, such issues would limit the potential of actual deployment.

It is not very clear how much difference is between sub-band overlapping and full overlapping, to us both can be considered as overlapping case but the portion of overlapping could be different.

6 – TELECOM ITALIA S.p.A.

Agree with moderator proposal to include only the subband non-overlapping scheme in the scope. However, even this technique DOES NOT solve the issue of inter-operator coordination and in practice will be very unlikely to be deployed in real networks.

As stated before, it is much more urgent to improve uplink performance by allowing flexible TDD operation. This is a very urgent market need, and solutions should be provided. Once solved the issue of flexible TDD operation, the proposed techniques for the evolution of duplex operation could also be applied in real world, since the inter-operator interference need to be solved.

7 – China Mobile Com. Corporation

For subband non-overlapped full duplex, when the UL/DL time-frequency resource partitioning is different among neighboring cells, the inter-cell interference handling is similar as for dynamic/flexible TDD scenario. Therefore, we agree with Moderator's proposal to include enhancement on dynamic/flexible TDD in the scope and it can be discussed as part of the interference management.

Regarding the full duplex schemes, we agree with Moderator's that subband non-overlapping full duplex should be included in the scope, and we also think the possibility of a follow-up WI should not be precluded.

8 – Intel Corporation (UK) Ltd

Intel

We support the proposal from the moderator.

We would like to emphasize that the consideration of dynamic/flexible TDD in multi-cellular deployments should be one of the first steps since they form a necessary component to support of enhanced duplex operations. Further, dynamic/flexible TDD operation, under similar assumptions on NW coordination, should be the baseline for evaluation of potential gains from any enhanced duplexing scheme.

On other full duplex schemes, both should not be in scope for Rel-18 studies. Just handling the case of sub-band non-overlapping requires considerable investigations by RAN4 and RAN1. Adding the “overlapping” cases would not be reasonable at this stage, especially when practically achievable levels of isolation at the gNB for real-world multi-cellular deployments remain unclear and the impact to UE implementation is likely significant.

9 – Spreadtrum Communications

We agree that subband non-overlapping scheme should be included in the scope. We are open to study subband overlapping or full overlapping duplex operation if TU permits.

Regarding the enhancement on dynamic/flexible TDD, we agree with the proposal to include it in the scope and inter-gNB CLI management solutions should be studied.

10 – Beijing Xiaomi Electronics

We also think the study in Rel-18 duplex enhancement should only include non-overlapping subband. We are OK to include enhancement on dynamic/flexible TDD.

11 – NTT DOCOMO INC.

We support to include the sub-band non-overlapping schemes in the scope.

We assume there are mainly two possible approaches, 1) Rel-18 has SI and WI for sub-band non-overlapping scheme only, and 2) Rel-18 has SI only for studying both sub-band non-overlapping scheme and full/sub-band overlapping scheme. We slightly prefer 2) approach, since the “Evolution of Duplex Operation” can be a long-term project towards full duplex. Regarding overlapping scheme, we would like to focus on sub-band overlapping scheme, since inter-operator CLI can be avoided by placing the sub-band at the middle.

12 – Nokia Corporation

In our view it is important to first focus on enhancements for short term deployment needs and thereby to study first enhancements for TDD flexibility in practical deployments. More complex duplex operation enhancements should be studied in the second phase of the studies. As part of the second phase studies it could also be studied if only subband non-overlapping schemes should be considered or whether other full duplex schemes, like subband overlapping and full overlapping schemes should be included.

13 – NEC Corporation

We prefer to focus on the subband non-overlapping duplex operation in Rel-18. And it is not necessary to include the subband overlapping or full overlapping duplex operation in the scope even in the study phase as it will introduce the interference management more complexity.

14 – Panasonic Corporation

We think some aspect on spatial domain would need to be clarified.

The overlap is for per one beam or per one SSB.

We thought this is the main discussion but not sure. Then our preference is to focus on sub-band non-overlapping case.

The overlap is for between different beams or different SSBs.

Depending on the spatial isolation, even if the network is operating full overlapping or the subband overlapping, the required UE function may be similar to sub-band non-overlapping case. Or this may be just realized as network implementation. Some study could be useful.

The overlap is for between different cells.

This is similar to eIMTA discussed in LTE. We think this should be supported in order to have comparable function with LTE.

15 – LG Electronics Inc.

In general, we are fine with moderator proposal.

* Even in subband non-overlapping full duplex operation, bandwidth adaptation and dynamic DL/UL scheduling are required for supporting various demands of DL/UL traffic. In this case, performance degradation can be appeared if severe co-channel interference among gNBs is not handled. Also, it is well known that for subband/full overlapping operation and dynamic/flexible TDD operation, method of mitigating inter-cell CLI should be studied. In this aspect, we think management method of inter-cell CLI (i.e., BS2BS CLI and UE2UE CLI) should be discussed for not only full duplex schemes and but also dynamic/flexible TDD.

In addition, it seems that management method of intra-cell UE2UE CLI should be studied for full duplex schemes.

16 – LG Electronics Inc.

* We should carefully investigate a technical benefit of full duplex schemes in Rel-18 SI. In our initial SLS, it is observed that achievable benefit from each scheme (i.e., subband non-overlapping and subband overlapping) is different depending on traffic size. **Therefore we think it is reasonable to study both subband non-overlapping and subband/full overlapping cases to get a complete insight on the full duplex operation in the study.**

(If fixed TDD configuration for non-overlapping is assumed, management of BS2BS CLI is easier, but throughput enhancement is limited due to bandwidth limitation. On other hand, in case of applying subband overlapping, if management of BS2BS CLI is performed, higher throughput enhancement can be achieved by bandwidth utilization flexibility.)

17 – ZTE Corporation

We support the first two bullets, i.e., to include enhancement on dynamic/flexible TDD and subband non-overlapping scheme.

Regarding the other full duplex schemes, we support to add both subband overlapping and full overlapping schemes in the scope. Compared with sub-band non-overlapping, sub-band overlapping and fully overlapping schemes can be used for different scenarios. For example, they can have higher gain in small cell. Overall, we should at least study these two schemes in the SI and further decide whether to include them in the WI. It would be too restrictive to preclude these two schemes before we do any evaluation for them.

18 – KDDI Corporation

We support the moderator's proposal to include sub-band non-overlapping scheme in the scope, and we prefer to study this scheme only in Rel-18 considering the feasibility and a limited TU.

19 – Samsung Electronics Co.

We think that subband non-overlapped operation is the most immediately commercially feasible approach for both FR1 and FR2. In the case of full-duplex operations such as the full or partially overlapped cases, it is very clear that gNB will experience more interference than in the subband non-overlapped case. Subband non-overlapped also has the benefit that the adjacent channel isolation budget to provide isolation in terms of inter-operator interference is more easily controlled. Moreover, we have no indication of commercial interest from operators for supporting isolated cells for duplex enhancement where fully or partially overlapped cases might be of higher interest. Based on commercial interest and feasibility, we therefore support to only include subband non-overlapped operation in the scope of a focused R18 SI. We are open to include inter-CC non-overlapped full-duplex as operation mode in FR2 to be evaluated and with likely impact in RAN4 only.

20 – Fujitsu Limited

We support to include the subband non-overlapping scheme in the scope. We are open to include other schemes if there will be enough TUs.

21 – MediaTek Inc.

Though we share the same view as other companies that subband non-overlapping scheme may be more practical for potential deployment in the future, it would be beneficial to study all full duplex schemes to fully understand the system benefits, technical challenges and related trade-offs in Rel-18.

22 – SHARP Corporation

We are supportive of the proposal. We are OK to include dynamic/flexible TDD in the scope. Deployment scenario is similar to the one for duplex enhancement.

23 – VODAFONE Group Plc

We agree with the moderator's first two points:

Conclude that the enhancement on dynamic/flexible TDD is in the scope and will be discussed as a part of the interference management.

Conclude that the subband non-overlapping scheme is included in the scope

We do not expect that there will be time in Rel 18 to study "overlapping subband" and "full overlap", but are open to their study if there is time.

24 – CEWIT

We are fine to study enhancement to dynamic TDD.

At least in the study phase, subband non-overlapping, subband overlapping and full overlapping should be included. In our view, subband non-overlapping and overlapping duplex are simplified sub-part of full overlapping duplex. Hence, the study phase should focus on all the three to make the study complete and understand the pros and cons. Further, the study on partial/full overlapping can be limited to certain channels (control/RS) where high SINR can be achieved

The normative work can be done in a phased approach depending on the time availability, that is, subband non-overlapping duplex can be taken up in the Rel. 18 WI phase and the other two can be continued in the next Release.

25 – HUAWEI TECHNOLOGIES Co. Ltd.

We support moderator proposal to 1) Conclude that the enhancement on dynamic/flexible TDD is in the scope and will be discussed as a part of the interference manage, and 2) Conclude that the subband non-overlapping scheme is included in the scope.

For other full duplex scenarios, subband overlapping scenario and full overlapping scenario are more complicated than subband non-overlapping scenario. We therefore suggest full duplex scenarios be handled step by step and suggest subband/full overlapping scenarios to be handled in later releases.

26 – Futurewei Technologies

We agree with the Moderator that subband non-overlapping full-duplex should be in the scope. Partial overlapping and full-overlapping may be considered in the future.

27 – Sony Europe B.V.

The other full duplex schemes can be studied in the SI but for the WI we agree to consider only non-overlapping subband operation at least at the UE. We think it is possible for the gNB to operate overlapping subband among different UEs but at the UE point of view, it operates only on non-overlapping subband.

28 – InterDigital

Considering limited TUs in Rel-18, it is desired to focus on the most commercially feasible approach which is the subband non-overlapping scheme. This should have the first priority during the study phase. We are okay to further study other schemes including subband overlapping cases as lower priority.

29 – CATT

For full overlapping schemes, we support it. Full overlapping full duplex can provide significant spectrum efficiency/capacity efficiency which sub-band non-overlapping cannot achieve. Full overlapping full duplex study can be limited to isolated scenarios which alleviate the BS-to-BS cross link interference.

30 – Motorola Mobility UK Ltd.

We prefer to prioritize the subband non-overlapping scheme. Also, we are open to include subband overlapping and full overlapping schemes in the study. Interference management study can include dynamic/flexible TDD scenarios, and solutions to manage inter-gNB and inter-UE CLI can address both full duplex and dynamic/flexible TDD scenarios.

31 – Apple France

The R18 study should start with non-overlapping sub-bands at gNB, given that full-duplex operation at gNB on partial/full overlapping sub-bands increase UE-to-UE CLI interference

32 – Ericsson LM

There are significant implementation, coexistence and system performance aspects that need to be evaluated even with a restriction to only the sub-band non-overlapping case. It is preferable to have a thorough study of this case first in Rel-18 before considering other more challenging cases.

On enhancements for dynamic/flexible TDD, we should not re-do what has already been done in prior study and work items. Any aspects that are common to this mode of operation and sub-band full duplex operation can be included in the study.

33 – LG Uplus

We agree with moderator's view. Non-overlapped sub-band should be prioritized in Rel-18. We prefer to minimize essential practical scenarios in order to ensure fast commercialization.

34 – Qualcomm Korea

We agree with the moderator that subband non-overlapping should be included in the scope for the study item. Frequency separation between the DL and UL helps with self-interference mitigation and makes it simpler to deploy full duplex. In our views, SBFD is perfect technology to adopt for macro cell in FR1 with large Tx power to leverage gains of lower latency and improved UL coverage.

In addition, we are open to study of subband overlapping case at least focusing on FR2, if TU permits. For small cells with lower Tx power and/or isolated cells, overlapping subband could be possible especially in FR2 where separate UL/DL beam pairs could provide enough isolation to enable simultaneous UL/DL. In addition, the self interference modelling of non-overlapping scheme is essentially a special case of overlapping schemes, and the CLI mitigation schemes for flexible TDD can be mostly reused for both non-overlapping and overlapping schemes as well. Therefore, a unified interference modelling/mitigation framework would be preferred by considering both non-overlapping and overlapping schemes.

Finally, we are okay with the moderator conclusion that enhancement on dynamic TDD should be included in the scope as part of the interference management.

35 – China Unicom

We agree with the Moderator first two proposals.

1) Conclude that the enhancement on dynamic/flexible TDD is in the scope and will be discussed as a part of the interference management.

2) Conclude that the subband non-overlapping scheme is included in the scope.

For other full duplex schemes, since the TU is limited, the subband overlapping scheme can be discussed with lower priority.

1.5 Interference management

Taking into account the outcome of the last NWM discussion, the moderator proposal is as follows.

- Conclude that the followings are in the scope.
 - Study inter-gNB and inter-UE CLI and identify solutions to manage them [RAN1],
 - Study RF requirements considering the self-interference and the inter-operator CLI at gNB [RAN4].
 - Study co-channel and adjacent-channel co-existence with the legacy operation [RAN1/4].

- Company views are invited on how to organize interaction between RAN1 and RAN4 regarding the study on co-channel and adjacent-channel co-existence with the legacy operation.

Feedback Form 5:

1 – Spark NZ Ltd

Comments from Spark NZ

as discussed in all of the above comments we have strong reservations of this work . Before proceeding too far, a simple study of non overlapping sub bands to confirm the different interference scenarios and their mitigation techniques is needed. This could be done in RAN4.

2 – vivo Communication Technology

we are fine with moderator proposal.

3 – TELECOM ITALIA S.p.A.

If the scope is to enable flexible TDD, this topic is the most important to allow flexible TDD operation in real world networks. Moreover, as stated before, in my opinion is a pre-requisite to allow new duplex operations in a multi-operator environment.

Rather than a generic study, it should be a study and specify interference management techniques to allow flexible TDD operation. RAN3 and RAN4 should be involved since the beginning, since new interfaces may need to be specified. On the other hand, not sure if RAN1 involvement is needed, since it is more an issue of coordination among different nodes and receiver performance.

