[RAN93e-R18Prep-11] Evolution of duplex operation - Version 0.0.6
RAN

3GPP TSG RAN#93e **RP-211661**

Electronic Meeting, September 13 - 17, 2021

Agenda Item: 9.0.1

Source: Samsung

Title: Moderator's summary for discussion [RAN93e-R18Prep-11] Evolution of duplex operation

Document for: Information & Decision

The discussion in this thread covers topic #11 "Evolution of duplex operation" [RWS-210659].

Deadline and NWM organization are based on the guidelines provided by the RAN Chair [RP-211639].

As per guidance [RWS-210659] of the RAN Chair the discussion in this thread should be based on the (RAN REL-18 workshop) RWS submissions.

The aim is to converge on a set of areas with a reasonable scope as a "high-level description" – where "high-level description" herein is not a "draft SID/WID" but is something like a single slide with a set of bullets. In other words, it can be viewed as a skeleton of the possible objectives with some high-level notes.

Please avoid any input like "We support / we do not support" as this is no "number counting" driven discussion, but focus on tangible commercial interests (near & longer terms).

1 Initial Round

1.1 Collection of company views

1.1.1 General high-level views

Feedback Form 1:

1 – vivo Communication Technology

A step-by-step approach is preferred for the study of duplex evolution in 5G-Advanced. In Rel-18, we propose to consider the potential "full duplex" operation at NW side only, and the "sub-band" full duplex is prioritized.

"full duplex" operation at the UE side is not considered in Rel-18 study. Furthermore, we propose that Rel-18 study does not impact UE RF implementation.

2 – OPPO

Due to limitations coming from regional regulation and hardware implementation, we would view the duplex evolution as a long-term and step-by-step (as phrased by vivo) roadmap, with sufficient study being

put ahead of each step to determine the feasible progress that meanwhile offers satisfactory technical advantages. With this in mind, we prefer to have a Rel-18 study item first (if RAN eventually agrees to do something in Rel-18 for full-duplex), focusing on gNB-side sub-band based full-duplex, and leaving UE-side full-duplex to future RAN discussion. As for the gNB-side shared-spectrum full-duplex, whether or not it is included in Rel-18 should be depending on TU budget (especially in RAN4).

3 – OPPO

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4 – Futurewei Technologies

Futurewei supports the study of full-duplex in Rel 18 only for gNB sub-band scenarios. Other FD features (such UE full duplex, and gNB full duplex) may be considered in later releases. In Rel 18 the study should be led by RAN4 or joint RAN4/RAN1 and it should consider the reuse UE RF existing design and requirements. The coexistence investigation should have higher priority.

5 – Beijing Xiaomi Electronics

Considering xDD is more advanced duplex method targeting on Rel-18 UE, it should be fully backward compatible. The impacts on the legacy UEs should be carefully estimated and restricted. The co-existence issue between xDD-UE and legacy UE needs exhaustive investigation, including interference management, scheduling flexibility and performance. Furthermore, xDD should be focused on gNB side, additional RF requirements/changes should be avoided at UE side.

6 – Motorola Mobility UK Ltd.

In general, we think Rel-18 duplexing enhancement work should focus on unpaired spectrum and full duplex operation at gNB. Rel-18 UE may be configured as “full-duplex-cell aware mode” to accommodate full duplex cell operation, but full duplex operation at UE should not be assumed for Rel-18. To minimize impact on legacy UEs, critical signals/channels may need to be protected from potential interference caused by gNB’s full duplex operation.

7 – Apple France

In our view, if full-duplex operation is included in Rel-18, it should start with a study item with a focus on non-overlapping, i.e. sub-bund, full-duplex operation at gNB only. The study shall assume half-duplex operation at UE side, with no additional impact on UE RF design/requirements.

8 – InterDigital

Focusing on full-duplex capable gNB and half-duplex capable UEs in Rel-18 is desired with its practical importance. Prioritize a subband-wise full-duplex at gNB which validates implementation-based solutions to efficiently cope with self-interference issues at gNB. CLI related issues can be RAN1’s highest priority, and SI related issues can be within RAN4 scope.

9 – China Mobile Com. Corporation

Both SI and WI are suggested to be covered in R18.

In the leading SI, a relative thorough study for some cases is suggested to identify the enabling technique potentiality and potential specification impact, where the cases may include:

1) Only focus on TDD band.

2) Only full duplex at gNB side is considered, and UE works in half duplex.

3)Both sub-band full duplex (SBFD) and same-frequency full duplex (SFFD) at gNB side are considered.

- For SBFD, both same and different UL/DL time-frequency resource partitioning pattern among neighboring cells are considered.
- For SFFD, focus on isolated scenario.

In the following WI, narrow down the scope to specify some easy to commercial cases as identified in the SI phase, e.g., sub-band full duplex (SBFD) at gNB side only, may be studied with higher priority in WI phase.

10 – SoftBank Corp.

In our understanding, full scope of this SI/WI requires huge amount of RAN4 TUs for e.g. self-interference study. On the other hand, we think most part of this item is for long-term discussion, and we see no strong reason to give high priority from RAN4 point of view. Therefore, it is required to take a phased approach and Rel-18 scope should be concise in order to keep the RAN4 impact minimal.

11 – Intel Corporation (UK) Ltd

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 (as against following RAN1 studies) and budgeted accordingly.

Given the potential large scope and uncertain feasibility and gains from different flavors of full-duplex operation, it would be reasonable to consider initial studies with the following limitations:

- Any full-duplex operation is limited to gNB side only
- None to minimal impact to UE implementation and complexity
- Limited to TDD bands
- Focus on massive MIMO BS
- Full duplex is limited to FDM of DL/UL transmissions within TDD spectrum ("Sub-band-based full-duplex")
- Limited to FR1

As part of the studies, it would be necessary for RAN1 to evaluate the key distinctions and gains compared to what is already possible with current NR specifications with respect to dynamic TDD. Fundamentally, NR already supports UE-specific indication (semi-static as well as dynamic) of slot formats, and the key challenge for implementation of dynamic/flexible TDD relates to intra- and inter-cell interference across link directions. This aspect needs to be addressed as a first step as part of studies on potential enhancements to interference management, and then, the potential gains from further enhanced duplexing over what can be achieved with current RAN1/RAN2 specs need to be established.

12 – NTT DOCOMO INC.

We support the evolution of duplex operation, since full duplex (FD) realizes efficient and flexible UL and DL resource configuration with providing benefits. Final goal for full duplex (FD) is FD operation at gNB and UE with spectrum sharing, and phased approach is possible way with considering the technical and implementation challenges.

13 – SHARP Corporation

UL coverage is one of key factors for commercializing networks. Therefore, for meeting such demand, static DL-centric TDD configuration is not suitable since maximum transmittable power is limited by UL/DL ratio. Further, benefit of uplink coverage enhancement scheme (e.g., joint channel estimation) would also be limited. On the other hand, solution based on dynamic TDD may not be suitable considering aspects for both DL and UL. The issue is that, with an assumption of endless downlink traffic in a serving cell, dynamic change of DL-to-UL in a certain time will reduce downlink transmission opportunity, which will reduce latency for the downlink traffic. Therefore, static DL-centric TDD configuration should be maintained while uplink allocation of narrowband relative to whole carrier should be possible.

In that sense, we support to focus on gNB side full duplex in Rel-18.

14 – KDDI Corporation

In our view, the combination of sub-band based full duplex operation for gNB side and half duplex operation (i.e., same as the legacy operation) for UE side is the most reasonable operation in Rel-18 study and work considering the previous discussion in Rel-18 workshop. Other combinations of evolutional duplex operation, e.g., spectrum sharing full-duplex operation for gNB side and sub-band based full-duplex operation for UE side, may be considered in later releases. We have same understanding as vivo, OPPO and other companies that evolution of duplex operation is long-term item so that phased approach should be considered in Rel-18 and later releases.

15 – TELECOM ITALIA S.p.A.

3GPP must distinguish between two main issues:

Short term: how to allow operations with flexible TDD frame format. Currently the regulators impose a fixed DL centric frame format which is strongly impacting UL performance and suitable solutions should be provided as soon as possible. A Work Item should be approved to enable flexible TDD frame formats.

Long Term: full duplex (or its variants) are not a solutions for the short term problems that impairs 5G operations. Moreover backward compatibility should be ensured. This is more a topic for 6G

We have a strong concern with 3GPP focusing on ”6G” rather than solving critical operation issues. We would appreciate to see practical proposals to address the ”short term” issue.

From our side a proposal is to specify SON procedures to verify the load in a given frequency band (considering all the operators using that band), allow the exchange of information of traffic load and expected traffic load among operators and allow temporary frame reconfiguration if resources are available

16 – LG Uplus

Our main target is to improve UL coverage in throughput perspective. It should be achieved within Rel-18 timeline such as to be meaningful.

We prefer non-overlapped sub-band full-duplex primarily and overlapped sub-band one as secondary. DL throughput improvement full-duplex could be studied in later release by a long-term manner since interference cancellation on device is too challenging.

17 – Spreadtrum Communications

We support to study the evolution of duplex operation in Rel-18. It should be assumed that UEs do not support full duplex and no more stringent RF requirements are expected for UE. Between sub-band full duplex (SBFD) and spectrum sharing full duplex (SSFD), we prefer to start with SBFD which is less challenging for gNB.

18 – Fraunhofer HHI

Both SI and WI are supported for R18

During the SI-phase use cases and related full-duplex technology components are to be investigated wrt. standardization impact

A WI to be started delayed during R18 should focus on a subset of use cases and technology components of high commercial interest to be standardized within R18.

19 – Nokia Corporation

Proposals in the workshop varied from enhancing flexible UL/DL allocations for TDD operation to flexible and full duplex operation on TDD.

Enhancements for flexible UL/DL allocations for TDD could provide benefits in practical deployments in the short term, whereas flexible and full duplex proposals for TDD would require more studies on how to obtain gains with practical implementations and impact analyses for legacy devices as well as devices not supporting flexible or full duplex TDD operations.

For enabling earlier deployment opportunities, we see it beneficial to start by studying more practical enhancements for flexible TDD UL/DL allocations like gNB-2-gNB Cross Link Co-channel Interference mitigation solutions first, before starting more complex studies like self interference studies etc. A number of companies in the workshop also felt that gNB-2-gNB Cross-Link Co-channel Interference mitigation solutions are anyway needed for all the proposed enhancement schemes both for short term and long term proposals.

20 – LG Electronics Inc.

For 5G, many of the new service types are characterized by dynamic variation of traffic in both DL and UL directions, requiring low latency in the packet delivery. Therefore, full duplex operation within a single carrier should be studied in terms of achieving enhancements in the low-latency and efficient resource utilization in NR.

We may consider full duplex operation for gNB and UE.

- gNB Full Duplex & UE Half Duplex
- gNB Full Duplex & UE Full Duplex

Considering on supporting legacy UE and minimizing scopes of item, gNB FD & UE HD should be focused as a first step of introducing FD operation within a single carrier.

Two types of full duplex operation depending on spectrum utilization method can be categorized.