4 – China Mobile Com. Corporation

Regarding the interaction between RAN1 and RAN4 on evaluating the self-interference (SI) and co-channel co-existence with the legacy UE for subband non-overlapping duplex operation at gNB side, the following two options can be considered:

Option 1: Two interaction steps are considered.

- Step 1: RAN4 first study the RF requirements for SI and co-channel co-existence with legacy UE, and make the conclusion on the achievable SI cancellation capability and inter-subband interference leakage.
- Step 2: RAN1 perform system level evaluation based on RAN4's conclusion.

Option 2: Four interaction steps are considered.

- Step 1: RAN1 first discuss and conclude on the interested deployment scenario and subband layout configuration.
- Step 2:
 - o RAN1 perform the preliminary evaluation based on a set of SI cancellation capability assumptions and inter-subband interference leakage assumptions. Based on the evaluation, RAN1 conclude a set of requirement levels for SI cancellation capability and inter-subband interference leakage, which can guarantee the perform gain of full duplex operation.
 - o RAN4 parallely discuss on the RF requirements for SI and co-channel co-existence with legacy UE.

- Step 3: Based on the input for RAN1 on a set of requirement levels for SI cancellation capability and inter-subband interference leakage, RAN4 confirm the feasibility.
- Step 4: RAN1 conclude/perform the final evaluation based on the SI cancellation capability and inter-subband interference leakage confirmed by RAN4.

5 – Intel Corporation (UK) Ltd

Intel

The studies on coexistence and handling of co-channel and adjacent-channel interference falls mainly under RAN4 expertise and thus, should primarily be led by RAN4 (and NOT RAN1). Based on RAN4 studies, RAN1 can use suitable approaches to model some of these interference (e.g., in-band interference) in RAN1 system and link evaluations.

Note that, while impact to legacy operation is a fundamental component of these studies, the handling of self- and cross-link interference that can be either in-band or from OOB should be modeled and used in RAN1 based on RAN4 studies first. In this regard, we see a tight coupling between the second and third bullets, that should both be led by RAN4.

For the second bullet, we suggest replacing the last part with “... and co-existence studies, including inter-operator co-existence” instead of “... and the inter-operator CLI at gNB” as the latter is not a typical term used so far.

Back to the first bullet, although CLI will be primarily evaluated by RAN1, for enhanced duplex operations at gNB, it would also require inputs from RAN4, e.g., modeling based on in-band or OOB interference depending on assumptions on sub-band filtering. Thus, like the third bullet, the first bullet should also include RAN4 in addition to RAN1 as a responsible WG.

6 – Spreadtrum Communications

Regarding inter-gNB CLI management, RAN3 should be involved.

7 – Beijing Xiaomi Electronics

We are fine with moderator’s proposal

8 – Nokia Corporation

In our view RAN4 and RAN1 should study RF performance, self-interference and interference management aspects in collaboration. It is important to understand how UE and BS RF performance may limit the overall performance and where CLI related enhancements can provided enhancements in practice. We also see that the study should start by identifying target deployment scenario(s) and assumptions and by validating targeted deployment scenarios against BS and UE RF requirements. Furthermore, in our view short term deployment needs to enable more flexible DL/UL allocations for TDD should be addressed first. After that more challenging duplex enhancements cases should be studied. Therefore, we see that the studies should be organized as follows:

Study and identify target deployment scenario(s) and assumptions including frequency ranges for the Phase 1 and Phase 2 studies [RAN1, RAN4]

- Validate targeted deployment scenarios against BS and UE RF requirements [RAN4]

Phase 1 enhancements: Study targeting to address short term needs to enhance TDD flexibility in practical deployments

- Validate UE and BS RF out of band related requirements and assumptions to allow more flexible UL/DL transmissions during TDD DL/UL slots [RAN4]
- Study and identify solutions for gNB-2-gNB Cross Link Co-channel Interference mitigation [RAN1]
- Solutions discussed in Rel-14 SI on NR (TR 38.802) to be used as starting point
- Study further Cross Link inter-cell co-channel UE-2-UE interference mitigation enhancements [RAN1]
 - o E.g. de-prioritized cases in Rel-16 and additional network signaling

Phase 2 enhancements: Study duplex enhancements for TDD

- Study system performance of flexible/full duplex TDD when legacy UEs are operating on the same and adjacent TDD channel. Study impacts of flexible/full duplex TDD on legacy UE performance and operations [RAN1, RAN4]
- Study UE RF in-band requirement enhancements [RAN4]
- Study system level impacts and new potential solutions for UE-2-UE Cross Link intra-cell co-channel interference mitigation if gains exist over already standardized mechanisms [RAN1]
- Study self interference issues and their impacts on gNB performance and needs for gNB requirement enhancements [RAN4]
- Study self interference issues and their impacts on UE performance and needs for UE requirement enhancements [RAN4]

9 – Panasonic Corporation

Our view is following.

- RAN4 provide the amount of the adjacent-channel interference level to be simulated in RAN1.
- RAN1 runs the system level simulation and to specify the functionality required to enable the target with the help from RAN4 feasibility check.

10 – LG Electronics Inc.

We are fine with moderator proposal.

* RAN1 can lead the discussion for potential benefit of duplex enhancement by performing system level evaluation based on an assumption of residual self-Interference and/or subband leakage according to companies' proposal.

* RAN4 can discuss on RF requirement for self-interference cancellation and the inter-operator CLI at gNB.

For study of co-channel and adjacent-channel co-existence with the legacy operation, RAN4 can study RF requirement of co-channel and adjacent-channel co-existence, then RAN1 can discuss management scheme by performing system level evaluation based on the study result of RAN4.

11 – ZTE Corporation

We are fine to conclude the three bullets in the scope.

RAN1 may start its work before RAN4. RAN1 first perform some preliminary study on the potential scenarios, duplex schemes and then shares these info with RAN4. Then RAN4 can study self-interference, inter-operator CLI, etc. based on RAN1's input. RAN4 will provide its study outcome to RAN1 later.

12 – KDDI Corporation

We support proposals from the moderator in principal. For the second sub-bullet, we believe that it is quite important to study UE RF performance/requirements in addition to that of BS, considering CLI handling in various deployment scenarios.

13 – Samsung Electronics Co.

We support the current bullets as objectives and scope as shown above. Similar to past evaluations done by 3GPP, adjacent channel co-existence should be evaluated as part of the RAN4 objectives and evaluations accounting for co-channel should be conducted by RAN1. Impact to legacy UEs (and legacy gNBs) and identification of deployment constraints like guard bands or maximum Rx/Tx power levels during full-duplex operation will be part of these evaluations in both RAN1 and RAN4.

14 – MediaTek Inc.

For the study on co-channel and adjacent-channel co-existence with the legacy operation, the interaction between RAN1 and RAN4 can be organized as follows.

1. RAN1 concludes the scenarios/assumptions for the study, identifies potential RAN4 impacts and sends LS to RAN4.
2. RAN4 kick-off the study work based on RAN1's input and sends LS to RAN1 after concluding the study. At the same time, RAN1 continues system-level evaluation works and sends LS to RAN4 if any further questions come out from the evaluation.
3. Based on RAN4's input(s), RAN1 updates the evaluation and conclude the study.

15 – SHARP Corporation

We are OK with the moderator's proposal.

16 – CEWIT

We support the moderator proposals. The interference scenarios, mitigation techniques etc., can be discussed in RAN1 with inputs from RAN4.

17 – HUAWEI TECHNOLOGIES Co. Ltd.

We support the moderator's proposal that the listed objectives are in the scope of this item.

Regarding RAN1/RAN4 interaction, our view is that RAN4 needs to provide the capability and requirement for the self-interference, and such input is important for the performance evaluation in RAN1. So RAN4 should start the corresponding study as early as possible.

18 – Futurewei Technologies

We are fine with the moderator's proposal.

19 – Sony Europe B.V.

Moderator's proposal is fine

20 – InterDigital

We support moderator’s proposal, which includes RAN1 to study inter-gNB and inter-UE CLI and identify solutions to manage them, and RAN4 to study RF requirements considering the self-interference and the inter-operator CLI at gNB. Between the working groups, the scopes are reasonably organized and separated based on the expertise area in each WG.

21 – CATT

We generally agree with moderator’s proposal.

With respect to interaction between RAN1 and RAN4, RAN4 will provide the reference value of BS self-interference mitigation ability, co-channel CLI mitigation ability (blocking interference handling ability/ACL/ACS) and inter-operator CLI mitigation ability (ACL/ACS) before RAN1 performing system level evaluation.

22 – Motorola Mobility UK Ltd.

Fine with the moderator proposal. RAN1 can study co-channel coexistence based on RAN4 RF requirements. RAN4 can study adjacent channel co-existence independently.

23 – Apple France

We are fine with moderator’s proposal.

24 – Ericsson LM

RAN4 should be involved in all aspects of interference management from the beginning of the SI. It is important that any link or system performance evaluations done by RAN1 are grounded in realistic assumptions that are checked by RAN4. It is also important that the deployment scenarios that are considered are ones that can be expected to work from an inter-operator co-existence perspective. Otherwise, we will risk producing misleading results or targeting deployment scenarios that in reality cannot be used in a multi-operator environment. Given this, RAN1 can take the lead in system performance aspects, while RAN4 can take the lead on aspects such as inter-operator co-existence and self-interference management (i.e. BS implementation and feasibility aspects including antenna configuration and design to achieve high isolations and other needed improvements such as enhanced linearization for sub-band full duplex).

RAN4 should first study the RF requirements for self-interference and the inter-operator CLI, and after RAN4 makes conclusions on RF requirements, RAN1 can perform system level evaluations based on the conclusion. Also, RAN3 should be involved in any inter-gNB CLI management discussions.

25 – LG Uplus

We can support moderator’s conclusion.

26 – Qualcomm Korea

We agree with the structure of the interference management. In addition, we believe that the following should be included as well:

- Inter-operator CLI at the UE. Considering two UEs in close proximity (e.g., two persons sitting next to each other in a conference room or a stadium) where one UE of operator A is jamming (UL) the DL reception of UE operator B.
- Self-interference at the UE, if the study scope include full duplex at the UE.

We suggest the following edit (add ”and UE”):

- Study RF requirements considering the self-interference and the inter-operator CLI at gNB ”and UE” [RAN4].

27 – China Unicom

We are fine with the moderator proposal.

1.6 Deployment scenarios

In the last email discussion prior to RAN#93-e, macro, micro, and small cell layouts were proposed and companies showed diverging views on which scenario has to be focused on. While these three were major scenarios for consideration, there were requests to consider other scenarios.

Taking into account the above status, the moderator proposal is as follows.

- Conclude that macro, micro, and small cell layouts are included in the scope and further details will be developed after starting the study item.
- Company views are invited on whether other scenarios need to be considered.

Feedback Form 6:

1 – OPPO

In our view, all these deployment scenario discussions could be part of SI contents/objectives, given this may relate to technical discussion. RANP does not need to enforce any agreement before SI is established.

2 – Spark NZ Ltd

The most simplest scenario in the first instance- if we must - is the case of a small cell in an indoor environment. here there may not be adjacent cell interference from an outdoor macro that has high power and only source of interference is self interference and perhaps an interference from a neighbouring indoor cell of a different operator(s)

3 – AT&T

We are OK with the moderator’s proposal and it is understood that different scenarios can impact the performance and feasibility of full duplex operation. One important deployment scenario that we do not yet see explicitly mentioned is IAB. For both wide-area and local-area form factors, full duplex operation at the IAB node could provide significant performance benefits by reducing multi-hop latency and increasing spectrum utilization on access and backhaul links.

4 – China Telecommunications

Simplest scenario can also be included such as indoor etc.

5 – vivo Communication Technology

To our understanding, duplex enhancement is more feasible for low power BS, e.g. micro or small cell, but we are open to consider also macro BS in the study.

6 – China Mobile Com. Corporation

In addition to macro, micro, and small cell layouts, isolated and indoor scenarios can also be included in the scope and further details will be developed after starting the study item.

Furthermore, if full overlapping full duplex is supported, focus on isolated/indoor scenarios with limited Tx power and antenna number at gNB side.

7 – Intel Corporation (UK) Ltd

Intel

The scenarios should be scoped in accordance to feasibility of practical cross-link interference management at gNB and UEs, and in this regard, the observations from Rel-16 studies should be considered as starting point.

Thus, while we can consider all three (macro, micro, small cell cases), homogeneous outdoor macro-only deployments may be of less practical relevance and could be deprioritized. On the other hand, deployments with massive MIMO at gNB should be the focus since massive MIMO is expected as the key enabler for enhanced duplexing or cross-link interference management. At least, the assumptions on minimum and typical numbers of antennas and/or panels at the gNB side needs careful consideration.

In any case, agree with moderator that these could be finalized as part of the study. To this effect, an objective for RAN1 (possibly with RAN4 involvement) to develop a suitable evaluation methodology, including deployments, traffic, channel, and interference models, is necessary.

8 – Spreadtrum Communications

Agree to include macro, micro, and small cell layouts are included in the scope.

9 – Beijing Xiaomi Electronics

We are fine to include the scenarios mentioned by moderator in Rel-18 study item.

10 – NTT DOCOMO INC.

We support the conclusion.

11 – Nokia Corporation

In our view it is important that RAN1 and RAN4 will study and identify together target deployment scenario(s) and assumptions including frequency ranges for the Phase 1 and Phase 2 studies by RAN1 and RAN4. As part of this first phase study, we see it important that RAN4 will validate targeted deployment scenarios against BS and UE RF requirements to identify feasibility of these target scenarios.

12 – NEC Corporation

We support macro, micro, and small cell layouts are included in the scope and further details will be developed after starting the study item. And we prefer other scenarios, such as IAB should not be included in the scope. And IAB FD can be handled in another SI/WI if needed in Rel-18. Urban and Indoor scenarios can be considered for evaluation.

13 – Panasonic Corporation

We agree the suggestion from the moderator.