- Subband Full Duplex (SB-FD)
- Spectrum-sharing Full Duplex (SS-FD)

These two operation methods show different tendency depending on traffic size, deployment scenario. In this sense, both SB-FD and SS-FD should be studied in Rel-18.

(Ex1) A benefit of reduction of uplink latency for packet delivery can be achieved by both methods because more UL occasions are provide by introducing Full Duplex operation. But, if traffic load of UL is increased, the benefit of SB-FD would be diminished. On the other hand, SS-FD could have a potential benefit to reduce UL latency and enhance UL throughput even if traffic load of UL is increased. In addition, SS-FD can provide a benefit to reduce DL latency and increase DL throughput.

(Ex2) If gNB operates higher transmission power (e.g., Urban Macro), SB-FD could be available rather than SS-FD. On other hand, in some deployment scenario of gNB with lower transmission power (e.g., Dense Urban), adaptation between SB-FD and SS-FD could be necessary. In indoor scenario, SS-FD could be more feasible approach rather than SB-FD.

21 – NEC Corporation

We support to study feasibility of duplex deployment for sub-band/BWP based full duplex operation at gNB/NW side, and do not consider any type of full duplex at the UE side in Rel-18 for RF and interference mitigation challenge.

22 – Samsung Electronics Co.

In the last Rel-18 WS, the key motivation of duplex Enhancement is to solve the various problems of TDD unpaired spectrum. As mentioned by many operators and vendors, the limitations of UL part need to be solved in 5G NR. From the preferences of multiple companies, there are some ways to use a new duplex scheme either at the gNB or at the UE, or both. At gNB-side, “XDD” using subband non-overlapping, and full duplex family using subband overlapping and fullband overlapping are presented. At UE-side, it can be categorized as using half duplex and full duplex. Considering the feasibility in terms of implementation and standardization efforts in Rel-18 time frame, we believe that XDD for the gNBs and half duplex at the UEs is feasible, and full duplex at the UE might be ok for isolated cells. We believe that XDD applied to the TDD band is the first step of this duplex evolution. With this XDD, latency, coverage, and capacity gain can be simultaneously or selectively obtained from UL perspective. Based on this, duplex enhancement for Rel-18 is needed to discuss the following with RAN1 leading:

- Identify applicable and relevant deployment scenarios and use cases (RAN1)
- Summarize regulatory status when deploying enhanced duplex mode in TDD bands (RAN1/4)
- Evaluate performance for duplex enhancement (RAN1)
- Study RF coexistence, impacts & constraints, feasibility of self-interference scenarios (RAN4)
- Study potential solutions to enable enhanced duplex mode and identify performance gains (RAN1)

We do not see any interaction other TSGs for this work.

23 – CATT

We are supportive of full duplex study in Rel-18. We can focus on full duplex at gNB side in Rel-18, and potential full duplex operation at UE could be considered in future releases. Both sub-band based full duplex and fully overlapped full duplex can be studied in Rel-18. But the fully overlapped full duplex shall be limited to isolated scenarios to alleviate the impact of inter-cell cross link interference.

24 – Orange

Further work is welcome to enhance the management of flexible UL/DL configurations, especially between outdoor macro cells and indoor small cells, which is a more realistic deployement case than between macro cells.

25 – Ericsson France S.A.S

It is important to consider the following for any 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.

26 – ZTE Corporation

1) Overall, we are open to have a study item for evolution of duplex operation in Rel-18. Considering that companies need to simulate and figure out the scenarios, use cases and potential gain and also study the feasibility with RAN4 involvement, we think it is too premature to have a work item in Rel-18 for duplex operation.

2) Early RAN4 involvement is preferred. Evolution of duplex operation, especially for full duplex, needs lots of RAN4 expertise. Tight coordination between RAN4 and RAN1 is necessary for the feasibility study for this study item. It is important for RAN to specify something that is implementable.

3) RAN3 involvement is also necessary considering that network coordination is one of the most attractive solutions for interference mitigation/cancellation.

27 – China Telecommunications

It seems most companies have interest in evolution of full duplex. Considering the complexity, power consumption, and cost to implement full duplex, the application of full duplex can be step by step. We share the same view with most companies that the first phase to support full duplex could be full duplex at gNB, and the UE remains half duplex.

Regarding the scope of the study, we think the Rel-18 SI can have a comprehensive study. Both frequency overlapped and non-overlapped full duplex mode can be studied to determine the feasibility and suggest applicable scenarios.

28 – Qualcomm Korea

Introductiong full duplex operation into NR TDD bands will help reducing latency, improving UL coverage, improving system throughput while enabling fleixble UL/DL resouce allocation and adapation based on UL/DL traffic. The UL/DL resources could be split on a sub-band based (Subband Full duplex 'SBFD'), or alternatively they can share the same frequency resources (Single Frequency Full Duplex 'SFFD') to enable simulatoneous transmission and reception within the CC bandwidth. Each of the SBFD and SFFD have their own advantages. SBFD is a simpler techncology to enable full duplex operation and more suitable for FR1 macro cells with large transmit power. SFFD can provide additioal benefits in terms of resource allocation flexibility, latency, and system capacity, but may be challenging to implement for large cell

scenarios for FR1 with high Tx power. In FR2 and higher frequency, the full duplex (FD) operation can be facilitated by the corresponding higher beamforming gain to fruther mitigate various types of interference. In addition to gNB side FD, UE side FD becomes more feasible in FR2 at least for certian types of UE, e.g. CPE with multiple well separated panels and large number of antennas per panel. Therefore, the consideration of FD in FR2 and higher frequency would be benefitial.

We support RAN1-led Rel-18 Study item for both SBFD (focusing on FR1) and SFFD (focusing on FR2 and FR2x) where RAN1 study general objectives while RAN4 confirm the feasability.

29 – CEWiT

In our view, both sub-band and spectrum shared full duplex should be studied in Rel. 18. The focus can be on full duplex at the gNB side. The study should thoroughly cover all aspects including the pros and cons of each type in various deployment scenarios w.r.t latency, spectral efficiency improvement, UL coverage etc. , interference management (both SI and CLI) and impact in TDD and FDD system. Like most other companies suggest, a phased approach can be taken where the focus should be more on the detailed study in the SI phase and then the WI phase can be started which can be further continued in the next release.

30 – HUAWEI TECHNOLOGIES Co. Ltd.

The duplex evolution should reflect the commercial interest. Currently the commercial interests for duplex enhancements are mainly to provide UL capacity boost and low latency services in factories. UL high capacity are demanded by HD video uploading, while low latency services are needed by factory automation, AR/VR etc. Large bandwidth and UL-dominant TDD configuration are needed.

1.1.2 Deployment scenarios, including duplex mode (TDD only?)

Feedback Form 2:

1 – vivo Communication Technology

The scenarios with low gNB Tx power could be prioritized, e.g. indoor scenario or dense urban.

we think TDD bands could be prioritized.

2 – VODAFONE Group Plc

As uplink coverage is a key concern for us, normal gNB tx powers are expected along with wide area coverage scenarios.

TDD bands can be the focus here (with FDD concepts being under the flexible Spectrum integration heading in NWM thread #14)

3 – OPPO

As a tradition, the deployment scenario could be determined in RAN WG during the SI. On the other hand, it would be good for RANP to give the guidance to prioritize/focus on unpaired spectrum. The full-duplex in paired spectrum may have potential issues with regulation and UE RF hardware implementation.

4 – Futurewei Technologies

The FD study should consider for now only TDD deployments for small cells and IAB backhaul links.

The study should:

- Define the baseline system
- Define the performance metrics (power saving, spectrum usage, latency, capacity, etc.)

5 – Beijing Xiaomi Electronics

TDD is the typical case for xDD and deserves a higher priority. From RAN1 point of view, xDD is frequency range transparent. However, it may introduce additional workload for RAN4 if both FR1 and FR2 are considered. In order to control the workload, we can firstly focus on FR1.

6 – Motorola Mobility UK Ltd.

Sub-band based full duplex operation (i.e. gNB uses one sub-band for UL reception and another sub-band for DL transmission simultaneously) in unpaired spectrum may be a good candidate scenario for Rel-18. Both macro and micro cell deployments and both FR1 and FR2 deployments can be considered. Beamforming and spatial separation thorough multiple antenna panels and/or multiple TRPs should be taken into account.

7 – Apple France

If full-duplex operation at gNB is included in R18, the study should focus on TDD band, as UL latency reduction is among the envisioned advantages of full-duplex operation by the proponents.

8 – InterDigital

TDD bands are to be the focus of the study, where subband-wise full duplex (in terms of gNB) inside a TDD band needs to be mainly considered in Rel-18. Full-band full duplex at gNB should be a lower priority or to be excluded in Rel-18 work scope. Focus on only half duplex UEs in the network, or study full duplex UEs in a limited scenario (e.g., IAB) with lower priority in Rel-18.

9 – China Mobile Com. Corporation

In CMCC's view, the objective at least includes the following:

1) Identify the scenarios for different variants of full duplex operation in TDD bands [RAN1]

- Deployment scenarios (e.g., Isolated, Indoor, Urban, Rural)
- Frequency range and regulation (e.g., FR1, FR2)
- Duplex mode at gNB (e.g., sub-band full duplex, same-frequency full duplex) assuming UE does not support simultaneous transmission and reception
- Antenna configuration (e.g., Single-/multi-panel, Co-located/distributed antennas, antenna scale)

10 – Intel Corporation (UK) Ltd

As mentioned in the first section, any consideration of duplex enhancements should be limited to TDD systems. This is in consideration of (1) regulatory constraints; (2) impact to UE implementation; (3) impact to legacy UEs; (4) need to support "TDD in FDD" from perspective of technical requirements and justification.

Deployment scenarios should be clearly identified with sufficient justification, e.g., based on prior conclusions from Rel-16 studies on feasibility of adjacent channel interference handling for cross-link interference. They should also be clearly identified and justified in terms of assumptions on different levels of network coordination which is an essential component to duplex enhancements in multi-cellular systems.

Between FR1 and FR2, FR2 should be deprioritized. The main benefit for duplex enhancements at this stage (e.g., based on "sub-band based full-duplex") is in terms of latency, which is not a critical factor at present for FR2.

11 – NTT DOCOMO INC.

As the first step for Rel-18, following can be considered.

-Study for spectrum sharing and sub-band based FD at least for gNB

Potential study points can be also considered as follows.

-Applicable frequency band/range

-Applicable duplex mode (TDD/FDD)

-Deployment scenario, e.g. Rural, Urban, Indoor, Multiple links (access and backhaul links) for IAB-node

-Antenna configuration, e.g. single/multiple antenna ports/panels

-MIMO operation for FD

12 – SHARP Corporation

TDD band could be the prioritized target since uplink coverage could be one of the targets.

13 – KDDI Corporation

TDD bands should be focused on this study. For TDD bands, the motivation of this evolution is mainly for UL enhancements such as UL coverage and latency reduction. On the issue in the real deployment in wide areas, the imbalance between DL and UL coverage can occur. Therefore, we should have macro scenario in addition to micro and indoor scenarios.