<p>14 – LG Electronics Inc.</p> <p>Deployment scenario where lower Tx power of gNB (i.e., micro cell, indoor) is applied should be prioritized for study of duplex enhancement in Rel-18.</p>
<p>15 – ZTE Corporation</p> <p>We support to include all the three scenarios (macro, micro, and small cell layouts) in the scope. We also propose to study other scenarios, e.g., Hetnet and indoor hotspot, to fully investigate the potential scenarios and gain of full duplex. At the very least, we should not explicitly preclude the scenarios in the SI scope. Companies are encouraged to study and evaluate their interested scenarios as many as they can.</p>
<p>16 – KDDI Corporation</p> <p>We support moderator’s proposal to include three deployment scenarios (macro, micro and small).</p>
<p>17 – Samsung Electronics Co.</p> <p>The most immediate commercial interest for TDD FR1 duplex enhancements exists for macro and micro cell deployments. Duplexing enhancements for small cell or hotspot deployments may be of more immediate interest for FR2.</p>
<p>18 – Fujitsu Limited</p> <p>We are fine to include IAB in addition to macro/micro/small cell layouts in the scope.</p>
<p>19 – MediaTek Inc.</p> <p>Agree with CMCC and China Telecom, indoor scenario can be included in the study.</p>
<p>20 – SHARP Corporation</p> <p>We think mixed deployment (e.g., macro cell for DL and small cell for UL) can be also included.</p>
<p>21 – VODAFONE Group Plc</p> <p>Agree with moderator to <i>”Conclude that macro, micro, and small cell layouts are included in the scope”</i>. We expect that the study will already be very large and hence adding other scenarios will not be helpful.</p>
<p>22 – CEWiT</p> <p>We support the moderator’s proposal. All the mentioned scenarios can be studied to understand the benefits of full duplexing in each of them. However, we also feel that, IAB scenario should also be included since full duplexing in IAB Rel. 17 is left to implementation.</p>
<p>23 – HUAWEI TECHNOLOGIES Co. Ltd.</p> <p>Apart from the scenarios listed by moderator, we suggest HetNet scenario should be included as well, i.e. Macro cell BS and small cell BS with different TDD DL/UL configurations operating in the same carrier frequency, and small cells are deployed in factory with more UL slots than that of Macro cells</p>
<p>24 – Telia Company AB</p> <p>Moderator’s proposal is fine. Macro and micro TDD FR1 deployments are most important.</p>

<p>25 – Futurewei Technologies</p> <p>We are fine with moderator proposal that that macro, micro, and small cell layouts should be included in the scope, and further deployments (such IAB) may be defined later during the study.</p>
<p>26 – Sony Europe B.V.</p> <p>Agree to include macro, micro & small cell layouts in the SI. The full duplex operation should not be limited to a single deployment.</p>
<p>27 – InterDigital</p> <p>We support moderator’s proposal, which includes macro, micro, and small cell layouts for the study.</p>
<p>28 – CATT</p> <p>We generally agree with moderator’s proposal.</p>
<p>29 – Motorola Mobility UK Ltd.</p> <p>In our view, urban macro, dense urban, and indoor hotspot should be included to study potential benefits of capacity enhancement and TDD latency reduction.</p>
<p>30 – Ericsson LM</p> <p>The focus should be on scenarios where system level performance improvements may be more realistically possible, i.e., where cross-link and inter-operator coexistence issues are of somewhat lower concern. Hence, scenarios where the DL-UL assignments are the same across all co-channel nodes (including macro and micro), UE-UE inter-operator interference is not expected to be an issue and/or smaller cells where gNB and UE Tx powers are more similar are of greater interest. All BS classes should be considered. We do not see a need to include IAB in the scope. Hence, while the moderator’s proposal is ok, it may be important to prioritize some scenarios over others during the study based on the factors listed above.</p>
<p>31 – LG Uplus</p> <p>We are fine with moderator’s view.</p>
<p>32 – Qualcomm Korea</p> <p>We agree with the conclusion that deployment scenario to include macro, micro, and small cell layouts. This deployment should consider the scenarios where different gNBs may deploy same or different UL/DL subbands and/or legacy TDD.</p>
<p>33 – China Unicom</p> <p>We are fine with moderator proposal. Regarding to other deployment scenarios, we agree with CMCC and CT that indoor/isolated scenario should be included.</p>

1.7 Frequency range

In the last email discussion prior to RAN#93-e, there was not much discussion on which frequency ranges have to be considered. It should be noted that FR1 and FR2 are being used in commercial networks and there is no reason to limit the frequency range on which duplex enhancements can be applied.

Taking into account the above status, the moderator proposal is as follows.

- Conclude that there is no limit on the frequency range on which duplex enhancements can be applied. Hence, applicable frequency ranges will not be further discussed.

Feedback Form 7:

1 – OPPO

We appreciate Moderator for raising a good point which might be overlooked in past discussion. From our view, it is safer to focus on FR1 in Rel-18. The following conclusion would be our preference:

- The Rel-18 duplex enhancement focuses on FR1, with the assumption[/condition] that the same enhancement considered for FR1 is applicable to FR2. No additional enhancement is specifically considered for FR2 in Rel-18.

2 – Spark NZ Ltd

We believe the study should be limited to FR1 in the first instance and . The learnings in a FR1 TDD band can be transported to other bands later.

3 – AT&T

We support both FR1 and FR2 bands for the study and whether normative work is differentiated for different bands or frequency ranges can be made once the study is concluded. In some scenarios, FR2 may actually be more advantageous for full duplex operation compared to FR1, due to the ability to provide spatial isolation between the Tx/Rx using beamforming.

4 – China Telecommunications

Agree Moderator’s proposal. RANP does not limit the frequency range. The solutions for each frequency range is discussed after SI is started.

5 – vivo Communication Technology

We are fine to study both FR1 and FR2.

6 – TELECOM ITALIA S.p.A.

We think it would be better to limit the scope to FR1

7 – China Mobile Com. Corporation

FR1 should at least be include in the scope, since it is currently the NR most popular band. We are open to include FR2 in the scope.

8 – Intel Corporation (UK) Ltd

Intel

We do not agree to inclusion of FR2 at this point.

The main motivation of studies on enhanced duplex is to reduce achievable latency in TDD systems.

For FR2 there is still no justification provided to motivate further latency reduction schemes. There is hardly any practical FR2 deployment today that is being “driven to its full potential” even with basic TDD operation. It is understood that interference handling may be less of an issue for FR2, but the original motivation does not apply. Thus, we should not be including FR2 just because it may be more feasible in some aspect (interference handling in this case) when the main motivation for such enhancements remains questionable.

In addition, consideration of FR2 implies almost double the amount of work in an already-overloaded RAN4 to assess the feasibility of self-interference handling.

In summary, we think the applicability of Rel-18 studies on enhanced duplex should be limited to FR1 only.

9 – Spreadtrum Communications

Fine to study both FR1 and FR2. FR1 is the first priority.

10 – Beijing Xiaomi Electronics

We prefer to focus on FR1.

11 – NTT DOCOMO INC.

We support the conclusion. Since impact of interference or requirement for the full duplex operation may be up to frequency bands, we prefer to study both FR1 and FR2.

12 – Nokia Corporation

In our view it is important that RAN1 and RAN4 will study and identify together target deployment scenario(s) and assumptions including frequency ranges for the Phase 1 and Phase 2 studies by RAN1 and RAN4. As part of this first phase study, we see it important that RAN4 will validate targeted deployment scenarios against BS and UE RF requirements to identify feasibility of these target scenarios.

13 – NEC Corporation

We support both FR1 and FR2 bands for the study.

14 – Panasonic Corporation

We agree the suggestion from the moderator.

15 – LG Electronics Inc.

We think study of duplex enhancement can be performed for both FR1 and FR2.

16 – ZTE Corporation

We support to include both FR1 and FR2 in the scope, or at the very least, SI should not preclude either frequency range in the scope. Full duplex has potential gain in both FR1 and FR2, maybe targeting different scenarios.

17 – KDDI Corporation

We prefer to prioritize FR1 study. But we are fine to include FR1 and FR2 in the scope.

<p>18 – Samsung Electronics Co.</p> <p>As we mentioned in the duplex scheme, we think both FR1 and FR2 should be considered and support the moderator’s proposal.</p>
<p>19 – Fujitsu Limited</p> <p>We support to study both FR1 and FR2.</p>
<p>20 – MediaTek Inc.</p> <p>OK with moderator’s proposal.</p>
<p>21 – SHARP Corporation</p> <p>We are OK with the moderator’s proposal.</p>
<p>22 – VODAFONE Group Plc</p> <p>We are OK to study both but if we have to prioritise, then FR1 is our priority.</p>
<p>23 – CEWiT</p> <p>We support the moderator’s proposal. However, the study might need to differentiate between FR1 and FR2. E.g., in FR2, beamforming using different antenna sets for DL and UL can be used to suppress SI but in FR1 same set of antennas can be used for DL and UL which requires additional SI cancellation circuitry.</p>
<p>24 – HUAWEI TECHNOLOGIES Co. Ltd.</p> <p>We agree with moderator proposal to conclude that there is no limit on the frequency range on which duplex enhancements can be applied. FR2 should also be considered instead of FR1 only, as the coverage enhancement and throughput enhancement using duplex evolution is important for FR2 performance enhancements.</p>
<p>25 – Telia Company AB</p> <p>Priority for FR1.</p>
<p>26 – Futurewei Technologies</p> <p>We think that we should start with FR1, and we are open to include FR2 as well if time allows. FR2 provides a better directional beamforming for TX/RX spatial isolation.</p>
<p>27 – Sony Europe B.V.</p> <p>Agree to Moderator’s proposal.</p> <p>This enhancement should be applicable to FR1 and FR2 albeit it may benefit FR2 (with larger bandwidth) more.</p>
<p>28 – InterDigital</p> <p>We support the suggestion from the moderator. The study should be for both FR1 and FR2.</p>

<p>29 – CATT</p> <p>There may be some difference between FR1 and FR2 (e.g. beam coordination can be used for interference management in FR2), so additional enhancement can be considered for FR2. If taking the work load into account, OPPO’s proposal can be adopted.</p>
<p>30 – Motorola Mobility UK Ltd.</p> <p>Fine with the moderator proposal.</p>
<p>31 – Ericsson LM</p> <p>Since the implementation feasibility and potential complexity vs gains may differ, both FR1 and FR2 should be considered. It should be noted that some of the key benefits such as better coverage are arguably more critical in FR2 while at the same time some of the key problems such as cross-link interference may be easier to handle in FR2. Therefore, it is important not to preclude FR2 in the study.</p>
<p>32 – LG Uplus</p> <p>We prioritize FR1 in Rel-18.</p>
<p>33 – Qualcomm Korea</p> <p>We agree with the moderator suggestion that no restriction on the frequency range. We think both FR1 and FR2 have good use-cases and should be included in the scope.</p>
<p>34 – China Unicom</p> <p>We agree to moderator’s suggestion. Both FR1 and FR2 should be included in Rel-18.</p>

1.8 Moderator Summary and Recommendation

Taking into account the comments received in the initial round, it can be concluded that the followings are non-controversial.

[Non-controversial points]

- TDD is included in the scope.
- Duplex enhancement at gNB is included in the scope.
- For duplex enhancement approaches,
 - The enhancement on dynamic/flexible TDD is in the scope and will be discussed as a part of the interference management.
 - The subband non-overlapping full duplex scheme is included in the scope.
- In terms of study on interference management,
 - The study should include the aspects related to the dynamic/flexible TDD and the subband non-overlapping full duplex scheme.
 - Study inter-gNB and inter-UE CLI and identify solutions to manage them [RAN1].

- Study performance aspects of co-channel and adjacent-channel co-existence with the legacy operation [RAN1].
 - Study RF requirements considering the self-interference and the inter-operator CLI at gNB [RAN4].
 - Study RF requirements of co-channel and adjacent-channel co-existence with the legacy operation [RAN4].
 - RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed.
- There should be no restriction on the frequency ranges to be considered.

The followings didn't get meaningful level of support. Hence, the moderator recommends discontinuing the discussion on them.

[Controversial points that should discontinue in moderator's assessment]

- Inclusion of FDD as a duplex mode in the scope.
- Inclusion of duplex enhancement at UE in the scope.

The followings are controversial and hence require more feedbacks to derive a conclusion.

[Controversial points that require further discussion]

- Whether the other full duplex schemes, i.e., the subband overlapping and full overlapping schemes will be included in the scope. While there are views requesting to include them in the scope, there are strong concerns on feasibility of applying them in practical networks, workload, and TU availability. There also is a suggestion to consider them in the future as the next step.
- The past discussion about the dynamic/flexible TDD should not be repeated.
- Views on deployment scenarios are still diverging.

2 Intermediate Round

2.1 General

The moderator recommends continuing the discussion about the controversial points that require further discussion (see section 1.8 “Moderator Summary and Recommendation” for initial round).

Feedback Form 8:

1 – Spark NZ Ltd

Spark NZ

we made observations in the first round and pointed to the regulatory difficulties in implementing any form of duplex evolution. None of these are explicitly mentioned in the moderator summary. Additionally backwards compatibility is a critical issue that must be included in any studies. Is duplex evolution to be introduced in a green fields environment ? , there will be legacy terminals, and the gNB must also

be capable of access for these legacy terminals. Furthermore co existence with adjacent bands is a key regulatory issue. we request the moderator to consider all of the above.

2 – OPPO

The moderator listed "The enhancement on dynamic/flexible TDD is in the scope and will be discussed as a part of the interference management" as a non-controversial point. However, our understanding is that this item is still subject to further discussion in section 2.3. In addition, we still think the above scoping for dynamic/flexible TDD is not clear enough for the discussion. For example,

1). Would dynamic/flexible TDD enhancement in Rel-18 intend to make TDD DL/UL adjustment even more dynamic/flexible (so that RAN needs some thing new on interference side) or just to have additional interference management to better support what existing spec can do on DL/UL adjustment?