14 – LG Uplus

Prioritized deployment scenario is followings;

- FR1 TDD band
- Outdoor scenario and O2I scenario
- UL improvement through prolong UL slot duration (non-overlapped sub-band full-duplex)
- Dense urban, Urban

Additional deployment scenario is followings;

- FR2 TDD band

15 – Spreadtrum Communications

In our opinion, the motivations to study full duplex mainly lie on UL data rate/coverage/latency improvement. It is more demanding for TDD and considering the regulatory constraints, we suggest to discuss full duplex in TDD band at first. During SI, the scenarios including small cells and wide area can both be studied.

16 – Fraunhofer HHI

Full-Duplex in TDD bands should be studied at high priority and extension in paired spectrum with medium priority.

Primary focus in TDD scenarios should be on:

- latency reduction,
- co-located operation of cells in different TDD modes,
- hetnet deployments with different TDD modes and Full-Duplex modes (including indoor vs. outdoor cells with coverage overlap),
- inter-operator coexistence for adjacent band operation with different TDD and Full-Duplex modes

Study of Full-Duplex in paired spectrum should be on:

- paired satellite spectrum: uplink traffic in sat DL bands
- Flexible operation of adjacent FDD and TDD bands in Full-Duplex mode

17 – Nokia Corporation

In our view truly enabling flexible UL/DL allocations and UL heavy configurations for TDD should be prioritized in the studies first as practical solutions are needed in short term.

18 – LG Electronics Inc.

gNB with lower power (i.e., Indoor, hotspot, Dense Urban) should be prioritized for study in Rel-18.

Also, we are open to study **both TDD and FDD.**

19 – NEC Corporation

The deployment scenarios, e.g. Urban, Indoor in FR1 TDD band can be considered in Rel-18.

20 – Samsung Electronics Co.

Among FR1, which is currently the NR most popular band, is the largest portion of TDD improvement in the market. Therefore, the important deployment scenario of duplex enhancement is macro / micro cell in TDD spectrum. For FR2, it can be applied to small cells like micro cells. Since FR2 has multiple component carriers, together with intra-cc subband, inter-cc XDD operation (different TDD UL/DL configurations per each CC) can be one possible scenario in FR2 and this can be handled in RAN4 work. For FDD, since either DL or UL bandwidth is relatively small, it is difficult to solve the cross-link interference of an adjacent operator. Thus, it is desirable to focus on the TDD only.

21 – CATT

Inter-cell cross-link interference management is very challenging for deployment of full duplex. We suggest start from scenarios where inter-cell CLI has less impact, e.g., isolated scenarios.

22 – Orange

Focus should be made on TDD between outdoor macro cells and indoor small cells.

23 – Ericsson France S.A.S

The focus should be on scenarios that are more realistic from an implementation perspective in BS and possibly device. Therefore, it is better to limit the study to full duplex in separated frequency resources (sub-band full duplex) rather than the more complex problem of full duplex in fully shared resources. Also, realistic antenna configurations providing higher isolation should be assumed as part of the studied scenarios. Any impact of the needed antenna configuration on the output power and gains needs to be understood and taken into account. Furthermore, 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 and/or smaller cells where gNB and UE Tx powers are more similar are of greater interest.

24 – ZTE Corporation

From our perspective, the deployment scenarios can be UMA, indoor and dense urban. We are also open to consider other deployment scenarios if they are well justified.

For the TDD/FDD issue, we are open to that.

25 – China Telecommunications

At the first study phase in Rel-18, the study of the feasibility and potential scenarios for full duplex operation at gNB side could consider: deployment scenario (e.g. rural, urban, indoor, isolated, etc.), frequency range (FR1,FR2, unpaired/paired spectrum), duplex mode(frequency overlapped, non-overlapped), antenna configuration. And later WI can focus on the identified prior scenarios.

26 – Qualcomm Korea

Deploymment Scenaro:

- The Rel-18 study of Full duplex should consider multple evolution scenarios. Starting from full duplex operation at gNB only with HD UEs (including HD UEs aware of gNB full duplex operation) and progress to study full duplex operation at both nodes gNB and UE.
- The study shoud only focus on full duplex deployment in TDD band for both FR1, FR2 and FR2x.
- For FR1, the study should focus on subband full duplex macro cell with large Tx power to get the coverage and latency benefits.

For FR2 and FR2x, the study should consider both SBFD and SFFD (i.e., FDM and SDM of UL/DL resources) following the same discussion as IAB in Rel-17.

27 – CEWiT

In SI phase, macro/micro scenarios and IAB backhaul can be studied. Both TDD and FDD can be studied.

28 – AT&T

At least both FR1 and FR2 TDD bands should be considered

29 – HUAWEI TECHNOLOGIES Co. Ltd.

For the use cases of commercial interests, large bandwidth is preferred, and therefore we suggest to focus on **TDD band**.

We are interested in two scenarios below:

Scenario 1: Macro cell BS and small cell BS with different TDD DL/UL configurations operating in the same carrier frequency, and small cells have more UL slots

There is strong needs for uplink capacity enhancement as To B services are dramatically increasing. UL capacity enhancement can be achieved via UL-dominant TDD configurations. However there are Macro base station deployment with DL-dominant TDD configurations. If small cells with UL dominant TDD configuration are deployed in the factory, the TDD configuration used by small cells will be different from that of the Macro base stations. Heavy BS-BS co-channel cross link interference will occur.

Scenario 2: subband full duplex for small cell TDD deployment (UE only transmits or receives in one OFDM symbol in a band; gNB DL and UL in same symbol but not in same resource element)

Sub-band full duplex could be one of the potential solution to provide high uplink capacity and DL/UL low latency in factory. However there are Macro base stations outside the factory creating co-channel cross link interference on the UL subband in the small cells in the factory. Such BS-BS cross-link interference should be mitigated in order to have satisfactory performance.

For the subband full duplex operating in a Macro network, there might be improvement in uplink coverage when self-interference and cross-link interference are properly handled. For the subband full duplex operating on a Macro network in FR1, the DL to UL (BS-BS) cross link interference from adjacent RBs is serious. Furthermore the DL signal from other base station may result in blocking of the victim receiver of the BS performing UL receiving on the UL subband using a band-level filter before the LNA. We thus view the application of subband full duplex on Macro network challenging.

1.1.3 Interference management

Feedback Form 3:

1 – vivo Communication Technology

both self-interference and cross-link intereference are to be studied.

For self-interference, consider both analog and ditital self-interference cacellation. and following aspects should be considered

1) Impact due to gNB discontinuous transmission

The dynamic variation of gNB transmission in time/frequency/power domain will cause trouble for the phase and amplitude tracing in RF cancellation

2) Near field reflections

Besides on board and direct interference, near field reflections also very strong part signal need to be canceled.

3) Non-linear self-interference

Harmonics and inter intermodulation interferences sometimes can not be ignored and difficult to dealt with.

For cross-link interference, consider

1) intra-operator and inter-operator interference

2) intra-frequency and adjacent channel interference

2 – OPPO

For gNB-side full-duplex accompanied with UE-side half-duplex, the Rel-18 study can cover both self-interference and cross-link interference, where

– self-interference is mainly in RAN4 study scope;

– the study for cross-link interference is led by RAN1, including both gNB-to-gNB and UE-to-UE interference types. For UE-to-UE interference, the study should focus on whether the legacy solution is sufficient, rather than immediately open new solutions.

3 – Futurewei Technologies

The FD study of interference should consider both :

- Inter gNB cross-link interference
- Inter UE cross-link interference (both Intra gNB and Inter gNB)

The impact of the interference on performance metrics should be investigated for the baseline system. In additions, various initial solutions may be considered to show FD feasibility and to evaluate the performance bounds (for instance, and not only):

- Guard bands
- Flexible symbols
- MIMO (Beam management, Reference signal, CSI measurement/report, Multi-TRP/Cell)

4 – Beijing Xiaomi Electronics

Interference management is a fundamental issue for xDD. Before jumping into the detail design on interference management, the following cases should be carefully investigated:

A. Intra-gNB self interference

B. Inter-gNB cross-link interference

C. Inter-UE cross-link interference

D. Inter-operator adjacent carrier interference

In order to reduce workload, maybe we can firstly try to achieve a consensus on which kind of interference can be handled by implementation. After that, we should identify how serious the interference is via simulation for the leftovers. Regarding the solution for interference management, we are open to discuss the potential mechanisms to cancel/alleviate/control the interference, e.g. dynamic mechanism, semi-static mechanism.

5 – Motorola Mobility UK Ltd.

During a Rel-18 SI phase, RAN1 and RAN4 WGs can define BS categories based on self-interference suppression levels for evaluation purposes and can use those defined interference suppression levels for feasibility study of full duplex cell operations.

RAN WGs may have to study whether implementation (e.g. scheduler) based interference handling and/or existing mechanisms for interference handling (e.g. RIM) are sufficient or whether any enhancement is needed to handle intra-cell and inter-cell UE-to-UE interferences and gNB-to-gNB interferences.

6 – Apple France

If full-duplex operation at gNB is included in R18, the study for cross-link UE-to-UE interference management should first strive to keep existing solutions at UE side. Only if it is revealed that additional solutions are necessary, such solutions can be based on techniques specified in eIAB R17 for interference management. For self-interference management at gNB, we share similar view with OPPO, that the scope is mainly RAN4 led.

7 – InterDigital

In RAN1 side, high-priority is to be given on study for cross-link interference, as major impacts to UE will be a UE-to-UE CLI. Since a half-duplex UE is a primary focus on Rel-18, issues on self-interference are to be handled only at the gNB, for which RAN4 is to lead the relevant discussions including implementation-based solutions. Note the implementation-based solutions to mitigate self-interference at gNB may have subsequent impacts to RAN1, if any, which may be a part of RAN1 work scope with clearly identified issues. Inter-operator interference can also be a part of RAN1 discussion, along with CLI related issues, considering both implementation-based approaches and potential standard supports.

8 – China Mobile Com. Corporation

In CMCC's view, the objective at least includes the following:

1) Study on the feasibility of interference cancellation to enable full duplex [RAN4, RAN1]

- Techniques of self-interference/cross-link interference cancellation and corresponding capabilities [RAN4, RAN1]
- Requirement of self-interference cancellation capabilities for different deployment scenarios [RAN1, RAN4]

2) Study on coexistence among different operators in adjacent channels [RAN4]

3) Study on coexistence with legacy UE [RAN1, RAN4]

4) Evaluate the performance of full duplex [RAN1]

- Evaluation methodology and performance metrics (e.g., spectrum efficiency, user perceived throughput, latency, etc.)

Furthermore, we provide some detailed analysis as following:

Regarding SI cancellation for SBFD (sub-band full duplex), the following FD transceiver architectures are considered:

- Alt 1: Add [frequency tunable] Sub-band analog filter before LNA to avoid blocking issue, and involve digital cancellation circuit to mitigate residual SI interference.
- Alt 2: At least involve RF cancellation circuit to avoid blocking issue and mitigate SI interference.

Alt 1 may be cheaper than Alt 2 for utilizing less RF hardware, but frequency tunable Sub-band analog filter is not mature enough.

Alt 2 is a universal solution for both SBFD and SFFD.

Regarding SI cancellation for SFFD (same-frequency full duplex), the academic Propagation domain/ Analog domain/ Digital domain SI cancellation techniques should be considered.

Regarding CLI cancellation for SBFD, Sub-band analog filter, and legacy time/frequency/power domain CLI cancellation techniques as studied in Rel-16 can be further studied.

Regarding CLI cancellation for SFFD, legacy time/frequency/power domain CLI cancellation techniques as studied in Rel-16 can be further studied.

9 – Intel Corporation (UK) Ltd

For RAN4, interference studies should consider at least:

- Adjacent channel interference at gNB and UE
- Self-interference at gNB

For RAN1, interference studies should consider both intra- and inter-cell cross-link interference (both at UE and gNB) and identify necessary enhancements to the Rel-16 CLI framework, including necessary enhancements to facilitate better network coordination.

The interference studies should be conducted starting from consideration of dynamic/flexible TDD operations, and in this regard, handling of adjacent channel cross-link interference and co-channel intra-/inter-cell cross-link interference should be sufficiently prioritized over self-interference management at gNB.

Finally, all of the above should be studied in the context of intra- and inter-operator scenarios, and under different assumptions on backhaul/fronthaul latency/capacities and resulting level of NW coordination.

10 – NTT DOCOMO INC.

We support to have this objective for Rel-18, because on top of cross link interference (CLI) in Dynamic TDD, self interference should be managed for FD operation.

11 – SHARP Corporation

In Rel-18, for gNB side full duplex, the following can be listed for study;

1) intra-gNB adjacent-frequency interference

2) inter-gNB intra-frequency interference

3) intra-UE adjacent-frequency interference

4) inter-UE intra-frequency interference

12 – KDDI Corporation

If we consider that sub-band full duplex operation on gNB side and half duplex operation on UE side are prioritized in Rel-18, following interference scenarios as commented by Xiaomi should be considered in the study phase:

- Intra-gNB self interference
- Inter-gNB cross-link interference
- Inter-UE cross-link interference
- Inter-operator adjacent carrier interference

13 – Spreadtrum Communications

The feasibility of interference cancellation to enable full duplex should be studied, including the techniques of self-interference and BS-to-BS CLI cancellation. Regarding UE-to-UE CLI management, whether the legacy solution is sufficient should be investigated at first.

14 – LG Uplus

In Rel-18,

- inter-gNB cross-link interference (Victim: gNB UL receiver, Aggressor: gNB DL transmitter) should be studied. e.g. measurement, RF requirement, etc. [RAN1, RAN4].
- inter-UE cross-link interference (Victim: UE DL receiver, Aggressor: UE UL transmitter) should be studied. e.g. measurement, detection, RF requirement, etc. [RAN1, RAN2, RAN4]
- Self interference in gNB should be studied. e.g. RF requirement, etc. [RAN4]

15 – Nokia Corporation

In our view the first studies should focus on gNB-2-gNB Cross-Link Co-channel Interference mitigation solutions and ensuring adjacent channel deployments from the co-existence perspective in line with Rel-16 TDD adjacent channel coexistence conclusions from RAN4.

In our view more demanding and challenging deployment scenarios requiring self-interference mitigation and other complex studies and solutions should only be considered once the basic gNB-2-gNB Cross-Link Co-channel Interference mitigation solution(s) are specified.

16 – LG Electronics Inc.

For enabling full duplex operation within a single carrier, self-interference and cross-link interference should be considered.

- **Impact of self-interference should be investigated.**
  Also, mitigation/cancellation methods for self-interference can be studied. For example, antenna separation, Beam-coordination, Analog domain self-interference cancellation, Digital domain linear self-interference cancellation, Non-linear Interference mitigation method can be studied. In addition, guard bands can be considered.

- **Impact of BS2BS interference should be evaluated, and impact of intra-cell UE2UE CLI and inter-cell UE2UE CLI should be evaluated. In addition, CLI management schemes should be studied.**

17 – NEC Corporation

We think the below interference issues and applicable interference mitigation schemes could be studied for duplex operation.

- Adjacent channel interference.
- Cross-link interference between inter/intra operator.
- Intra-/inter- gNB interference.

18 – Samsung Electronics Co.

f a duplex scheme as XDD is applied, the following four interference problems may occur: Intra-gNB Self Interference, Inter-gNB Cross-Link Interference, Inter-UE cross-Link Interference, and Inter-operator adjacent carrier Interference. In case of Intra-gNB self-interference, this can be handled by implementation. For both Inter-gNB cross-link interference and Inter-UE cross-link interference, situation is same as in dynamic TDD but can be enhanced in terms of RIM and CLI, if needed. For inter-operator adjacent carrier interference, we think it is hard to have coordination between operators and should be solved with UL subband alignment between cells and then, DL subband will act as duplex gap between operators. For both RAN1/4, such evaluation and study are needed in duplex enhancement SI.

19 – CATT

Feasibility of self-interference mitigation shall be studied mainly in RAN4. RAN1 should focus on cross link interference management. Existing CLI management scheme could be used as baseline for the study.

20 – Ericsson France S.A.S

Cross-link interference both at the gNB and the UE should be considered (but repeating work done in previous study and work items should be avoided) as a first priority, considering both intra-operator and inter-operator interference. This first stage of the study should clarify and inform which kind of deployment scenarios are possible for Full Duplex considering (i) co-existence among operators and (ii) impacts of intra-operator CLI to overall gains.

For self-interference, the study should address at least the following factors, with this mostly being handled by RAN4

- LNA linearity and dynamic range
- Non-linearity in Tx and Rx radio front-ends
- Coupling between different transceivers in an AAS array
- Reflections due to objects close to the antenna
- Intermodulation products from the Tx degrading noise floor/sensitivity of the Rx for operation in separated frequency resources (Improvements in TX linearization)
- Filtering limitations and flexibility based on the number of guard carriers between DL and UL for operation in separated frequency resources

21 – ZTE Corporation

From our perspective, the existing CLI and RIM management should be reused as much as possible instead of defining totally new interference management mechanism.

From our perspective, the following information can be taken into normative work for cross link interference coordination in Rel-18. The information includes:

- 1: SRS resource exchange (Measurement resource exchange)
- 2: Measurement report information
- 3: Protected zone information
- 4: Intended beam scheduling information
- 5: Scheduling information
- 6: Transmit power information
- 7: CLI sensitivity vector (e.g., indication of the sensitivity level of the interfered slots)

Enhancements for network coordination is also crucial. We are open to consider enhancements for network coordination as long as they are well justified.

22 – China Telecommunications

Both self-interference and cross-link interference should be considered. CLI includes not only inter cell interference from gNB to gNB/UE to UE, but also exists intra cell from UE to UE. For the dealing with interference, the potential objectives are:

- Evaluation of interference cancellation requirement for self-interference and cross-link interference

- Study the self-interference and cross-link interference handling techniques
- Perform coexistence study to identify conditions of coexistence among different operators in adjacent channels
- Study the backward compatibility to accommodate legacy UEs

The previous study on the CLI handling should be taken as baseline. RAN1 and RAN4 should cooperate tightly during the study.

23 – Qualcomm Korea

In the study phase of full duplex feasbility, RAN1 should study both co-channel and adjacent-channel interference management. There are three main sources of interference in full duplex:

- Self-interference at the full duplex node (gNB, UE or IAB). This is direct near-field leakage from the Tx side to the Rx side.
- Clutter echo from nearby reflector (e.g. metal surface).
- Cross-link interference considering inter-gNB CLI and inter-UE CLI for both intra- and inter-cell scenarios.

In addition, inter-operator adjacent channel interference and coexistence with legacy node should be studied.

As general inter-UE CLI enhancement, the latency/flexibility of inter-UE CLI can be improved via L1 based report, and subband based inter-UE CLI can be exploited to determine the required guardband in SBFD. In addition, FD can be applied to channels related to initial access to improve corresponding latency/overhead. In this scenario, CLI framework should be extended to consider the impact to/from idle UE.

As general inter-gNB CLI enhancement, inter-gNB interference measurement/report framework should be studied for better inter-operability, e.g. inter-DU and inter-CU CLI measurement/report config. In addition, inter-gNB signaling is also benefitical to indicate resources allowed/disallowed for reverse direction traffic from neighbor gNBs.

As FR2 and higher frequency specific CLI enhancement, the CLI framework should be extended to fully expoit the higher beamforming gain. For inter-UE CLI, the existing R16 CLI framework should be extended to FR2 by considering QCL indication for measurement resource, panel specific CLI measurement, CLI measurement via Tx/Rx beam sweep, etc. For inter-gNB CLI, the existing R16 RIM framework can be extended to FR2 by considering inter-gNB beam management, e.g. compatiable beam group identification and signaling.

24 – CEWiT

For interference management:

1. Requirements for SI should be defined
2. gNB-to-gNB CLI should be studied, and it might be necessary to develop a framework to manage it.
3. UE-UE CLI framework improvement to include intra-cell CLI

25 – HUAWEI TECHNOLOGIES Co. Ltd.

- **BS-BS co-channel cross link interference should be included in the scope of the duplex evolution.**

For small cells in the factory, both scenario 1(UL dominant TDD configuration) and Scenario 2 (subband full duplex) will meet serious BS-BS co-channel cross link interference from Macro base stations. There

are some work on the cross link interference in Rel-14 and Rel-16, but BS-BS cross link interference is not standardized except a signaling between the gNB about the intended TDD configuration. The work in Rel-14 and Rel-16 are not sufficient, and some better solutions e.g. more accurate UL RE muting for IRC receiver should be studied and specified in Rel-18 to mitigate the BS-BS cross link interference.

And for the scenarios that subband full duplex operated in a Macro network, there are adjacent RB interference and blocking interference, e.g. adjacent channel cross link interference and co-channel cross link interference. Such BS-BS cross link interference should be addressed if subband full duplex for Macro network is to be discussed in Rel-18.

- **UE–UE cross link interference should be included in the scope of the duplex evolution of R18 if subband full duplex is included.**

In R16, the UE-UE interference management is specified targeting UE-UE cross link interference in two cells due to different TDD configurations. However in subband full duplex, the UE-UE cross link interference may occur between the UEs in the same cell due to one UE is receiving in the DL subband the other UE is transmitting on the UL subband. Such cross link interference will result in the demodulation performance degradation or blocking of the victim UE's receiver. Hence, UE–UE cross link interference should be included in the scope of the duplex evolution of R18 if subband full duplex is included.

26 – AT&T

At least at the gNB, SI and CLI resulting from full duplex operation should be considered. Feasibility of full duplex operation at the UE may be considered with secondary priority

1.1.4 Other proposals

Feedback Form 4:

1 – vivo Communication Technology

UE RF impact (e.g. tighter in-band emission requirment to mitigate UE-UE interference) is not considered in Rel-18.

2 – OPPO

We agree with what vivo mentioned. In fact, we believe that is a part of general backward compatibility principle set upon the potential specification work, applicable to both UE baseband/RF behaviors and requirements.

3 – Motorola Mobility UK Ltd.