2). If this Rel-18 enhancement on dynamic/flexible TDD is for interference management only, should UE be made able to differentiate the interference enhancement between for full-duplex (even on gNB side) purpose and for dynamic/flexible TDD purpose? We wish not. In other words, UE may not need to be aware of whether the enhanced interference management is specifically for dynamic/flexible TDD or gNB side full-duplex.

3 – Samsung Electronics Co.

We are generally fine with the moderator's summary and open to further discussing the remaining controversial points.

Regarding Spark NZ's comment about the regulatory issues - we believe that addressing this issue is within the scope of this study item. We suggest including the following objective in this study

- Summarize regulatory aspects when deploying enhanced duplex mode in TDD bands

Regarding dynamic/flexible TDD, we share our comments in 2.3.

4 – LG Uplus

We are fine with moderator's summary.

5 – KDDI Corporation

For interference management for inter-operator CLI, we believe that the scope should include the study of RF requirements for inter-operator inter-UE CLI, considering the common case where two UEs belonging to different operators are in close proximity to each other. Thus, we suggest following:

- Study RF requirements considering the self-interference and the inter-operator CLI at gNB "and UE" [RAN4]

6 – SK Telecom

We are fine with the moderator's summary and need to discuss about subband overlapping and full overlapping schemes .

7 – TELECOM ITALIA S.p.A.

We are in general fine with the moderator's summary.

However, we should distinguish between urgent and long term objectives.

As stated by many companies, the current regulation (at least in Europe) is forcing a fixed frame structure to avoid inter-operator interference (intra-operator is to be solved "at home"). This is seriously creating

issues in answering many customers' requirements. 3GPP has to study and possibly find solutions to make the Regulators allow a flexible TDD frame format. We know this is a regulatory issue, but 3GPP has to provide a solution.

Full duplex (or its variants) is a long term scenario, which in any case require to solve the regulation constraints.

On the basis of the above, the short term problem (i.e. the study on interference management) should lead to a Rel 18 Work Item, while I expect the "full duplex" aspects will, in case, lead to a Rel 19 Work Item.

Hopefully the same solution to manage interference (as required by several companies) can be found.

Proposal: Allow the spin off of an interference management Work Item within the Rel 18 timeframe

8 – Spark NZ Ltd

Spark NZ

we respectfully submit that the moderator has chosen to ignore our concerns with this work.

Limitations imposed by local regulatory requirements means all operators must at the same time adopt the new duplex scheme. if this does not happen, and it may not, then if this SI were to proceed it should address interference scenarios and their mitigation with multiple duplex schemes concurrently present.

Adjacent band co existence is another issue we pointed out. Co existence in adjacent bands may preclude the evolution of duplex mode in certain bands and or impose the requirements of guardbands and exclusion zones. This issue must be considered in the study item.

backwards compatibility is another area we pointed out. Even if one were to evolve the duplex mode there will be legacy terminals unless an operator chooses to replace them at the operator's cost- and no one will do that. so backwards compatibility is a key requirement and interference scenarios and their mitigation with legacy systems is a key part of this study.

The impact of any signal processing techniques to mitigate the interference on power consumption, computation time etc is another issue that needs to be considered and this is not so.

extending this study to FDD bands will open a Pandora's box of regulatory conditions different in each band. we pointed this out too but the moderator has not considered.

we request the moderator to please consider all of the above points in a summary of the intermediate round.

9 – InterDigital

We are generally fine with moderator's summary. Samsung's suggestion to capture one bullet on summarizing regulatory aspects sounds reasonable and sufficient to address the raised concern.

10 – Intel Corporation (UK) Ltd

[Intel]

We tend to agree with the comment from Spark that coexistence considerations (inter-operator as well as considering legacy UEs) should be explicitly captured as part of interference studies. Also, as suggested in the previous round, it would be more appropriate to say "co-existence studies, including inter-operator co-existence" instead of "inter-operator CLI at gNB". In addition, we should avoid using "RF requirements" as part of SI objectives. Thus, we suggest to update the RAN4-related bullets on interference studies as below:

- ***Study feasibility and RF impacts of duplex enhancement considering the self-interference and co-existence studies [RAN4]***
- ***Study co-channel and adjacent-channel co-existence with the legacy operation [RAN4]***

On frequency range, we are still not comfortable in including FR2. In fact, based on our reading of Round 1, there are multiple companies suggesting to focus on FR1. The impact on RAN4 work (which is already the most critical components of this study) would be significant with inclusion of FR2 as well. Thus, at the minimum there should be clear guidance to prioritize studies on FR1, and that studies on FR2 may follow in a second phase of the SI.

11 – ZTE Corporation

Regarding the non-controversial part, we think RAN3 should be added at least for the following sub-bullet.

- Study inter-gNB and inter-UE CLI and identify solutions to manage them [RAN1, RAN3].

Regarding the controversial points, overall we would suggest to include them in the scope (be part of the SI discussion) or at least should not preclude them explicitly in the scope. This can provide RAN a bigger picture of full duplex, which is helpful for companies to investigate the potential target scenarios and use cases for full duplex.

12 – China Telecommunications

Regarding not to continue discussing inclusion of duplex enhancement at UE in the scope, we agree full duplex at UE is not considered in Rel-18. However, we would like to clarify that the study of UE side enhancements to enable full duplex operation at the gNB should not be precluded.

13 – Beijing Xiaomi Electronics

We are fine with Samsung's suggestion.

14 – China Mobile Com. Corporation

We are generally fine with the current non-controversial points. We just have some clarification questions to ensure we have correct understanding on the interference management part.

1) Regarding “Study inter-gNB and inter-UE CLI and identify solutions to manage them [RAN1]”,

- In our understanding, different cells may have the same or different UL-DL time-frequency resource pattern for subband non-overlapping full duplex scheme. There could be two possible interpretations regarding the inter-gNB and inter-UE CLI for subband non-overlapping full duplex scheme.

- Interpretation 1: The study of inter-gNB and inter-UE CLI here only targets the case that different cells have different UL-DL time-frequency resource pattern for subband non-overlapping full duplex scheme, i.e., for a certain symbol, the 20MHz in the middle part of the whole 100MHz bandwidth is used for uplink transmission in cell A, while the 20 MHz for cell B is used for downlink transmission. We only study the intra-subband inter-gNB and inter-UE CLI here (e.g., we only consider cell A will suffer the inter-gNB CLI from cell B in the 20MHz), and we do not consider the inter-subband inter-gNB and inter-UE CLI (e.g., we do not consider the possible interference suffered by cell A in the 20MHz from the leaked interference of cell B from the other 80MHz.)

- Interpretation 2: The study of inter-gNB and inter-UE CLI here not only targets the case that different cells have different UL-DL time-frequency resource pattern, but also targets the case that different cells have the same UL-DL time-frequency resource pattern for subband non-overlapping full duplex scheme. That is, for a certain symbol, even both cell A and cell B use the 20MHz for uplink transmission and the other 80MHz for downlink transmission, we also need to study the CLI suffered by cell A in the 20MHz from the leaked interference of cell B from the other 80MHz.

- If your intention is to include interpretation 2, I'm wondering whether RAN4 needs to be involved since we need to model how much interference will be leaked from the neighboring subband, or you think this modeling can be handled by RAN1 self.

2) Regarding "Study performance aspects of co-channel and adjacent-channel co-existence with the legacy operation [RAN1]" and "Study RF requirements of co-channel and adjacent-channel co-existence with the legacy operation [RAN4]",

- In our understanding, here we mainly consider that both legacy UEs and R18 UEs exist in the same network. For a certain symbol, R18 UE may use the central 20MHz for uplink transmission and the legacy UE may use the other 80MHz for downlink transmission, the legacy UE may experience inter-subband interference from the R18 UE which is leaked from the central 20MHz if they are close. The study task for RAN1 here is to evaluate how much performance impact will this inter-subband interference will have on the legacy UE. Is my understanding correct? Is there any other issues beside this we need to consider regarding this study task for RAN1? Here it seems we also need to model the interference leakage from the neighboring subband, does RAN1 need any input from RAN4 on this?

- Regarding the "adjacent-channel" in these two bullet, how to understand it? Is your intention to study the performance impact on legacy UEs of the interference from the central 20MHz (uplink) in one 100MHz band to another 100MHz band (downlink)?

- According to the wording, the co-channel and adjacent-channel co-existence with the legacy operation matters both RAN1 and RAN4, RAN1 to study the performance aspect and RAN4 to study the RF requirement. Do you assume RAN1 and RAN4 will start their work on this issue parallelly or in a staggered manner?

15 – Qualcomm Korea

We agree with the moderator conclusion on the non-controversial point. However, it seems that our comment in the initial round may be overlooked. On the 4th subbullet under interference management, the study should include as well inter-operator UE-to-UE CLI. In addition, it may include self-interference handling of UE if full duplex is in scope. We suggest the following edit:

- Study RF requirements considering the self-interference and the inter-operator CLI at gNB and UE [RAN4].

16 – HUAWEI TECHNOLOGIES Co. Ltd.

Generally we support the non-controversial part in the moderator's summary to be included in the scope of SI. One comment on the detailed scope: RAN4 usually does not define co-channel RF requirements. So we suggest to have as revision as below:

- Study RF requirements of ~~co-channel and~~ adjacent-channel co-existence with the legacy operation [RAN4].

17 – Apple France

We support moderator's assessment and we are in general OK with the proposed scope.

18 – CATT

In principle we agree with moderator's recommendation.

However, regarding the scope of study on interference management, although we can include aspects related to dynamic/flexible TDD and subband non-overlapping full duplex scheme, we should make clear in the

objectives that one single common solution is targeted. Otherwise not only the UE implementation will be complicated, the size of this item will also be a concern.

19 – Sony Europe B.V.

We prefer to elaborate what is being considered under dynamic/flexible TDD.

20 – Spreadtrum Communications

We are fine with moderator's summary in general and agree with huawei that "co-channel" should be deleted from the bullet "Study RF requirements of co-channel and adjacent-channel co-existence with the legacy operation [RAN4]".

21 – LG Electronics Inc.

We are generally fine with the non-controversial points in moderator's summary. We also think that 'co-channel' should be deleted from 'Study of RF requirements of co-channel ... [RAN4]' as commented by Huawei.

22 – Nokia Corporation

We are generally ok with the listed non-controversial points but we have some update proposals to the objectives to ensure that RAN4 aspects will also be taken into account in CLI studies to avoid RAN1 developing solutions, which do not help in practice due to requirement related constraints. One missing aspect is about prioritization among the considered duplex enhancements. During the first round of discussions, several companies indicated the need to primarily focus on enhancements targeting real and urgent market needs, and only after that, on longer term objectives. We think this should be captured in the moderator's summary and recommendations.

Thus, we propose the following updates to the SID objective proposal:

- TDD is included in the scope.
- Duplex enhancement at gNB is included in the scope.
- For duplex enhancement approaches,
 - o The enhancement on dynamic/flexible TDD is in the scope and will be discussed as a part of the interference management. Studies on enhancement on dynamic/flexible TDD are be prioritized first.
 - o The subband non-overlapping full duplex scheme is included in the scope.
- In terms of study on interference management,
 - o The study should include the aspects related to the dynamic/flexible TDD and the subband non-overlapping full duplex scheme.
 - o Study inter-gNB and inter-UE CLI, and identify solutions to manage them and identify feasible deployment scenarios and requirement assumptions [RAN1, RAN4].
 - While respecting the outcome of Rel-16 SI on CLI handling and RIM
 - o Study performance aspects of co-channel and adjacent-channel co-existence with the legacy operation [RAN1].
 - o Study RF requirements considering the self-interference and the inter-operator CLI at gNB [RAN4].
 - o Study RF requirements of co-channel and adjacent-channel co-existence with the legacy operation [RAN4].

- RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed.
- There should be no restriction on the frequency ranges to be considered.

About the controversial points, we are ok to leave those out of the SI.

But we also see benefits in Qualcomm's proposal to update the study objective to include UE aspects as follows: Study RF requirements considering the self-interference and the inter-operator CLI at gNB and UE [RAN4].

It should though be noted that CLI and self-interference issues in case of sub-band non-overlapping full duplex operation are somewhat similar to the sub-band/full overlapping case, at both the gNB and at the UE. Therefore, conclusions/solutions from the Rel-18 SI should be considered as starting point for future studies considering e.g. sub-band non-overlapping full duplex operation at the UE, as well as sub-band/full overlapping full duplex operation at both the gNB and the UE.

23 – MediaTek Inc.

Agree with moderator's proposals in [Non-controversial points].

For [Controversial points that require further discussion]:

1. For full duplex schemes, considering the focus in R18 will be on study the full-duplexing scheme rather than starting the normative work, we see it is beneficial to include all the full-duplex schemes in the R18 study. We acknowledge that subband non-overlapping is more practical, but there is a lot of commonalities between these schemes, and including the other two schemes (subband overlapping and full overlapping) will not lead to high increase in the workload. If work load is really the main concern, prioritizing subband non-overlapping scheme over the other two schemes in the study can be one way to consider.
2. For deployment scenarios, it can be further discussed in the study and not necessarily concluded in SI scoping.

24 – ROBERT BOSCH GmbH

We prefer to understand if dynamic/flexible TDD and sub-band non-overlapping full-duplexing solutions will be harmonized? If yes, how ?

25 – Ericsson France S.A.S

We have the following comments for the parts assigned as non-controversial by the moderator.

- The aspects related to inclusion of dynamic/flexible TDD as part of interference management, are the ones for which the discussion on avoiding repeating past work applies. There may also be some solutions already studied or specified that may apply to interference management for sub-band full duplex operation as well. Hence, we should add a note somewhere along the lines of the following. "Note: Any enhancements studied should consider what has already been studied earlier and solutions that are already part of current specifications and avoid repeating past work."
- We agree with ZTE that RAN3 should be added to the second objective under interference management as follows. "Study inter-gNB and inter-UE CLI and identify solutions to manage them [RAN1, RAN3]."
- Regarding the bullet "Study performance aspects of co-channel and adjacent-channel co-existence with the legacy operation [RAN1]" should also involve RAN4 where adjacent channel co-existence is concerned. Also RAN4 should be involved in determining the leakage within from a sub-band to the rest of the carrier and adjacent carriers. Hence RAN4 should probably also be included in "Study inter-gNB and inter-UE CLI and identify solutions to manage them [RAN1]". The split of work between RAN1 and RAN4 (i.e. RAN4 providing information on inter-subband and inter-carrier leakage) could be further clarified.

- We agree with the comment from KDDI and Qualcomm to also consider CLI at the UE and the proposed bullets from Intel.
- On FR, in our view FR2 is important to include as coverage for FR2 TDD is important to improve
- RAN4 should be involved early studying the feasibility aspects due to high impact in RF/antenna and algorithm design, which fundamentally impact the feasibility and gains.

2.2 Subband Overlapping and Full Overlapping Full Duplex

While there are views requesting to include the subband overlapping and full overlapping full duplex schemes in the scope, there are strong concerns on feasibility of applying them in practical networks, workload, and TU availability. There also is a suggestion to consider them in the future as the next step.

Feedback Form 9:

<p>1 – Spark NZ Ltd</p> <p>Spark NZ</p> <p>we agree that full overlapping full duplex should wait until we see results of teh sub band approach</p>
<p>2 – OPPO</p> <p>Based on the 1st round feedback, it looks infeasible to include sub-band overlapping and sub-band full overlapping schemes into Rel-18. In addition, because this discussion is only for Rel-18, let's not bother to worry about future release.</p>
<p>3 – vivo Communication Technology</p> <p>We suggest that Rel-18 study should focus on sub-band non-overlapping case, and dynamic/flexible TDD case. The inteference managemenet solutions for these two cases are to be studied and will cosume a lot of TUs. More advanced duplex schemes including sub-band overlapping and full overlapping can be studied in Rel-19, if necessary.</p>
<p>4 – LG Uplus</p> <p>We prefer non-overlapped cases within Rel-18.</p>
<p>5 – China Unicom</p> <p>Since the TU is limited, subband overlapping can be studied with lower priority. And full overlapping scheme can be discussed in Rel-19 based on the outcome of Rel-18.</p>
<p>6 – VODAFONE Group Plc</p> <p>We also agree that the non-overlapping scheme/case appears to be more feasible and realistic for inclusion within Rel-18, and it would be our preference to focus on this.</p>
<p>7 – SK Telecom</p> <p>Since There is a limitation of TDD, we are looking forward to sub-band case, to find the best solution of flexible TDD case we want to focus on sub-band non-overlapping case. but to avoid the interference situation we need to discuss next step.</p>

8 – Futurewei Technologies

We are prefer limiting the scope of Rel. 18 to sub-band non-overlapping case only.

9 – AT&T

We continue to support the inclusion of overlapping cases in the study item scope. At least from a modeling and evaluation perspective, a common set of assumptions can be applied for both overlapping and non-overlapping cases. Whether or not overlapping cases are feasible should be an outcome of the study item, not necessarily an assumption going into Rel-18. Of course, if specific normative work for the overlapping cases is identified, whether there is sufficient TUs for that can be separately considered in the work item phase.

10 – Motorola Mobility UK Ltd.

We are okay to consider subband overlapping and full overlapping full duplex schemes in the future.

11 – InterDigital

We are fine to focus only on the subband non-overlapping case in Rel-18, considering the limited TU. But, we are open to include the subband/full overlapping cases as long as these are captured with lower priority in Rel-18.

12 – NTT DOCOMO INC.

Based on the discussion in the initial round, it seems that we may focus on the sub-band non-overlapping full duplex scheme in Rel-18.

13 – Intel Corporation (UK) Ltd

[Intel]

We do not think it is appropriate to include overlapping cases at this point. The scope with the inclusion of subband non-overlapping case is already rather broad, with significant workload, especially on RAN4 and especially when practical feasibility in multi-cellular/multi-operator networks still remains to be established. At this stage, it would not be prudent to expand scope beyond subband non-overlapping case.

14 – ZTE Corporation

We think the subband overlapping and full overlapping duplex schemes should be included in the scope.

The workload may not be an issue considering that most of the simulation framework of sub-band non-overlapping can be reused.

Regarding the feasibility of applying them in practical networks, we think the goal of this study is trying to identify their potential target scenarios and use cases, it is too premature to preclude them directly in the SI scope. If companies have concern on them after the SI phase, companies can preclude them in the WI phase.

15 – China Telecommunications

We are fine to focus on sub-band non-overlapping case in Rel-18 if it is the majority view.

16 – Beijing Xiaomi Electronics

We prefer to limit the study on non-overlapping case in Rel-18.

17 – China Mobile Com. Corporation

We think we should not preclude the possibility of a follow-up WI at the beginning. We prefer a follow-up normative work in Rel-18 and the work scope can be restricted to subband non-overlapping full duplex schemes to make it realistic to complete the WI. Our second preference is a comprehensive and thorough investigation in the study item without follow-up WI on all potential full duplex schemes including subband non-overlapping full duplex and full overlapping full duplex.

18 – Qualcomm Korea

We recommend to include overlapping schemes at least for study. For the feasibility, it is likely to be feasible in some scenarios, e.g., FR2 where compact panels can be well isolated with narrow beams to further reduce self interference. We don't think it is judicious to mandate gNB for non-overlapping scheme if gNB can handle self interference with other means. For the workload, the self interference mitigation with overlapping scheme may not have too much additional spec impact, while the inter-gNB/UE CLI mitigation can reuse the same framework as that for the flexible TDD. Therefore, we recommend to at least study overlapping schemes, and further decide whether to proceed if feasible/beneficial scenarios can be identified.

19 – HUAWEI TECHNOLOGIES Co. Ltd.

Subband overlapping scenario and full overlapping scenario are more complicated than subband non-overlapping scenario. We therefore suggest full duplex scenarios can be handled step by step and suggest subband/full overlapping scenarios to be handled in later releases.

20 – NEC Corporation

We agree not to include the subband overlapping or full overlapping duplex operation in the scope even in the study phase as it will introduce more complexity on the interference management. Besides, the TU may be not enough.

21 – Apple France

As mentioned by some other companies and also by the moderator, there are concerns on feasibility of applying partial/full overlapping sub-bands in terms of UE-to-UE CLI, practical NW implementation, etc. So given the workload, we prefer the scope to be limited to non-overlapping sub-bands

22 – CATT

We prefer to have a overall study of full duplex schemes which includes sub-band/full overlapping schemes in special scenario, e.g. isolated scenario. In the end, whether to actually have them in the following WI can be further discussed, based on conclusion from feasibility and gain study in the SI.

23 – CEWiT

We agree with the comments from Qualcomm Korea regarding inclusion of partial and full overlapping in the study phase.

24 – Sony Europe B.V.

It will be good to consider subband overlapping & full overlapping duplex at least in the SI phase. However, we are also fine to consider this in later releases.

25 – Spreadtrum Communications

We prefer to focus on subband non-overlapping full duplex only in R18. But we are open to study subband overlapping or full overlapping duplex operation if TU permits.

26 – LG Electronics Inc.

We recommend that both non-overlapping and band-overlapping duplex operation should be studied for comprehensive investigation of potential benefit of duplex operation.

- In evaluation work, most of assumption and environment can be applied for both duplex operations. Also, inter-gNB CLI handling and inter-UE CLI handling can be commonly studied for both band-overlapping duplex operation and flexible TDD. In this aspect, we think work load may not be increased significantly.
- For study of implementation feasibility for self-interference mitigation, we think many of implementation for non-overlapping duplex operation (e.g., Antenna solution and RF solution for SI mitigation, and method for Non-linear SI mitigation) can be reused for band-overlapping duplex operation. In addition, for band-overlapping duplex operation, we may investigate further the potential of applying linear SI mitigation in digital domain.

Therefore, we recommend to study both non-overlapping and band-overlapping schemes, then we may decide a scope of normative work based on the study result.

27 – Panasonic Corporation

The subband non-overlapping full duplex scheme is mainly within the same beam. Spatial isolation aspect should be clarified or studied. In our view, full overlapping full duplex between different cells should be at least supported. It means cell A uses DL and cell B use UL in the same time frequency resource. This is same as eIMTA in LTE. Subband Overlapping and Full Overlapping Full Duplex within the same cell depends on the spatial isolation. Our view is at least not to target in the same beam. For the different beams, it can be studied.

28 – Nokia Corporation

It is ok to focus the SI on sub-band non-overlapping case at the gNB, though conclusions/solutions from the SI could be generalized to other duplexing schemes, at the gNB as well as at the UE.

29 – KDDI Corporation

We prefer to focus on subband non-overlapping scheme only in Rel-18.

30 – ROBERT BOSCH GmbH

We prefer the sub-band non-overlapped full-duplex to be in Rel-18. However, we would like to encourage studying sub-band non-overlapped full-duplex for UE form factors other than hand-held devices, e.g., vehicles.

31 – Fujitsu Limited

We are open to study the feasibility of subband overlapping full duplex in Rel-18. We are also fine to not include overlapping schemes in the scope supposing limited TUs.

32 – Rakuten Mobile

we also propose to focus the SI on sub-band non-overlapping case at the gNB

33 – Ericsson France S.A.S

We agree that it is more practical to limit the study in Rel-18 to the sub-band non-overlapping case. It is preferable to have a thorough study of this case first in Rel-18 before considering other even more challenging cases.

2.3 Avoiding Repetition of the Past Discussion

There was a comment that the past discussion about the dynamic/flexible TDD should not be repeated. It could be helpful to get views from companies on this to ensure efficient use of available TUs.

Feedback Form 10:**1 – OPPO**

We share the similar concern as the comment that the past discussion on dynamic/flexible TDD should not be repeated. In addition, we would like to copy one of our questions in form 8 here since they are relevant.

– If this Rel-18 enhancement on dynamic/flexible TDD is for interference management only, should UE be made able to differentiate the interference enhancement between for full-duplex (even on gNB side) purpose and for dynamic/flexible TDD purpose? We wish not. In other words, UE may not need to be aware of whether the enhanced interference management is specifically for dynamic/flexible TDD or gNB side full-duplex.

It seems sufficient to make the interference management of gNB-side full-duplex also applicable to handle existing dynamic/flexible TDD, instead of pursuing the enhancement specifically for dynamic/flexible TDD but not necessarily applicable to full duplex.

2 – Samsung Electronics Co.

NR already supports dynamic TDD and the difficulty in deploying dynamic TDD is inter-operator interference and inter-gNB interference. Among these two types of interference, inter-operator interference is the most critical problem that requires coordination between operators. Based on the past discussion for dynamic TDD, we would like to ask what kind of solutions companies prefer to study for dynamic/flexible TDD. As mentioned by OPPO, we want to understand whether to target a common solution or separate solutions for the two different duplex schemes (dynamic TDD and subband non-overlapped full-duplex).

3 – vivo Communication Technology

While dynamic/flexible TDD was supported since Rel-15 (actually since Rel-12 LTE), however, some interference problems are not solved, such as inter-operator (adjacent channel) interference management. These issues limit the practical deployment of dynamic/flexible TDD in the real network.

4 – LG Uplus

Our feeling is that dynamic/flexible TDD seems impractical through past standardization since Rel-12. We would like to focus on cases with manageable interference issues such as non-overlapped sub-band full duplex.

5 – TELECOM ITALIA S.p.A.

Samsung summarised the issue with standards and regulation. But if there is no solution to allow flexible TDD (which is required even for non-overlapping sub-bands: you need to have the same sub-bands for all operators!!!), we can close the discussion and do no activity on evolution of duplex operation. It would simply be a waste of time and resources, with no possibility for real field implementation.

Therefore 3GPP has to define techniques to manage inter-operator interference. As stated in the first round, this may require the definition of new interfaces, not only RAN1/4 activity.

6 – Spark NZ Ltd

Spark NZ

pls see our earlier comments. we support Telecom Italia here. Both of us made similar feedback in the first round and the moderator ignored this. as an operator we are concerned of the interference and the likely impact on quality of service and liability issues if the interference impacts say emergency calls. we request the moderator to pls pay attention to this key area.

7 – AT&T

Common solutions for dynamic TDD and evolution of duplex operation should be prioritized with specific enhancements for inter-operator interference coordination/mitigation.

8 – Motorola Mobility UK Ltd.

We agree that what had already been discussed and were not agreed for dynamic/flexible TDD during the NR Study Item phase and Rel-16 RIM SI/WI should not be repeated.

9 – Futurewei Technologies

It is not our preference to repeat the previous discussions on dynamic/flexible TDD scheme. However, if the companies provide new supporting facts and results in their contributions during the study phase, we are open to discuss and further clarify the relationship between dynamic/flexible TDD and non-overlapping sub-band solutions.

10 – Samsung Electronics Co.

@Telecom Italia We think that all operators should use the same subband when subband non-overlapped full-duplex is used in one operator. The main reason to have a UL subband is to mitigate DL interference from other operators and the main reason of this study is to verify the possibility whether such subband non-overlapped full-duplex can be used with the conventional systems.

11 – InterDigital

To obtain meaningful outcomes during this SI with limited TU, it is preferred in Rel-18 to preclude repeating past discussions on dynamic/flexible TDD (during the NR SI and the Rel-16 RIM SI/WI).

12 – NTT DOCOMO INC.

We think that the repetition of the past discussion should be avoided. Rel-18 discussion is mainly for the new duplexing scheme, so that we may focus on a new design/mechanism for the new scheme and it can be applicable for the existing scheme (dynamic/flexible TDD).

13 – Intel Corporation (UK) Ltd

[Intel]

It is not clear what is being alluded to by “repetition of past discussions” without specific details. Dynamic/flexible TDD has been specified since Rel-15. However, one of the challenges in practical implementation is due to lack of solutions to address inter-gNB (and inter-operator) cross-link interference.