We think that a network should be able to flexibly enable/disable full duplex cell operation based on its operating conditions. Also, full duplex cell operation in unlicensed spectrum (e.g. simultaneous UL transmission from a UE and gNB DL data transmission to other UEs within a COT) can be studied to extend enhanced duplexing to unlicensed spectrum.

4 – Apple France

We also agree with vivo and OPPO that no new UE RF requirements is defined for Rel-18, if full-duplex operation at gNB is included in Rel-18.

5 – China Mobile Com. Corporation

In CMCC's view,

- The UE hardware impact should be minimized.
- Potential standardization impact to support full duplex operation may be identified in the SI phase.

6 – Spreadtrum Communications

We also agree with vivo, OPPO and Apple that no new UE RF requirements is defined for Rel-18.

And from the point of self-interference handling, it is the same for unlicensed spectrum and unpaired license spectrum. If TU budget allows, we suggest to study duplex enhancement in unlicensed spectrum as well.

7 – Fraunhofer HHI

Interference Management should focus on cross-link interference between:

- gNBs of same operator (macro-macro, small cell – small cell)
- gNBs of different operators (macro-macro, small cell – small cell)
- gNBs in hetnet deployment (macro-small cell, outdoor gNB vs. indoor gNB)

Interference Management framework should primarily focus on inter-gNB cross-link interference including support of flexible TDD.

In parallel the UE-UE CLI framework should be extended to sub-band full-duplex including inter-operator reporting.

- Inter UE intra-frequency interference (same band)
- Inter UE inter-frequency interference (different bands)

8 – CATT

Performance metric and evaluation methodology shall also be studied to evaluate performance gain of full duplex over a proper baseline system.

9 – Qualcomm Korea

Potential enhancements for full duplex can be considered for IAB as well.

As for gNB side FD, certain scheduling restrictions can be lifted for future release UE, e.g. SSB + UL and RACH + DL on the same symbol. Furthermore, to achieve various benefits from FD while maintaining better relaibility from HD, FD and HD slots/frames can be introduced and interlaced based on semi-static switching pattern. The operation parameters in corresponding slots/frames can be optimized accordingly.

10 – HUAWEI TECHNOLOGIES Co. Ltd.

For FR2, the narrower beam and large pathloss make the flexible duplex in a Macro network possible, i.e. different base Macro base stations may operate with different TDD configurations to accommodate the different DL and UL traffic ratio. Hence both FR1 and FR2 should be included in the scope of the duplex evolution in Rel-18

1.2 Moderator summary and recommendation

Moderator would like to thank all companies (30 companies) for their valuable comments on duplex enhancement.

In general, high level of interest was shown on duplex enhancement to improve coverage and latency of TDD mode. Based on the provided comments, the following summary can be made.

To improve the UL coverage and latency in TDD, 22 companies supported duplex enhancement only for TDD. 4 companies are open to include FDD as well to support DL-heavy traffic using both DL and UL bands in paired spectrum.

To avoid impact on UE implementation complexity for handling self-interference, of the 30 companies, 18 companies supported enhancements on gNB only. Many companies preferred to keep half duplex operation, i.e., the conventional TDD operation, at the UE. A few companies supported considering full duplex for FR2 CPE type UEs that might have capability to handle self-interference between antenna panels.

Subband non-overlapping, subband overlapping, and full overlapping duplex were suggested as possible enhancements on duplex operation. 15 companies supported studying subband non-overlapping duplex operation (dividing DL and UL into non-overlapping subbands) considering gNB implementation feasibility of handling self-interference and inter-operator cross-link interference. 4 companies proposed to consider subband overlapping or full overlapping duplex at least for isolated cells or FR2 cells.

Most companies strongly suggested to have study on self-, inter-gNB, inter-UE, and inter-operator interference in RAN1 and RAN4, since the interference management is the most critical part for deploying enhanced duplex gNB in the network.

Regarding deployment scenarios, different preferences were shown on macro, micro, and small cell layouts. There was also a view to include IAB in the scope for further enhancement on Rel-17 IAB.

Based on the above summary, moderator would like to make the following recommendation.

- Duplex mode: Including TDD in the scope seems to be well justified. Companies are invited to provide views whether FDD also should be considered.
- Duplex enhancement at gNB only?: Study on duplex enhancement at gNB seems to be well justified. Companies are invited to provide views whether half duplex operation should be assumed at UE.
- Duplex enhancement approaches to study: Justification was provided on higher preference to focus on the subband non-overlapping duplex operation. Companies are invited to provide views whether it is necessary to include the subband overlapping or full overlapping duplex operation in the scope of study.
- Interference management: There seems a consensus on the need to study on the handling of self-, inter-gNB, inter-UE, and inter-operator interference in RAN1 and RAN4, Companies are invited to provide views on how to organize the study.
- Deployment scenarios: Companies are invited to provide views whether all or a subset of macro, micro, and small cell layouts should be considered. It is necessary to discuss whether IAB should be included in the scope.

2 Intermediate Round

2.1 Collection of company views

2.1.1 Duplex mode

Including TDD in the scope seems to be well justified. Companies are invited to provide views whether FDD also should be considered.

Feedback Form 5:

1 – OPPO Our answer is no. The concerns come from UE RF implementation and potential regional regulation restriction. In addition, as commented by other companies, full-duplex within paired spectrum does not seem to have a clear cut from flexible spectrum sharing in a separate Rel-18 topic.
2 – Futurewei Technologies We do not think that FDD should be considered in Rel. 18. We have similar concerns as oppo regarding the UE RF implementation and regulation restrictions.
3 – vivo Communication Technology We prefer to consider TDD only in Rel-18
4 – InterDigital Focusing only on TDD is desired, as the flexible allocation between UL and DL in a TDD band has clear benefits. However, practical merits of full-duplex on FDD as paired UL/DL spectrum are not justified, at least considering UE RF implementation complexity.
5 – NTT DOCOMO INC. If the scope covers both XDD and FD, we are fine to include FDD. And if the scope covers XDD only, we think TDD can be prioritized.
6 – China Mobile Com. Corporation We support to focus on TDD band only in Rel-18.
7 – KT Corp. Considering Rel-18 to be commercialized in 2nd half of 2024, some of FDD low band LTE spectrum will likely to begin refarmed for NR usage. This will give significant gains on coverage including O2I however, if only FDD low band refarmed coverage is available user will experience throughput degradation where TDD spectrum is not being covered. Applying FDR to FDD can solve this potential problem with utilizing both 2x20MHz of UL/DL spectrum can perform somewhere close to single 80MHz TDD spectrum. KT believes paired spectrum should also be included in the scope.

8 – Apple France

No. From the spectrum's perspective, usually TDD bands (n77/78/79) have advantage over paired spectrum by wider bandwidth which is desired for sub-and full-duplex operation. In addition, as mentioned by couple of other companies, full-duplex operation in FDD may raise regulatory concerns.

9 – Intel Corporation (UK) Ltd

The studies should be limited to TDD only. As mentioned in the previous round, FDD should not be pursued at this point in consideration of (1) regulatory constraints; (2) impact to UE implementation; (3) impact to legacy UEs; (4) need to support "TDD in FDD" from perspective of technical requirements and justification.

10 – Motorola Mobility UK Ltd.

We prefer to focus on unpaired spectrum in Rel-18. 3GPP can use an outcome from studying feasibility and interference handling in unpaired spectrum as a reference to determine whether duplexing enhancement for paired spectrum is beneficial in Rel-19.

11 – China Telecommunications

For TDD spectrum, it has been able to offer various DL/UL configurations to address DL/UL traffic asymmetry since LTE Rel-8. However, for FDD spectrum, it does not offer any means to effectively allocate the DL/UL resource split to adapt the traffic with asymmetric and ratio changing DL/UL service. The FDD paired spectrum also has useful scenarios in operators' deployment. Thus we expect the duplex operation in FDD to be enhanced. The difference from flexible spectrum integration is allowing transmission direction change.

In terms of the regulatory, the SI "Study on regulatory aspects for flexible duplex for E-UTRAN" outcome indicated that at least in one country and in some bands, utilizing UL spectrum for transmission from the network to UEs is possible. The formulate and revision of the regulation may lag behind technological innovation, 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.

Regarding the inter operator cross link interference, it depends on the deployment scenario. The coexistence among different operators could be one study objective for the potential scenarios suggestion.

12 – NEC Corporation

We do not think that FDD should be considered in Rel-18, and only include TDD is better.

13 – Beijing Xiaomi Electronics

We share the similar views that we should focus on TDD in Rel-18.

14 – SHARP Corporation

TDD should be prioritized. For FDD, enough uplink time resources are already available.

15 – Samsung Electronics Co.

We prefer to study TDD only. No clear benefit for subband operation in FDD and no clear solution for full overlapped.

16 – LG Uplus

We have similar view with Samsung. TDD only is preferred in Rel-18. Non-overlapped spectrum is sufficient to us.

17 – LG Electronics Inc.

For decision whether FDD should be considered, we should take commercial need (especially, efficiency enhancement of UL spectrum utilization, latency reduction for NTN service) into account. We are open to discuss on duplex enhancement for FDD.

18 – KDDI Corporation

We prefer to consider TDD-band only in Rel-18.

19 – Qualcomm Korea

In our views, the scope of full duplex study item should be limited to only TDD band. FDD band is already full duplex mode. In addition, UL latency and coverage gain are not justified for FDD as compared to full duplex operation in TDD band.

20 – Spreadtrum Communications

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

21 – Panasonic Corporation

FDD should not be considered in order to reduce the amount of study/work

22 – ZTE Corporation

Considering that majority view is to include TDD in the scope, we are OK to prioritize TDD in this SI. We are open to include FDD in the scope if operators have interests on it.

23 – HUAWEI TECHNOLOGIES Co. Ltd.

Regarding spectrum, we prefer to focus on the TDD band only, i.e. unpaired spectrum with relatively large bandwidth to provide uplink throughput and low latency.

24 – Nokia Corporation

Focus should be on TDD only.

25 – Ericsson France S.A.S

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.

Since the implementation feasibility and potential complexity vs gains may differ, both FR1 and FR2 should be considered.

2.1.2 Duplex enhancement at gNB only?

Study on duplex enhancement at gNB seems to be well justified. Companies are invited to provide views whether half duplex operation should be assumed at UE.

Feedback Form 6:

1 – T-Mobile USA Inc. We think it is fine to assume half duplex operation at the UE. However, the UE-UE and BS-BS interference issues still need to be addressed even if the full duplex is only at the gNB with half duplex UEs.
2 – OPPO We support the restriction of only half-duplex on UE side, as current spec allows.
3 – AT&T Certainly any full duplex work should be compatible with legacy half-duplex UEs. Feasibility study at the UE side may be considered if there is strong interest, but should not distract or complicate the work on the gNB/network side.
4 – vivo Communication Technology Yes, full duplex is only considered at gNB side and half-duplex assumption shall still hold in Rel-18. Furthermore, we have a strong position that any impact on UE RF impementation and requirement shall be avoided in Rel-18.
5 – InterDigital Half duplex at UE should be the primary focus in Rel-18. We are open to study full duplex UEs in a limited scenario (e.g., IAB, multi-panel UEs), but with lower priority.
6 – NTT DOCOMO INC. We support to consider half duplex operation for UE for Rel-18 with considering the technical and implementation challenges for UE. (e.g. device size, supporting number of antenna beams)
7 – China Mobile Com. Corporation We support to study full duplex at gNB side only in Rel-18. UE can work in half duplex.
8 – Apple France Yes. In our view, the study on full-duplex operation at gNB, if included in R18, should be to the extend possible UE backward compatible. In addition, it is well-known that it is much harder for UEs to implement full-duplex due to its constraints on size, power and processing capabilities. In the first WI on full-duplex, it is reasonable to start with gNB only. Thus, only half-duplex UE shall be assumed.
9 – Intel Corporation (UK) Ltd Yes, the moderator proposal is reasonable. Consideration of full duplex @ UE, even for the isolated cell case, is not justified for Rel-18.