Thus, studies on inter-gNB CLI handling and related signaling enhancements for dynamic/flexible TDD, with considerations on different levels of inter-gNB coordination, are in order so that an already-specified feature can be implemented. This part is also relevant to enhanced duplex operations, and a common framework of solutions may be able to address the general interference handling issue. However, we should start with focus on what has already been specified, i.e., dynamic/flexible TDD.

14 – ZTE Corporation

Agree that we should not repeat the past discussion. However, in practice, it is not clear how to differentiate which has been discussed, which has not. This can be a unwritten rule for this SI, however, not sure whether we need to explicitly include it in the scope.

15 – Beijing Xiaomi Electronics

We share the views that repetition of the past discussion should be avoided.

16 – China Mobile Com. Corporation

In our view, the discussion that has been done in Rel-16 to handle CLI in dynamic/flexible TDD scenario can be taken as the starting point for the discussion on interference management on inter-gNB and inter-UE CLI in subband non-overlapping full duplex.

We think the interference management of inter-gNB and inter-UE CLI in subband non-overlapping full duplex has already covered the interference in dynamic/flexible TDD, if we can consider different cells in subband non-overlapping full duplex scheme may have different UL-DL time-frequency resource pattern for subband non-overlapping full duplex scheme. Even we do not mention the study should include the aspects related to the dynamic/flexible TDD, we think it has already been included in the study as long as we make a conclusion that the case that different cells may have different UL-DL time-frequency resource pattern in subband non-overlapping full duplex scheme.

Therefore, we are OK to explicitly mention that the study includes the aspects related to the dynamic/flexible TDD or not explicitly mention it.

17 – Qualcomm Korea

We agree with the comment, and that we should utilize the available TUs efficiently and avoid duplicating earlier work done on dynamic/flexible TDD.

18 – HUAWEI TECHNOLOGIES Co. Ltd.

We agree with the general principal to use available TU efficiently. We also observed that Inter-gNB CLI handling for dynamic/flexible TDD in Rel-15/16/17 is not standardized except intended TDD configuration signaling between gNBs, and the available solution is not sufficient to enable efficient dynamic/flexible TDD for factory applications. Dynamic/flexible TDD and full duplex share some commonality when it comes to inter-gNB CLI, so they can be considered jointly in this study item.

19 – NEC Corporation

We have the same view that the past discussion such as the CLI mitigation aspects from the dynamic/flexible TDD should not be repeated in the SI. Besides the specified scheme in NR RIM afterwards, such as SRS-RSRP and CLI-RSSI measurements and reporting at the UE, and the network coordination mechanisms including exchange of intended DL/UL configuration among gNBs should also not be repeated. Other enhancements to mitigation of co-channel cross-link interference schemes with full duplex operation can be studied.

20 – Apple France

In our view, further study on dynamic TDD should be established on previous work.

21 – CATT

We think as CLI handling has been extensively discussed in R-16 CLI and R-17 IAB, further discussion for this topic should be based on Rel-16 CLI and R17 IAB results/conclusions to ensure efficiency of the discussion .

22 – CEWiT

We are fine to study dynamic/flexible TDD wrt inter-operator interference management.

23 – Sony Europe B.V.

It will be easier to avoid past discussion if we have more details on what exactly will be studied under dynamic/flexible TDD. As other companies suggested, this can be limited to only interference management at the gNB.

24 – LG Electronics Inc.

In Rel-16 CLI/RIM WI, RAN4 operated a study of coexistence issues among different operators (3GPP TR38.828). In co-existence analysis, full bandwidth (i.e., 100MHz for FR1) for UL was assumed.

But, in the evaluation for non-overlapping scheme and subband overlapping scheme, we may assume narrower bandwidth for UL because we expect the interference power from other operator is reduced. Hence, we may operate a study of coexistence with modified assumption.

25 – Nokia Corporation

Early work and studies should be utilized and enhancements should be developed on top of the existing solutions and e.g. RAN4 adjacent channel co-existence studies to enable practical deployments of dynamic TDD with flexible DL/UL allocations including UL heavy allocations.

We agree that previous work done on dynamic/flexible TDD should not be repeated. This includes both conclusions on the feasibility of dynamic/flexible TDD in different deployment scenarios, as well as solutions for CLI handling (mainly focused on inter-cell UE-to-UE CLI) from the Rel-16 SI and subsequent WI on CLI handling and RIM for NR. However, we think work on dynamic/flexible TDD in Rel-18 could focus on gNB-to-gNB CLI mitigation techniques.

26 – Ericsson France S.A.S

We think it should be obvious that we should not repeat past discussion or specify any new solutions for problems for which solutions in current specifications will suffice. In this case, the risk of this applies to any studies for dynamic/flexible TDD and associated interference management schemes since this topic

was extensively discussed in the Rel-15/16 timeframe. As others have pointed out, if co-channel gNBs use different DL/UL patterns, CLI will be an issue even for non-overlapping sub-band full duplex schemes. And even for non-overlapping sub-band full duplex, solutions in current specifications or work performed in earlier study items should be taken into account as applicable. Hence, it would be good to add a note applicable to all objectives as suggested in our response in Section 2.1 and repeated here along the lines of the following. “Note: Any enhancements studied should consider what has already been studied earlier and solutions that are already part of current specifications and avoid repeating past work.”

2.4 Deployment scenarios

Views on deployment scenarios were still diverging in the initial round. Considering that there is no progress in terms of developing a consensus on this subject, the moderator proposes to identify applicable and relevant deployment scenarios after starting the study item.

Feedback Form 11:

<p>1 – Spark NZ Ltd</p> <p>Spark NZ</p> <p>we should specify the scope of the SI. Start with the simplest deployment scenario, simplex duplex evolution, - ie low power indoor cells and see the results of this before proceeding to more complex scenarios. Leaving it open to the study item will not be a good idea.</p>
<p>2 – OPPO</p> <p>If RAN-P cannot settle on a comprehensive list of scenarios for Rel-18 scoping, we are also fine to start with just one or two most common scenario(s), such as micro/small-cell with low-power nodes. Indoor/isolated-cell scenarios can be on secondary priority, because the inter-cell interference for indoor/isolated-cell is either none or a bit more complicated than typical scenarios.</p>
<p>3 – Samsung Electronics Co.</p> <p>Support moderator’s suggestion</p>
<p>4 – vivo Communication Technology</p> <p>At least some deployment scenarios can be confirmed, e.g. indoor/small cell/low power nodes. Other deployment scenarios for example macro deployment can be further discussed during the SI, if controversial.</p>
<p>5 – LG Uplus</p> <p>In general, support moderator’s suggestion. If our preference is asked, urban and dense urban scenario w&w/o O2I is prioritized.</p>
<p>6 – China Unicom</p> <p>We support moderator’s suggestion. Besides, it will be helpful if some basic scenario can be settled at this stage and micro/small cell nodes scenario should be included.</p>

7 – KT Corp.

KT would like to emphasize on our interest in smallcell cases for TDD. If FDD is considered, applying FDR in macrocell should also be considered.

8 – SK Telecom

We suggest case for sea side and long-distance service in TDD. To solve the limitation of TDD UL Slot, We'd like to extend coverage using dynamic UL slot.

9 – TELECOM ITALIA S.p.A.

We think the most interesting (and challenging) scenario is a macro urban. And this is our first priority.

Not sure if small cells is the most representative scenario, but it could be a start.

Really isolated indoor pico cells (i.e. in a Faraday cage :-)) do not require any coordination. In practice, the case where a UE connected with a far macro enters the indoor environment should be considered.

10 – VODAFONE Group Plc

Our views are in line with Telecom Italia's. Isolated indoor pico cells don't seem very helpful. We also think macro and urban/micro with outdoor to indoor transition should be considered as a priority.

11 – Futurewei Technologies

We think that limiting the scenarios to small cells indoor will not be too helpful or conclusive. Adding outdoor scenarios such micro/macro cells should be considered to identify intra and inter-operator interference issues. We are fine to add more scenarios during the study phase, therefore we support the moderator's proposal.

12 – Spark NZ Ltd

Spark NZ

we re emphasise again to try simulating a simple case and build on more cases if the results of the simple case prove to be positive. This is why we suggested the indoor small cells case.

13 – AT&T

We believe that this can be finalized during the study item. There are use cases for outdoor, indoor, and O2I, however as mentioned by others certainly outdoor urban macro deployments should be considered due to their relevance and more limiting challenges compared to isolated indoor deployments.

14 – Motorola Mobility UK Ltd.

Fine with the moderator proposal. Working Groups can identify target deployment scenarios based on detailed technical discussions during the study.

15 – InterDigital

We support moderator's suggestion to identify deployment scenarios in more details during the SI.

16 – NTT DOCOMO INC.

We are fine with the moderator proposal.

17 – Intel Corporation (UK) Ltd**[Intel]**

We support the moderator’s suggestion to finalize the deployment scenarios and evaluation methodology as part of the SI. Considering the close relationship between frequency range and deployment scenarios, we suggest to at least capture explicitly that deployment scenarios for FR1 are to be prioritized, and deployment scenarios using FR2 bands may be studied in a second phase of the SI.

18 – ZTE Corporation

We support moderator’s suggestion to identify applicable and relevant deployment scenarios after starting the study item. It is too premature to exclude any scenario before the start of this SI without knowing its potential gain.

19 – China Telecommunications

If there is no consensus on full list of scenarios, maybe we can try to include some major scenarios in the SI scope. Other scenarios can be discussed and added after starting the study item.

20 – Beijing Xiaomi Electronics

We are fine with the idea to study the possible deployment scenarios during Rel-18 study item.

21 – China Mobile Com. Corporation

Macro, micro, small cell, isolated and indoor scenarios can be included in the scope and further details will be developed after starting the study item.

22 – Qualcomm Korea

It is also fine with us to discuss the deployment scenario at the very early stage of the RAN1 study item.

23 – HUAWEI TECHNOLOGIES Co. Ltd.

There are multiple companies (including operators) mentioning HetNet. We therefore suggest both heterogeneous network (e.g. macro base station + factory deployment) and homogeneous network to be included in this study. Considering that there is no consensus on detailed deployment scenario, maybe companies can agree on to include both heterogeneous network and homogeneous network in this study with details to be worked out during study item phase. Suggested objective:

- Both heterogeneous network and homogeneous network are in the scope of this study, with details to be identified during the study

24 – Apple France

We share similar view to majority, that deployment scenarios like macro, micro, and small cell layouts, can be included in the scope. In our view, further prioritization on which layout should be studied, can be technically discussed after starting the study item

25 – CATT

We are fine with moderator’s proposal.

<p>26 – CEWiT</p> <p>Fine with the proposal.</p>
<p>27 – Sony Europe B.V.</p> <p>We are fine with moderator’s suggestion. We do not see why we need to restrict the study of deployment scenarios for full duplex.</p>
<p>28 – Spreadtrum Communications</p> <p>It is fine to us to study the possible deployment scenarios during Rel-18 study item.</p>
<p>29 – LG Electronics Inc.</p> <p>We are generally fine with moderator’s suggestion.</p> <p>In addition, we can put a sentence that small cell with lower Tx power (i.e., micro cell, indoor) is prioritized for study of duplex enhancement.</p>
<p>30 – Nokia Corporation</p> <p>We agree with the moderator to include applicable deployment scenarios and related constraints to be part of the study item scope. The feasibility of a certain feature or enhancement in a given deployment scenario will need to be validated against BS and UE RF requirements, so the decision on deployment scenarios cannot be taken alone in RAN plenary.</p>
<p>31 – KDDI Corporation</p> <p>We are fine with moderator’s proposal.</p>
<p>32 – Fujitsu Limited</p> <p>We are fine with the moderator proposal.</p>
<p>33 – Ericsson France S.A.S</p> <p>It would be preferable to provide as much guidance in the study item description as possible, but if there isn’t convergence on the scenarios, it may also be ok to make determination of the scenarios to prioritize a part of the study. We believe the following scenarios should be prioritized. An option would be to agree on them first and then discuss other scenarios during the study item.</p> <ul style="list-style-type: none"> · DL-UL assignments are the same across all co-channel nodes (macro, micro and small cells) and UE-UE inter-operator interference is not expected to be an issue · Small cell scenarios where gNB with lowered and UE Tx powers are fairly similar

2.5 Summary and Recommendation

The moderator suggested further discussion about the following three subjects in the intermediate round.

- Whether to include the subband overlapping and full overlapping full duplex schemes in the scope
- Avoiding repetition of the past discussion

- Deployment scenarios

Taking into account the feedbacks, the moderator observes that there is a good level of consensus on the followings.

- The subband overlapping and full overlapping full duplex schemes are not included in the scope.
- Avoid repeating the same discussion that already took place in the past releases.
- Identify applicable and relevant deployment scenarios after starting the study item.

In addition to the above observations, the moderator also observes the need for capturing the followings.

- RAN3 needs to be mentioned in the objective about the study of inter-gNB and inter-UE CLI and the identification of solutions to manage them.
- Regulatory aspects needs to be investigated.
- Inter-operator CLI at UE

3 Final Round

3.1 General

Taking into account the outcome of the intermediate round, the moderator proposes to discuss about the text for justification and objective sections of the SID.

Feedback Form 12:

1 – Sony Europe B.V.
Fine with moderator’s proposal to discuss the texts for the SID.
2 – Verizon UK Ltd
It looks fine.

3.2 Text for SID Justification Section

[Proposed text - Start]

TDD is widely used in commercial NR deployments. In TDD, the time domain resource is split between downlink and uplink. Allocation of a limited time duration for the uplink in TDD would result in reduced coverage and increased latency. As a possible enhancement on this limitation of the conventional TDD operation, it would be worth studying the feasibility of allowing the simultaneous existence of downlink and uplink, a.k.a. full duplex, in unpaired spectrum systems.

The NR TDD allows the dynamic/flexible allocation of downlink and uplink in time and Rel-16 introduced enhancements on RIM/CLI. Nevertheless, the CLI between the networks of different operators may require further enhancements to enable the dynamic/flexible TDD in commercial networks.

This study aims to identify the feasibility and solutions of duplex evolution in the areas outlined above to provide enhanced coverage, reduced latency, improved spectral efficiency, and dynamic/flexible configuration for NR TDD operations in unpaired spectrum.

[Proposed text - End]

Companies are invited to provide feedbacks on the proposed text. It would be desirable to focus on the overall context instead of debating about specific words.

Feedback Form 13:

1 – OPPO

We have different views on "...enhanced coverage, reduced latency, improved spectral efficiency, and dynamic/flexible configuration for NR TDD operations".

First, configuration may never be dynamic/flexible.

Secondly, RAN could have some metrics to measure coverage, latency, spectrum efficiency. But what is the metric for "dynamic/flexible configuration"?

We suggest to remove "and dynamic/flexible configuration".

We still fail to see the relation between full duplex and dynamic/flexible TDD. There seems no justification to explain why the two are put in the same SI. The SI looks like containing two independent parts.

2 – vivo Communication Technology

Thanks for the effort from moderator. We have one major comments to the justification part.

In the first paragraph, it is necessary to mention the main focus of Rel-18 study item will be **sub-band non-overlapping type of "full duplex" at gNB side only**.

3 – Spark NZ Ltd

Spark NZ

Despite making submissions in the first two rounds the moderator has only taken a limited note.

we request the moderaor to consider our suiggestions as given in the appendix

4 – Apple France

We are supportive of the moderator's proposed SID justification.

5 – China Mobile Com. Corporation

We are supportive of the moderator's proposed SID justification

6 – VODAFONE Group Plc

Overall we are supportive of the moderator's proposed SID justification, but we also agree with Vivo that it should be clarified that "full duplex" means sub-band non-overlapping at the gNB side within a conventional TDD band.

7 – LG Electronics Inc.

We are generally fine with moderator’s proposed text for SID justification.

But, because Cross Link Interference (CLI) contains negative meaning, we suggest modification regarding ‘CLI part’ as follow:

The NR TDD allows the dynamic/flexible allocation of downlink and uplink in time and ~~Rel-16 introduced enhancements on RIM/CLI CLI handling and RIM for NR was introduced in Rel-16.~~ Nevertheless, ~~the CLI between the networks of different operators may require further enhancements study for CLI handling between the networks of different operators may be required to enable the dynamic/flexible TDD in commercial network.~~ Furthermore, enhancement for CLI handling between gNBs of same operator may be required.

8 – Sony Europe B.V.

On the last paragraph, the text says:

“... to provide enhanced coverage, reduced latency, *improved spectral efficiency*, and...”

It isn’t obvious how spectral efficiency, assuming it is in terms of *bps/Hz*, would be improved, since we are not introducing higher modulations or new coding techniques. Perhaps what we want to say is improved system capacity, since gNB can utilise sub-bands for DL and UL, that is:

This study aims to identify the feasibility and solutions of duplex evolution in the areas outlined above to provide enhanced coverage, reduced latency, improved ~~spectral efficiency~~**system capacity**, and dynamic/flexible configuration for NR TDD operations in unpaired spectrum.

9 – Spark NZ Ltd

Spark NZ

The justification for a new duplex scheme mentions improved coverage. One wonders how will this happen as coverage is governed by path loss that is intuen a function of frequency and distance. There is no duplex scheme dependency here

10 – Motorola Mobility UK Ltd.

In our view, a limited uplink duration in TDD is not directly related to coverage but makes an impact on uplink throughput. Thus, we suggest the following modification:

TDD is widely used in commercial NR deployments. In TDD, the time domain resource is split between downlink and uplink. Allocation of a limited time duration for the uplink in TDD would result in ~~reduced coverage~~ **limited uplink throughput** and increased latency. As a possible enhancement on this limitation of the conventional TDD operation, it would be worth studying the feasibility of allowing the simultaneous existence of downlink and uplink, a.k.a. full duplex, in unpaired spectrum systems.

The NR TDD allows the dynamic/flexible allocation of downlink and uplink in time and Rel-16 introduced enhancements on RIM/CLI. Nevertheless, the CLI between the networks of different operators may require further enhancements to enable the dynamic/flexible TDD in commercial networks.

This study aims to identify the feasibility and solutions of duplex evolution in the areas outlined above to provide enhanced coverage, reduced latency, improved spectral efficiency, and dynamic/flexible configuration for NR TDD operations in unpaired spectrum.

11 – Futurewei Technologies

We are supportive of the moderator’s proposed SID justification.

12 – InterDigital

We are generally fine with the justification part proposed by the moderator. One thing that needs revision in the last paragraph is that the phrase of dynamic/flexible configuration needs to be removed in the sentence, and it should be mentioned separately if needed, because it is not in the same level of describing potential benefits such as providing enhanced coverage, reduced latency, and improved spectral efficiency (described in the same sentence). It is, rather, another potential study scope in this study item.

13 – ZTE Corporation

We are generally fine with the above justification description. One suggestion from our side would be to have a separate paragraph to describe and emphasize flexible TDD configuration, which seems to be an urgent use case for operators.

14 – Intel Corporation (UK) Ltd

Intel

We support the suggestion from vivo, to add to the first paragraph that the “full duplex” behavior is limited to sub-band non-overlapping full duplex operation at gNB side only.

15 – NTT DOCOMO INC.

We are supportive of the proposed SID justification.

16 – Nokia Corporation

We have one minor comment on the moderator’s proposal. It could be clarified that the problem of CLI between the networks of different operators with dynamic/flexible TDD may be due to either adjacent-channel CLI, or co-channel-CLI, or both, depending on the deployment scenario. Also, it could be mentioned that the main problem not addressed in the previous releases is due to DL-to-UL interference, i.e. gNB-to-gNB CLI.

17 – CATT

We have similar view with other companies that for the following description in first paragraph “it would be worth studying the feasibility of allowing the simultaneous existence of downlink and uplink”, it is more appropriate to add the limitation of “at gNB side only”.

18 – CEWiT

We are fine with the justification

19 – Beijing Xiaomi Electronics

We are generally fine with the proposed SID justification. Furthermore, we think the refinements raised by Sony should be considered.

20 – HUAWEI TECHNOLOGIES Co. Ltd.

We support moderator proposed SID justification in general. We have one comment as below:

- According to company proposals in the previous email discussion, the CLI enhancement is not only apply for inter-operator scenario, but also for intra-operator scenario. So we suggest to revise the wording as below:

the CLI between the network **nodes of the same operator or of** different operators may require further enhancements to enable the dynamic/flexible TDD in commercial networks.

We also support Sony's suggestion to change "spectral efficiency" to "system capacity"

21 – TELECOM ITALIA S.p.A.

We are generally fine with the moderator's proposal.

Some notes:

- tend to agree with the comment that there are two activities within the same SID.
- We want to keep and underline the importance of enabling flexible TDD deployments in practice (not only on paper)

22 – Spreadtrum Communications

We are fine with the moderator's proposed SID justification.

23 – Ericsson France S.A.S

The proposed text is in general OK, but it is important to emphasize that to assess the feasibility, it is essential to assess aspects such as achievable antenna isolation, TX IM suppression, filtering, digital interference suppression etc. We propose to add the following to the text:

- To evaluate the feasibility, aspects including achievable DL/UL antenna isolation, suppression of TX IM products in the receiver bandwidth, filtering, digital interference suppression need to be considered in order to establish that the TX-RX isolation is feasible

24 – MediaTek Inc.

For 1st paragraph, share the same view as other companies that gNB-side full duplex should be mentioned.

For other paragraphs, okay with moderator's proposal.

3.3 Text for SID Objective Section

[Proposed text - start]

The objective of this study is to identify and evaluate the potential enhancements to support duplex evolution for NR TDD in unpaired spectrum.

In this study, the followings are assumed:

- Duplex enhancement at network side
- Half duplex operation at UE side
- No restriction on frequency ranges

The detailed objectives are as follows:

- Identify applicable and relevant deployment scenarios and use cases (RAN1)
- Develop evaluation methodology for duplex enhancement (RAN1)
- Study the non-overlapping full duplex and the enhancements on dynamic/flexible TDD
 - Identify possible schemes and evaluate their performances (RAN1)
 - Study inter-gNB and inter-UE CLI and identify solutions to manage them (RAN1/RAN3).
 - Study performance aspects of co-channel and adjacent-channel co-existence of the identified schemes with the legacy operation (RAN1).
 - Study the impact on RF requirements considering the self-interference and the inter-operator CLI at gNB and the inter-operator CLI at UE (RAN4).
 - Study the impact on RF requirements considering co-channel and adjacent-channel co-existence with the legacy operation (RAN4).
 - RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed.
- Summarize the regulatory aspects that have to be considered for deploying the identified duplex enhancements in TDD unpaired spectrum (RAN1)

Note: Avoid repeating the work and discussion done in Rel-15 and Rel-16

[Proposed text - end]

Companies are invited to provide feedbacks on the proposed text. It would be desirable to focus on the overall context instead of debating about specific words.

Feedback Form 14:

1 – OPPO

Is it the correct understanding that all tasks under 3rd bullet "Study the non-overlapping full duplex and the enhancements on dynamic/flexible TDD" would have double copies, one for full duplex and another for dynamic/flexible TDD? If yes, we may come up with concerns on available TU and WG's workload.

2 – vivo Communication Technology

Given the main focus of Rel-18 study will be sub-band non-overlapping type of "full duplex" at gNB side only, we do not agree to introduce UE hardware changes to support such kind of operation, specifically, we should not consider more stringent UE RF requirement, e.g. in-band emission, ACLR, etc. We should instead consider scheduling based solutions (with potential coordinations among intra-/inter- operator gNBs), which is the same principle for Rel-16 CLI feature. Therefore, the last two sub-bullets should be revised as below.

- Study the impact on **gNB** RF requirements considering the self-interference and the inter-operator CLI **at gNB and the inter-operator CLI at UE** (RAN4).
- Study the impact on **gNB** RF requirements considering co-channel and adjacent-channel co-existence with the legacy operation (RAN4).

3 – Spark NZ Ltd

Modify objectives as below:

1. Inter operator interference when adjacent operators have different frame structures and who will mitigate, **the aggressor, or the victim or both.**
 2. Backwards compatibility with legacy systems-
 3. co existence with adjacent **bands**.- this is possibly a regulatory issue.
 4. Impact of interference cancellation on UE aspects in general- in terms of signal processing requirements, energy consumption, control channel latencies, initial access times etc.
- we had also suggested that we start with preferably a simple case of small cell indoor and see the gains. could we kindly request the moderator to include these objectives.

4 – Apple France

Under the SI's assumptions, in addition to – *Duplex enhancement at network side – Half duplex operation at UE side*

– *No restriction on frequency ranges*

unpaired spectrum (TDD band) should also be added. Other than that, we are supportive of the moderator's proposed SID justification

5 – China Mobile Com. Corporation

Thanks for moderator's great effort on this. Some of our previous clarification questions are not reflected in current version, so we further provide several comments regarding 'Study the non-overlapping full duplex and the enhancements on dynamic/flexible TD':

- 1) In our understanding, the inter-gNB and inter-UE CLI include both the intra-subband CLI and inter-subband CLI, we suggest to clearly mention this.
- 2) We think the inter-subband CLI at gNB and the inter-subband CLI at UE should also be studied in RAN4.

3) the sub-bullet 'RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed' should be promoted to a higher level.

The suggested wording are as following:

- Study the non-overlapping full duplex and the enhancements on dynamic/flexible TDD
 - o Identify possible schemes and evaluate their performances (RAN1)
 - o Study inter-gNB and inter-UE CLI (including the intra-subband CLI and inter-subband CLI) and identify solutions to manage them (RAN1/RAN3).
 - o Study performance aspects of co-channel and adjacent-channel co-existence of the identified schemes with the legacy operation (RAN1).
 - o Study the impact on RF requirements considering the self-interference, the inter-subband CLI and the inter-operator CLI at gNB, and the inter-subband CLI and the inter-operator CLI at UE (RAN4).
 - o Study the impact on RF requirements considering co-channel and adjacent-channel co-existence with the legacy operation (RAN4).
 - o RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed.

6 – VODAFONE Group Plc

We are supportive of the proposed objectives.

7 – LG Electronics Inc.

Thanks for moderator's great effort.

Even though majority view is to support studying non-overlapping full duplex scheme only in Rel-18, we see that many companies propose to study both non-overlapping full duplex scheme and band-overlapping full duplex scheme.

We think even if band-overlapping full duplex scheme is included as a part of work scope, work load of feasibility study for duplex schemes may not be increased significantly.

For example, we think most of assumption and environment can be applied for both duplex operations in evaluation work. Also, we can expect if we decide feasibility study of band-overlapping duplex scheme is performed based on limited scenarios (if workload is concerned), overhead of feasibility study for band-overlapping full duplex scheme is not large. Furthermore, we think inter-gNB CLI handling and inter-UE CLI handling can be commonly studied for both band-overlapping duplex operation and flexible TDD.

In this sense, we suggest to keep band-overlapping full duplex scheme with square bracket as a candidate of study scope, then to decide in next RAN plenary meeting whether band-overlapping full duplex is precluded or not.

Modification suggestions are following:

- Study the non-overlapping full duplex[, **band-overlapping full duplex**] and the enhancements on dynamic/flexible TDD
- Study inter-gNB and inter-UE CLI **handling** and identify solutions to manage them (RAN1/RAN3).

8 – Sony Europe B.V.

We should not increase the UE's RF hardware complexity since Full Duplex is only performed at the gNB and we considered only non-overlapping sub-band. If UE's RF is affected for such an operation, then it isn't clear how legacy UEs would operate in such deployment. Hence we share similar view with vivo that only gNB's RF impacts should be considered and it should not impact the UE.

The last bullet on regulatory aspects should be under RAN4 rather than RAN1.