10 – Motorola Mobility UK Ltd.

In our view, half duplex operation in unpaired spectrum should be assumed for UE.

Due to size limitation of mobile devices, self-interference suppression at UE via spatial separation would be limited. Also, specifying new sets of UE RF requirements for full duplex UE would require significant amount of RAN4 work, which may risk the entire duplexing enhancement work not to be completed within a Rel-18 timeframe.

11 – China Telecommunications

At first study phase in Rel-18 for full-duplex, we support only consider full duplex at gNB while UE remains traditional TDD or FDD. Full duplex at UE can be considered in later release.

12 – NEC Corporation

Yes, we think Rel-18 can focus on full duplex at gNB side only, and half duplex operation should be assumed at UE.

13 – SHARP Corporation

Our view is similar with T-mobile. Even when UE keeps half duplex operation, gNB-to-UE interference needs to be addressed.

14 – Beijing Xiaomi Electronics

Yes, half duplex should be assumed at UE side in Rel-18.

15 – Samsung Electronics Co.

Considering UE implementation complexity, feasibility, and form factor, half duplex UE based duplex enhancement is reasonable step-by-step approach for Rel-18

16 – LG Uplus

Moderator's view is reasonable. Implementation of full duplex on UE seems not feasible in Rel-18 time due.

17 – LG Electronics Inc.

Considering on work load and specification impact, we are fine to focus on duplex enhancement at gNB only in Rel-18 and near future release. Also, we are open to discuss on full duplex for UE in future release.

18 – KDDI Corporation

We support that only UE half-duplex operation to be assumed in Rel-18.

19 – MediaTek Inc.

The moderator's view is good i.e. no full duplex consideration at the UE.

20 – Spreadtrum Communications

We support duplex enhancement at gNB only and half duplex at UE in R18.

21 – Qualcomm Korea

The study phase should consider the feasibility of full duplex mode at both gNB and UE. It should be the outcome of the study under what conditions full duplex is possible. In our view, full duplex mode is feasible for fixed wireless devices (e.g., CPE) with large spatial antenna isolation. Also, in FR2 beam isolation can improve the isolation and make full duplex operation more practical.

22 – Panasonic Corporation

We also think half duplex operation should be assumed at UE to manage the complexity of UE.

23 – ZTE Corporation

From our perspective, it is OK to include full duplex for UE in this study item considering the use cases (e.g., FR2 CPE type UEs) as mentioned by other companies. Companies can study the feasibility of full duplex for UE in this SI. If it is feasible, we can take it to WI; if not, we can leave it to the future release.

24 – HUAWEI TECHNOLOGIES Co. Ltd.

It is fine to assume half duplex operation at the UE. However, as there are legacy gNBs in the network, the UE-UE and BS-BS interference still exists. Therefore both UE-UE interference and BS-BS interference should be addressed in this SI.

25 – Nokia Corporation

Priority should be given to dynamic TDD and gNB-2-gNB interference mitigation. In case a study on full duplex operation is started in Rel-18, it may also cover full duplex operation at the UE. First in a following work item phase (if agreed) the scope could be limited to half duplex UEs . Furthermore it is important to study also UE aspects both legacy UE and UEs supporting full duplexing, not only gNB aspects in order to truly understand system gains, overall challenges and bottlenecks and how legacy UEs can operate in full duplex systems.

26 – Ericsson France S.A.S

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 FD.

27 – CEWiT

In Rel. 18 study, we prefer to assume half duplex operation at the UE side to limit the specification work depending on the availability of time. Considering full duplex at UE will complicate the network in terms of additional interference (CLI and SI), impact on legacy UEs etc., which requires more time to be studied in details. Thus, for the initial study, half duplex can be assumed at the UE.

2.1.3 Duplex enhancement approaches to study

Justification was provided on higher preference to focus on the subband non-overlapping duplex operation. Companies are invited to provide views whether it is necessary to include the subband overlapping or full overlapping duplex operation in the scope of study.

Feedback Form 7:

1 – T-Mobile USA Inc.

We don't think that full overlapping duplex operation is feasible due to neighbor coexistence. Subband overlapping is worth studying, but intelligent scheduling would be needed to be compatible with half duplex UEs.

2 – OPPO

From gNB full-duplex operation perspective, subband non-overlapping duplex is already sufficient. Sub-band overlapping may cause additional requirement on interference management, which could offset the potential saving in spectrum overlapping. We prefer not to include sub-band overlapping in Rel-18 study. Even if it is included, we understand the additional study work caused by sub-band overlapping may go to RAN4.

3 – Futurewei Technologies

We are OK for the FD study to investigate the potential issues related to sub-band overlapping with the understanding that the final decision is taken in RAN4. Having said that, we prefer that the non overlapping sub-band case to be considered first.

4 – AT&T

We believe both overlapping and non-overlapping cases should be considered. Depending on the scenario there may or may not be significant coexistence issues. Also some full duplex interference management solutions may be common for both overlapping and non-overlapping cases, so it should not be precluded at this stage. At least a thorough analysis of the requirements and potential impact on the gNB/network for the overlapping case should be established as a baseline.

5 – vivo Communication Technology

We suggest to focus on the most promising and feasible one, i.e. sub-band full duplex at gNB side. For the full-overlapping case, the adjacent channel interference in inter-operator scenario would be problematic.

6 – InterDigital

In Rel-18, RAN1's scope should be on subband non-overlapping case only. Study on subband overlapping or full overlapping can be in RAN4's scope, if needed, at least in Rel-18.

7 – CATT

Full overlapping duplex operation in isolated scenarios could provide spectrum efficiency/capacity improvement which subband non-overlapping duplex is unable to achieve. We support to keep full overlapping duplex operation limited to isolated scenarios in the scope.

8 – NTT DOCOMO INC.

We prefer to include both overlapping and non-overlapping duplex operation (XDD and FD), since our goal of this topic is the full overlapping duplex operation, therefore we would like to include all potential scenarios/configurations for the study.

9 – China Mobile Com. Corporation

In our view, we think it is early to preclude subband overlapping/full overlapping duplex operation before the SI, since we see possibility to apply it in isolated scenarios with low gNR transmission power, e.g., some indoor scenarios and industry scenarios with 4.9GHz (please note that about 70% traffic happen in indoor scenarios). If we only focus on isolated scenarios for subband overlapping/full overlapping duplex operation, then no inter-cell interference exists, and the self-interference is possible to be mitigated based on current self-interference cancellation techniques if the gNB transmission power level is low.

Although we prefer to have a thorough study for both subband non-overlapping duplex operation and sub-band overlapping/full overlapping duplex operation (only focus on isolated scenario for the latter case) and then perform narrowing down based on the conclusion in the study when going to WI, we are also fine to focus on subband non-overlapping duplex operation in R18 but the possibility should be allowed to have SI+WI in R18.

10 – Apple France

Even under the assumption of HD UE, UE may still suffer from UE-UE CLI. Given that UE-UE CLI can be potentially more sever in sub-band overlapping or full overlapping full-duplex operation, in our view the study should focus on sub-band non overlapping full-duplex operation at gNB.

11 – Intel Corporation (UK) Ltd

As mentioned in the previous round, we are open to studying potential duplex enhancements, but the focus should be on “subband non-overlapping duplex operation”. Further, the gains/benefits over dynamic TDD that is already possible need to be established.

In this regard, we share the views from Nokia that a pragmatic first step would be to ensure that dynamic/flexible TDD operation can be supported, via studies on cross-link intra- and inter-cell interference management aspects before jumping to duplexing enhancements.

12 – Motorola Mobility UK Ltd.

We don’t see a strong use case for full duplex operation in overlapping subbands. Interested companies can justify feasibility and benefit of fully overlapping duplex operation based on realistically achievable gNB self-interference cancellation levels.

13 – China Telecommunications

We support to have subband overlapping or full overlapping duplex operation in the scope of study, as the aim is to investigate the potential gain in some scenarios. If it is verified attractable gain can’t be achieved currently, down scope may be done after the SI.

14 – 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 of study which will introduce the interference management more complexity.

15 – SHARP Corporation

We think sub-band non-overlapping full duplex at gNB is enough to enhance uplink coverage without losing downlink performance. Subband-overlapping full duplex or full-overlapping full duplex can be studied once sub-band non-overlapping full duplex at gNB has been well studied.

16 – TELECOM ITALIA S.p.A.

xDD is a long term activity, unlikely leading to a Work Item in Rel 18. On the other hand operators raised the concern (see also the LS from NGMN in RP-211627 "LS on 5G NR TDD Uplink Throughput") that current regulations are impacting the possibility to deploy flexible TDD (and I assume xDD).

I am very concerned that 3GPP is looking to the long term, forgetting the immediate needs from the market.

Solutions to manage inter-operator CLI and allow a change in the regulation is an immediate requirement which should prioritized in Rel 18.

17 – Samsung Electronics Co.

We prefer to focus on subband non-overlapped operation with higher priority since it is not easy to solve CLI issues with overlapped cases.

18 – Beijing Xiaomi Electronics

Step-by-step evolution should be pursued for duplex operation. Not only the feasibility but also the workload across RAN1 and RAN4 should be carefully considered. We prefer to support non-overlapping subband case only in Rel-18. We shared the same view with OPPO that non-overlapping subband duplex is sufficient.

19 – LG Electronics Inc.

As clarified in Rel-18 WS, both immediate commercial need and long term commercial need should be considered for decision of scope. In this aspect, we think at least subband non-overlapping and subband overlapping for gNB Full Duplex operation should be investigated in Rel-18. Then, considering on the study result, practical timeline and TU, we can determine a prioritization among these two operation schemes for normative work.

20 – LG Uplus

Non-overlapped sub-band should be prioritized. Overlapped case could be studied but we have a concern that it would restrict our deployment scenarios into small cell due to RF requirement by interference cancellation.

21 – KDDI Corporation

Full overlapping duplex operation is more challenging to consider gNB self-interference and interference to adjacent carrier. We think sub-band non-overlapping duplex operation should be consider first in Rel-18.

22 – Spreadtrum Communications

Non-overlapping duplex is our first priority. For the overlapping case, since gNB-2-gNB CLI would be problematic in some scenarios, we suggest to limit to isolated scenarios if TU budget allows.

23 – Qualcomm Korea

The study phase should consider both overlapping and non-overlapping subbands. Based on the feasibility study for the different deployment scenarios, RAN1 can conclude on what subband duplex approach should be further considered. In our view, for small cells (e.g., in FR2) and/or low Tx Power isolated cell, subband overlapping is possible.