Our proposed changes:

- Identify applicable and relevant deployment scenarios and use cases (RAN1)
- Develop evaluation methodology for duplex enhancement (RAN1)
- Study the non-overlapping full duplex and the enhancements on dynamic/flexible TDD
- Identify possible schemes and evaluate their performances (RAN1)
 - o Study inter-gNB and inter-UE CLI and identify solutions to manage them (RAN1/RAN3).
 - o Study performance aspects of co-channel and adjacent-channel co-existence of the identified schemes with the legacy operation (RAN1).
 - o Study the impact on RF requirements considering the self-interference and the inter-operator CLI at gNB ~~and the inter-operator CLI at UE~~ (RAN4).
 - o Study the impact on gNB RF requirements considering co-channel and adjacent-channel co-existence with the legacy operation. *There should be no additional UE RF requirements* (RAN4).
- § RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed.
- Summarize the regulatory aspects that have to be considered for deploying the identified duplex enhancements in TDD unpaired spectrum (~~RAN1~~RAN4)

9 – AT&T

We have concerns about the following bullet: "Study the non-overlapping full duplex and the enhancements on dynamic/flexible TDD"

As we have mentioned previously, we are not OK with excluding the partial-overlapping and fully-overlapping cases from the study item. As a compromise we would be willing to accept a bullet limiting the scope of solutions/requirements for the partial-overlapping and fully-overlapping cases to only those which are common with the solutions/requirements identified for the non-overlapping full duplex case.

10 – Motorola Mobility UK Ltd.

In our view, study should be able to conclude whether any enhancement on dynamic/flexible TDD is necessary. Thus, we suggest the following modification:

- Study the non-overlapping full duplex and ~~the~~ **potential** enhancements on dynamic/flexible TDD

11 – Futurewei Technologies

We are supportive of the moderator's proposed objectives. We are concerned that further expanding the list of these objectives may add too much workload and require additional TUs.

12 – InterDigital

Overall, we are supportive to moderator’s suggestion for the drafted objectives. We have a few comments for update. Since we agreed to avoid repeating the work/discussion done in Rel-15/16 (as captured in the Note), it is reasonable to add ‘potential’ in front of “enhancements on dynamic/flexible TDD”, also commented by Motorola mobility. Correspondingly, most of its subbullets should be understood as being related to the non-overlapping full duplex, not necessarily to the potential enhancements on dynamic/flexible TDD. We also support Sony’s suggestion to switch the WG from RAN1 to RAN4, regarding the last bullet on summarizing the regulatory aspects.

13 – ZTE Corporation

We share similar view as LGE and AT&T that it is too premature to exclude sub-band overlapping and full-overlapping duplex at this stage. As also commented by other companies, the additional workload of including sub-band overlapping and full-overlapping may not be huge and we can prioritize the common assumption/solution to all the three different full duplex schemes.

14 – Intel Corporation (UK) Ltd

Intel

We support the latest proposal for the most part, including limiting to subband non-overlapping case for enhanced duplex operation.

The evaluation methodology should be under “the non-overlapping full duplex and enhancements on flexible/dynamic TDD” bullet. There can be different considerations for evaluations for different possible variants of duplex enhancements and we do not need to develop an evaluation methodology that covers all cases.

Also, the study on feasibility is essential and should be added back.

Moreover, the two objectives currently have considerable overlap in terms of the overall interference management issue, and thus, we suggest that these are combined into a single bullet to avoid confusion that these are disconnected objectives. This is suggested below.

- Study the ***feasibility and*** impact on RF requirements considering the self-interference; inter-operator CLI; co-channel and adjacent-channel co-existence with the legacy operation (RAN4).

The following bullet should be one level of indentation to the left (i.e., at same level as the RAN4 objectives) as it should apply to ALL bullets with RAN4-leadership.

- RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed.

15 – NTT DOCOMO INC.

We are supportive of the proposed objectives.

16 – Nokia Corporation

As discussed before, RAN4 should also be included in identifying applicable and relevant deployment scenarios and use cases as RF requirements, assumptions and co-existence aspects matter a lot. RAN4 should also participate in evaluating performance as RF and co-existence performance aspects may be the limiting factor for the overall performance.

The following bullet should be on the main level “RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed.” as RAN4 studies are needed on several areas of this study item including assessment of feasible deployment scenarios.

In the studies we should utilize the findings of Rel-15 and Rel-16. Thus, it would be better to reword the note.

Thus, we would like to propose the following updates to the SID objectives:

The detailed objectives are as follows:

- Identify applicable and relevant deployment scenarios and use cases (RAN1, RAN4)
- Develop evaluation methodology for duplex enhancement (RAN1)
- Study the non-overlapping full duplex and the enhancements on dynamic/flexible TDD
 - o Identify possible schemes and evaluate their performances (RAN1, RAN4)
 - o Study inter-gNB and inter-UE CLI and identify solutions to manage them (RAN1/RAN3).
 - o Study performance aspects of co-channel and adjacent-channel co-existence of the identified schemes with the legacy operation (RAN1, RAN4).
 - o Study the impact on RF requirements considering the self-interference and the inter-operator CLI at gNB and the inter-operator CLI at UE (RAN4).
 - o Study the impact on RF requirements considering co-channel and adjacent-channel co-existence with the legacy operation (RAN4).
- RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed.

Summarize the regulatory aspects that have to be considered for deploying the identified duplex enhancements in TDD unpaired spectrum (RAN1)

Note: Utilize ~~Avoid repeating~~ the work and discussion done in Rel-15 and Rel-16

17 – CATT

In general we are fine with the objective. We will have strong concern if the scope of the objectives are further extended. Since there are essentially two objectives (non-overlapping full duplex and the enhancements on dynamic/flexible TDD) now, it may be helpful, as OPPO suggested, to explicitly indicate the sub-objectives for each of them.

18 – CEWiT

We are supportive of the proposed objectives

19 – Beijing Xiaomi Electronics

We share the similar views with InterDigital.

20 – Telekom Deutschland GmbH

Deutsche Telekom generally supports moderator's proposal but agree with other companies that the topics TDD non-band overlapping full duplex and CLI should only be regarded at gNB site.

21 – NEC Corporation

We support to the proposed objectives.

22 – HUAWEI TECHNOLOGIES Co. Ltd.

1. As we commented in the intermediate round, RAN4 usually does not define co-channel RF requirements. So we suggest to the below revision “Study RF requirements of ~~co-channel and adjacent-channel~~ co-existence with the legacy operation [RAN4].” the proposal got support from Spreadtrum and LG Electronics. We noticed that in the final round, our suggestion is not captured. Let me clarify our intention again: Our understanding is that co-channel refers to overlapped frequency resources, and RAN4 usually does not define RF requirements for it. We do not have the intention to exclude RF requirements for co-existence between different non-overlapping subbands within the same carrier, and we understand the interference between non-overlapping subbands is addressed in “Study the impact on RF requirements considering the self-interference and the inter-operator CLI at gNB and the inter-operator CLI at UE (RAN4).” So we suggest below revision on top of the proposed objective in the final round.

- Study the impact on RF requirements considering ~~co-channel and adjacent-channel~~ co-existence with the legacy operation (RAN4).

2. The bullet (“RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed.”) should apply for both of the listed RAN4 objectives, and hence should not be put under “Study the impact on RF requirements considering co-channel and adjacent-channel co-existence with the legacy operation (RAN4).”

23 – Spreadtrum Communications

We share similar view with vivo and Sony that more stringent UE RF requirement should not be considered. Therefore, we suggest to revise the sub-bullet as below:

Study the impact on RF requirements considering the self-interference and the inter-operator CLI at gNB ~~and the inter-operator CLI at UE (RAN4).~~

24 – TELECOM ITALIA S.p.A.

We are in general supportive of the moderator’s proposal with the revisions from Nokia.

We do not support expanding the scope in Rel 18 to partially or fully overlapping sub-bands. This can be studied in rel 19 / 6G.

25 – Ericsson France S.A.S

The bullet “RAN4 work should start at the beginning of SI to provide necessary information to RAN1 as needed.” should be moved a level higher to be a main sub-bullet since this applies generally to other bullets as well such as the one before on the impact on requirements considering self-interference and inter-operator CLI.

In addition, as RAN4 feasibility study around advanced antenna design to increase the isolation, RF and algorithm improvements is essential, we propose to add additional bullet as following:

- RAN4 should be involved early to study the feasibility aspects due to high impact in antenna/RF and algorithm design . These include antenna isolation, TX IM suppression in the RX part, filtering and digital interference suppression.

For the bullet, “Study performance aspects of co-channel and adjacent-channel co-existence of the identified schemes with the legacy operation (RAN1)”, is the intention to study impact to legacy systems from a system performance perspective due to adjacent channel interference? Normally RAN1 doesn’t consider adjacent channel performance. Is the intention here to use models from RAN4 for adjacent channel interference in system simulations in RAN1?

26 – Fujitsu Limited

We are in general supportive of the moderator’s proposal with the revision by Motorola Mobility.

27 – MediaTek Inc.

We also share the same view as LGE/AT&T/ZTE that overlapping scheme should be included at least focusing on feasibility study (including RF aspects) only.

For 3rd main bullet, it’s better to clarify “non-overlapping full duplex” is from intra-beam or intra-gNB perspective? In addition, from inter-gNB perspective, is it allow to have overlapping case? Or only consider non-overlapping case?

For others, okay with moderator’s proposal.

28 – KDDI Corporation

We are supportive of the proposed objectives.

3.4 Summary and Recommendation

The final round discussion showed a good level of convergence on the text for justification and objectives. Most of the comments were accommodated and the moderator proposal for the text is as follows.

[Justification text – start]

TDD is widely used in commercial NR deployments. In TDD, the time domain resource is split between downlink and uplink. Allocation of a limited time duration for the uplink in TDD would result in reduced coverage and increased latency. As a possible enhancement on this limitation of the conventional TDD operation, it would be worth studying the feasibility of allowing the simultaneous existence of downlink and uplink, a.k.a. full duplex, or more specifically, subband non-overlapping full duplex at the gNB side within a conventional TDD band.

The NR TDD allows the dynamic/flexible allocation of downlink and uplink in time and CLI handling and RIM for NR were introduced in Rel-16. Nevertheless, further study may be required for CLI handling between the networks of different operators to enable the dynamic/flexible TDD in commercial networks. The inter-operator CLI may be due to either adjacent-channel CLI or co-channel-CLI, or both, depending on the deployment scenario. The main problem not addressed in the previous releases is gNB-to-gNB CLI.

This study aims to identify the feasibility and solutions of duplex evolution in the areas outlined above to provide enhanced coverage, reduced latency, improved system capacity, and improved configuration flexibility for NR TDD operations in unpaired spectrum.

[Justification text – end]**[Objective text – start]**

The objective of this study is to identify and evaluate the potential enhancements to support duplex evolution for NR TDD in unpaired spectrum.

In this study, the followings are assumed:

- Duplex enhancement at the gNB side
- Half duplex operation at the UE side
- No restriction on frequency ranges

The detailed objectives are as follows:

- Identify applicable and relevant deployment scenarios and use cases (RAN1).
- Develop evaluation methodology for duplex enhancement (RAN1).
- Study the subband non-overlapping full duplex and potential enhancements on dynamic/flexible TDD.
 - Identify possible schemes and evaluate their feasibility and performances (RAN1).
 - Study inter-gNB and inter-UE CLI handling and identify solutions to manage them (RAN1).
 - Study their impacts on inter-gNB interfaces if needed (RAN3).
 - Consider intra-subband CLI and inter-subband CLI in case of the subband non-overlapping full duplex.
 - 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).
 - Study the impact on RF requirements considering the self-interference, the inter-subband CLI, and the inter-operator CLI at gNB and the inter-subband CLI and inter-operator CLI at UE (RAN4).
 - Study the impact on RF requirements considering adjacent-channel co-existence with the legacy operation (RAN4).
 - RAN4 should be involved early to provide necessary information to RAN1 as needed and to study the feasibility aspects due to high impact in antenna/RF and algorithm design, which include antenna isolation, TX IM suppression in the RX part, filtering and digital interference suppression.
 - Summarize the regulatory aspects that have to be considered for deploying the identified duplex enhancements in TDD unpaired spectrum (RAN4).

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.

[Objective text – end]

Below are the responses on the comments that were not incorporated into the text.

While some concerns are still expressed about the dynamic/flexible TDD, the overall view is that short-term enhancements should be considered.

There were comments to mention the CLI handling between gNBs of the same operator in the justification section. It is not included in the spirit of avoiding the repetition of the past discussion.

There were concerns on introducing more stringent UE RF requirements. Whether there is any impact on UE RF would naturally be a part of the study. Outcome of the study will be useful to develop common understanding on the UE RF aspect and can be used to decide the next step. The potential normative work could be planned to avoid UE RF impacts if desired.

It was commented before that the interaction between RAN1 and RAN4 should be clarified. Otherwise, two WGs could have uncoordinated discussion on the same subject. Hence, each bullet is clarified and only the leading WG is denoted. It is the usual practice that the leading WG may request inputs from other WGs. Following this principle, the sequence of the study on inter-gNB and inter-UE CLI handling between RAN1 and RAN3 is now further clarified.

There were comments about explicit separation of detailed objectives for the subband non-overlapping full duplex and the enhancements on dynamic/flexible TDD. However, there also were comments emphasizing the possibility of common solutions. It seems more appropriate to keep the current formulation taking into account this situation.

A small group of companies are proposing to include the subband overlapping and full overlapping full duplex in the scope. On the other hand, the majority view is that they can be considered in Rel-19 or later. Considering this situation, it is difficult to include these two approaches in the scope.

The moderator recommendation is as follows.

- Consider the justification and objective text above stable and take them as the basis for the next round of discussion. Note that a draft SID will be provided following the RAN chair's guide in RP-212657.
- Regarding the roles of involved RAN WGs, RAN1 will be the leading WG and RAN4 and RAN3 will be secondary WGs.
- The next round of discussion should focus on TU allocation, target completion date of the SI, and whether to plan potential follow-up normative work for inclusion in Rel-18 specifications.