24 – Panasonic Corporation

We think it is focus on the subband non-overlapping duplex operation. The subband overlapping or full overlapping duplex operation should not be in the scope to reduce the amount of study/work.

25 – ZTE Corporation

From our perspective, it is OK to include sub-band overlapping or full overlapping duplex in this study item. Companies can study the feasibility of them in this SI. If they are feasible, we can take them to WI; if not, we can leave them to the future release.

26 – HUAWEI TECHNOLOGIES Co. Ltd.

In addition to the approaches/scenarios mentioned in the moderator recommendation, we suggest scenario 1 as we described in the initial round (Macro cell BS and small cell BS with different TDD DL/UL configurations operating in the same carrier frequency, and small cells have more UL slots) should be included, as this is a practical deployment for near term as mentioned by multiple companies. For subband full duplex scenario, it is not possible for all the gNBs in a network to operate in subband full duplex mode and there are always legacy gNBs operating in DL-dominant TDD configurations. Therefore there will be co-channel interference between the gNBs for subband full duplex scenario as well, and such BS-BS co-channel interference should be handled.

27 – Nokia Corporation

Priority should be given to dynamic TDD and gNB-2-gNB interference mitigation, i.e. neither subband non-overlapping nor full overlapping duplex operation are considered in first phase of the study/work item. Full duplex operation is only considered in a second phase of the study item. Here as self-, inter-gNB, inter-UE, and inter-operator interference management is similar for both subband non-overlapping and full overlapping duplex operation (though self-interference is more severe in case of fully overlapping DL/UL frequency resources), both duplex operation modes are included in the scope of the study. First in a following work item phase (if agreed) the scope could be limited to subband non-overlapping duplex operation.

28 – Ericsson France S.A.S

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.

29 – CEWiT

At least in the study phase both subband non-overlapping and full overlapping can be studied. In our view, subband non-overlapping duplex is a simplified sub-part of full overlapping duplex. Hence, the study phase should focus on both to make the study complete and understand the pros and cons of both. 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 full overlapping duplex can be continued in the next Release.

2.1.4 Interference management

There seems a consensus on the need to study on the handling of self-, inter-gNB, inter-UE, and inter-operator interference in RAN1 and RAN4, Companies are invited to provide views on how to organize the study.

Feedback Form 8:

1 – OPPO

In our view, the study of self-interference (for gNB side full duplex) is covered by RAN4; while the study of cross-link interference (including both inter-gNB and inter-UE) is led by RAN1 with assistance from RAN4.

2 – AT&T

It seems that both RAN1 (system level impact) and RAN4 (link level/RF requirements) should be involved jointly for all interference aspects. An initial phase will also be needed to decide on how best to model the self-interference as a function of link/system parameters (e.g. beamforming, Tx/Rx gain, impact of reflections etc.).

3 – InterDigital

Our view is that inter-gNB and inter-UE interferences as CLI can be RAN1's highest priority, and inter-operator interference can be a second priority for study. Self-interference issues should be led by RAN4, and RAN1's work may depend on inputs from RAN4. Such prioritizations are important to efficiently manage discussions in each working group and share meaningful outcomes across working groups in time, to progress well based on aligned understanding.

4 – vivo Communication Technology

Assuming only gNB side full duplex is studied in Rel-18, the gNB self-interferecne and inter-operator interference are better to be studied in RAN4, at those may have impact on gNB RF requirement and co-existence. And inter-gNB and inter-UE interference can be studied in RAN1, i.e. study of interference management solutions similar as we did for CLI in Rle-16

5 – CATT

Self-interference management is better to be studied in RAN4. Cross-link interference management shall be in RAN1.

6 – China Mobile Com. Corporation

Support.

Regarding the interference handling management across RAN1 and RAN4, in our view, we think RAN1 can study the general aspects of potential techniques for SI/CLI cancellation and study the required SI cancellation capabilities for different deployment scenarios in order to harvest desired performance gain, while RAN4 can study the concrete techniques and corresponding capabilities for SI/CLI cancellation and confirm whether it is feasible to achieve the required SI cancellation capabilities using the potential techniques.

Our initial consideration is that, during the study, w/o information on isolation and SI cancellation capabilities from RAN4, RAN1 can first perform evaluation based on its analyses of required SI cancellation capabilities for different deployment scenarios (e.g., RAN1 can assume some typical SI cancellation capabilities for performance evaluation), and RAN4 confirms whether it is feasible to achieve the required SI cancellation capabilities later based on RAN4's study.

Based on these considerations, the objectives regarding interference handling may be as following:

1) Study on the feasibility of interference cancellation to enable full duplex [RAN4, RAN1]

- Techniques of self-interference/cross-link interference cancellation and corresponding capabilities [RAN4, RAN1]
- Requirement of self-interference cancellation capabilities for different deployment scenarios [RAN1, RAN4]

2) Study on coexistence among different operators in adjacent channels [RAN4]

3) Study on coexistence with legacy UE [RAN1, RAN4]

4) Evaluate the performance of full duplex [RAN1]

- Evaluation methodology and performance metrics (e.g., spectrum efficiency, user perceived throughput, latency, etc.)

7 – Apple France

We also think interference management is the most critical part for full-duplex operation at gNB. Although to keep backward UE compatibility, it should be first investigated if the current solutions, mainly through scheduler, are sufficient in addressing the UE to UE interference, before looking for new solutions. New solutions, if identified to be required, can base on existing CLI (for UE-UE), RIM (gNB-gNB), and R17 eIAB multiplexing techniques. In our view, RAN4 should guide on the feasibility and requirements of the full-duplex operation, and RAN1 can work on required signaling for interference management.

8 – Intel Corporation (UK) Ltd

As suggested during previous round, for studies on interference management, for **RAN4**, interference studies should consider at least:

- Adjacent channel interference at gNB and UE
- Self-interference at gNB

For **RAN1**, interference studies should consider:

- Both intra- and inter-cell cross-link interference (both at UE and gNB) and identify necessary enhancements to the Rel-16 CLI framework, including necessary enhancements to facilitate better network coordination.

The interference studies should be conducted starting from consideration of dynamic/flexible TDD operations, and in this regard, handling of adjacent channel cross-link interference and co-channel intra-/inter-cell cross-link interference should be sufficiently prioritized over self-interference management at gNB.

Finally, all of the above should be studied in the context of intra- and inter-operator scenarios, and under different assumptions on backhaul/fronthaul latency/capacities and resulting level of NW coordination.

9 – Motorola Mobility UK Ltd.

First, RAN1 and RAN4 can define a couple of self-interference suppression levels for a given BS type for evaluation purposes. For a given deployment scenario and a given self-interference suppression level at gNB, RAN1 can evaluate impact of inter-gNB interferences, intra-cell inter-UE interferences, and inter-cell inter-UE interferences on DL/UL UPT. For any enhancement, the baseline for comparison should be Rel-16 RIM and CLI.

10 – TELECOM ITALIA S.p.A.

Inter-operator end intra-operator CLI are the first priority. In Europe regulators impose the frame structure. Therefore this feature is likely not possible to be deployed if the CLI issue is not solved to change the regulation

11 – NEC Corporation

We suggest cross-link interference (including both inter-gNB and inter-UE) is led by RAN1 and self-interference issues should be led by RAN4.

12 – SHARP Corporation

Study of tolerance level for inter-gNB interference and inter-UE interference should be handled by RAN4. RAN1 should focus on interference mitigation solution.

13 – Samsung Electronics Co.

We also think inter-gNB and inter-UE CLI can be mainly handled in RAN1 and RF requirement and co-existence study mainly in RAN4.

- Study feasibility enhanced duplex mode and identify performance gains (RAN1)
- Study RF coexistence, impacts & constraints, feasibility of self-interference scenarios (RAN4)

14 – LG Electronics Inc.

We think the study on handling of interference can be led by RAN1 with assistance from RAN4. Especially, we think RAN1 can lead to study the handling of inter-gNB interference and inter-UE interference, which was similarly studied by RAN1 in Rel-14.

15 – LG Uplus

In Rel-18,

- inter-gNB cross-link interference (Victim: gNB UL receiver, Aggressor: gNB DL transmitter) should be studied. e.g. measurement, RF requirement, etc. [RAN1, RAN4].
- inter-UE cross-link interference (Victim: UE DL receiver, Aggressor: UE UL transmitter) should be studied. e.g. measurement, detection, RF requirement, etc. [RAN1, RAN2, RAN4]
- Self interference in gNB should be studied. e.g. RF requirement, etc. [RAN4]

16 – KDDI Corporation

For RAN1, both UE-to-UE and gNB-to-gNB cross link interference should be studied for both intra and inter-cell scenarios. For RAN4, gNB self-interference, inter-operator (adjacent carrier) interference at both gNB and UE side should be studied.

17 – Panasonic Corporation

We support the view expressed by OPPO.

18 – Qualcomm Korea

RAN1 should discuss interference management techniques for the above listed four interference scenarios, while RAN4 should discuss and confirm the feasibility of self-interference mitigation by means of spatial antennal/panels isolation, frequency isolation, beam isolation, interference nulling and cancellation.

19 – ZTE Corporation

Early RAN1 and RAN4 involvement is necessary. In addition to that, RAN3 also needs to be involved since network coordination requires RAN3 expertise as well.

20 – HUAWEI TECHNOLOGIES Co. Ltd.

We prefer that both RAN1 and RAN4 are jointly involved for all the interference aspects. Both cross-link interference and self-interference should be included in the scope of the duplex evolution. And the cross-link interference with legacy gNB should be considered.

21 – Nokia Corporation

First focus on inter-gNB and inter-operator interference, as mitigation techniques for this interference types are generally applicable also to dynamic TDD. Self-interference management should only be considered in a second phase as part of the study on full duplex operation. When self-interference studies are started, they should also include UE self-interference studies, not only gNB self-interference studies. Inter-cell inter-UE interference has already been addressed as part of the Rel-16 work item on Cross Link Interference (CLI) handling and Remote Interference Management (RIM) for NR. Intra-cell inter-UE interference management may also be considered in a second phase as part of the study on full duplex operation.

22 – Ericsson France S.A.S

Both RAN1 and RAN4 should be involved in all aspects of interference management fromat the beginning of 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, self-interference management and(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).

23 – CEWiT

Self-interference related system level evaluations can be done in RAN1 with inputs from RAN 4. Other interferences can be studied in RAN 1.

24 – China Unicom

Specially, we think the scope of duplex operation in Rel-18 should support to configure different gNBs with flexible frame structures in 5G network. We propose to solve this issue in work item of duplex operation. This is urgent market requirements from operators and this issue should be treated in high priority.

2.1.5 Deployment scenarios

Companies are invited to provide views whether all or a subset of macro, micro, and small cell layouts should be considered. It is necessary to discuss whether IAB should be included in the scope.

Feedback Form 9:

1 – OPPO

We do not support to include IAB. Due to support of simultaneous Tx/Rx, Rel-17 IAB already has two-way competition/coexistence between parent link Tx/Rx and child link Tx/Rx. To include IAB into full-duplex gNB, RAN1 would need to handle a three-way competition/coexistence among parent link, child/access DL and child/access UL. In addition, the gNB antenna separation might be assumed in RAN4 in different ways between IAB (parent link and child link may face different directions) and normal gNB (DL-Tx and UL-Rx may follow the same/similar direction). We do not think the Uu duplex enhancement has obligation to cover additional case for IAB. Such IAB-related enhancement, if desired to be handled in RAN specification, should be handled in IAB-specific SI/WI.

2 – AT&T

We think IAB can be included in the scope as there is a lot of commonality with the regular gNB case with multiple sectors operating in a full duplex manner. Some of the issues already considered for simultaneous operation in Rel-17 IAB will likely be leveraged also in full duplex work (e.g. interference measurements, power control, TDD configuration coordination). It is not clear if any downselection of deployment scenario should be done at this stage as there are multiple pros/cons for each one. For example, UL coverage may be most improve in the macro scenario by full duplex operation, but dense urban micro or small cell layouts may have traffic dynamics more suited for capacity improvements from full duplex and especially for higher frequencies, more pathloss and environmental blockage may actually reduce the impact of neighbor cell/network interference.

3 – vivo Communication Technology

We think the deployment scenarios with lower gNB Tx power can be priotized.

For IAB, our understanding is that in Rel-17, the full duplex like operation between the parent link and child link has been already supported by the specification. On top of this, if we consider full duplex from the DU perspective, it seems no different from gNB side full duplex. The question might be then whether to consider full duplex from MT perspective, which is related to UE full duplex, which we prefer to not study it in Rel-18.

4 – CATT

We don't support to include IAB in the scope.

5 – NTT DOCOMO INC.

We support to include IAB scenario for XDD/FD operation among IAB-MT (for backhaul link) and IAB-DU (for access link). In our understanding, Rel-17 IAB is going to support simultaneous Tx (or Rx) operation among IAB-MT and IAB-DU, and not support simultaneous TRx. Since IAB-node has two links (backhaul and access links), we think XDD/FD operation for the links is beneficial and one of the potential use case for XDD/FD operation.

6 – China Mobile Com. Corporation

We think for subband non-overlapping duplex operation, macro, micro, and small cell layouts all can be considered, and for subband overlapping/full overlapping duplex operation, isolated/indoor scenarios are considered.

We prefer IAB FD is handled in another SI/WI if needed in Rel-18.

7 – Intel Corporation (UK) Ltd

The scenarios should 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.

In this regard, homogeneous outdoor macro-only deployments may be of less practical relevance and thus, 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.

On frequency bands, FR1 should be prioritized as the benefits for FR2 needs further justification at this stage.

8 – Motorola Mobility UK Ltd.

Macro, micro, and small cells can be evaluated for SI work. We think that discussions for interference management should include IAB scenarios, since full duplex operation at an IAB node can provide more flexibility for resource utilization and configuration.

9 – TELECOM ITALIA S.p.A.

Clearly the macro cell scenario is the most challenging, but it is unlikely a perfectly isolated cell can really exist (there is always the possibility of UEs from other operators to enter the cell).

The macro cell scenario should be therefore considered in the study

10 – NEC Corporation

We prefer IAB should be not 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.

11 – Samsung Electronics Co.

We think the access link is the most critical part to solve using this study so that we support macro, micro, and small cell scenarios with higher priority.

12 – LG Electronics Inc.

We think deployment scenarios where gNB operates lower power (i.e., Indoor hotspot, Dense Urban) should be prioritized for study in Rel-18.

13 – LG Uplus

We have similar view with Samsung. IAB is not our critical use case so far.

14 – KDDI Corporation

Considering the motivation of evolution of duplex enhancements includes UL coverage enhancement thanks to sufficient available UL resources on time domain. And, coverage issue typically seems to be happening in a macro deployment scenario. Therefore, for layouts to be assumed in the study, all candidate layouts (i.e., macro, micro and small cell) should be included in the scope.

15 – Spreadtrum Communications

We are open to include IAB in the scope and prefer to study it in the IAB-specific SI/WI if there will be.

16 – Qualcomm Korea

In our views, all deployment scenarios including macro, micro, and small cell layouts should be considered. In addition, IAB node should be included in the scope. If full-duplex IAB is not included in Rel-18 IAB item, then this bucket is the is the right place to discuss full-duplex IAB.

17 – China Mobile Com. Corporation

We think for subband non-overlapping duplex operation, all layouts, e.g., macro, micro, small cell, and **coexistence between macro cells and small cells**, can be considered, and for subband overlapping/full overlapping duplex operation, isolated/indoor scenarios are considered.

18 – ZTE Corporation

In this study item, we propose to study all the three scenarios, i.e.,

Macro, Micro, small cell layouts. In addition to that, we propose to also add Indoor hotspot and Dense Urban. One of the motivation of full duplex is to increase spectrum efficiency, Indoor hotspot and Dense Urban can be potential scenarios for full duplex.

Since it is a totally new study item, it is better if we can have study it under more scenarios to figure out its target scenarios and use cases, which can be used as reference for future use.

We are open to include IAB in this scope.

19 – HUAWEI TECHNOLOGIES Co. Ltd.

Our understanding is that scenario 1 as we described in the initial round (Macro cell BS and small cell BS with different TDD DL/UL configurations operating in the same carrier frequency, and small cells have more UL slots) is in the scope of this discussion. In the initial round, some companies (Orange/TIM/Nokia/Huawei) proposed similar scenario and mentioned this scenario is more relevant for practical deployment in near term. So we suggest this scenario to be included in this study.

20 – Nokia Corporation

Study should only consider flexible duplex operation (dynamic TDD and/or full duplex on overlapping/non-overlapping resource) for low power base stations (small cell/micro). Deployment scenarios may also consider a macro overlay using static TDD. Anyway, details on the specific deployment scenarios to be considered are to be discussed and agreed as part of the study item phase.

21 – Ericsson France S.A.S 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.
22 – CEWiT All scenarios including IAB should be looked into in the study phase to evaluate the pros and cons in every scenario. In Rel. 17, there was no specification work done for IAB full duplex. Thus, we feel that atleast some study and normative work should be done for IAB full duplex in Rel. 18.
23 – VODAFONE Group Plc As uplink coverage and capacity are drivers for XDD, macro cells need to be considered.

2.2 Moderator summary and recommendation

Summary of discussion for each question of the intermediate round is as follows.

Duplex mode:

Many companies (21 companies) preferred to consider TDD only while there still was support for considering FDD (4 companies). Regarding FDD, companies showed concerns on UE RF implementation, potential regional regulation restriction, and unclear relationship with flexible spectrum sharing.

Duplex enhancement at gNB only?:

Similar to the discussion in the initial round, there was strong support for focusing on duplex enhancement at gNB only and assuming the half duplex operation at UE. Nevertheless, there still was proposal from a few companies to study duplex enhancement at UE.

Duplex enhancement approaches:

Many companies (25 companies) suggested studying the subband non-overlapping duplex operation as the first step, considering that its self-interference level is lower than the others and the feasibility of handling cross-operator interference. On the other hand, there were views (10 companies) that the subband overlapping or full overlapping duplex should be studied as well. In addition, 5 companies suggested considering the CLI enhancement on dynamic/flexible TDD as a first part of the work.

Interference management:

There seems a good level of consensus to organize the study as follows.

- Study system level impact including inter-gNB and inter-UE CLI and identify a solution to manage them [RAN1-led, RAN2/RAN4]
- Study RF requirements considering the self-interference and the inter-operator CLI [RAN4-led, RAN1]

- Study co-existence with the legacy UE [RAN4]

Deployment scenarios:

It is clear that companies' views are still diverging. Mentioned scenarios include macro, micro, IAB, hetnet, small cell, and even indoor hotspot.

Based on the above summary, the moderator's recommendation is as follows.

- Duplex mode: TDD is included in the scope. Continue discussion whether FDD will be included in the scope.
- Duplex enhancement at gNB only?: Duplex enhancement at gNB is included in the scope. Continue discussion whether duplex enhancement at UE will be included in the scope.
- 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.
- Interference management: Organize the study as follows.
  - Study inter-gNB and inter-UE CLI and identify a solution to manage them [RAN1-led, RAN2/RAN4]
  - Study RF requirements considering the self-interference and the inter-operator CLI [RAN4-led, RAN1]
  - Study co-existence with the legacy UE [RAN4]
- Deployment scenarios: Continue discussion aiming to narrow down the deployment scenarios to be considered.

3 Final Round

3.1 Collection of company views

The following conclusion is proposed.

- Duplex mode: TDD is included in the scope. Continue discussion whether FDD will be included in the scope.
- Duplex enhancement at gNB only?: Duplex enhancement at gNB is included in the scope. Continue discussion whether duplex enhancement at UE will be included in the scope.
- 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.

- Interference management: Organize the study as follows.
  - Study inter-gNB and inter-UE CLI and identify a solution to manage them [RAN1-led, RAN2/RAN4]
  - Study RF requirements considering the self-interference and the inter-operator CLI [RAN4-led, RAN1]
  - Study co-existence with the legacy UE [RAN4]
- Deployment scenarios: Continue discussion aiming to narrow down the deployment scenarios to be considered.

Feedback Form 10:

1 – OPPO

There seems another important point to abstract from companies' feedback: whether the Rel-18 work on duplex enhancement is formulated as a SI or a WI. Our preference is to make it a SI.

Our comments on some other proposals for conclusion:

1). For "Duplex enhancement approaches", based on companies' feedback, there seems no concern on sub-band non-overlapping full-duplex scheme. So we wonder whether the group can at least put this particular scheme into consensus, while keep the other schemes under "continue discussion".

2). For "Study RF requirements considering the self-interference and the inter-operator CLI [RAN4-led, RAN1]", it is our understanding that RAN1 has no expertee for the study of RF requirements, including the RF-related evaluation. It is not clear to us what RAN1 should do for the RF requirement aspect. RAN1 can always answer LS request from RAN4 w/o a need of assignment in SID/WID. Meanwhile, it is not clear to us what is the fundamental difference between inter-operator CLI and inter-gNB CLI. It seems to us that inter-operator CLI is in general a specific type of inter-gNB CLI, unless people considers one gNB to be operated by multiple operators. In summary, we would like to suggest to put uncertain parts into bracket, i.e.,

— Study RF requirements considering the self-interference [and the inter-operator CLI] [RAN4-led, [RAN1]]

We prefer to remove the contents inside [], but can live with them in the bracket for now to further discuss.

2 – ETRI

We support the proposal.

Also fine with the first suggestion from Oppo. (i.e. OK to put "sub-band non-overlapping full-duplex scheme" into consensus, while keep the other schemes under "continue discussion").

3 – InterDigital

We are okay on most parts of the suggest conclusion, except a couple of comments as follows. Re 'Duplex enhancement approaches', by observing super-majority in companies' views on the subband non-overlapping case, we think it is more fair and constructive to have at least one solid statement that 'subband non-overlapping full duplex is included in the scope' and continue discussion whether subband overlapping and/or full overlapping cases will be included in the scope, similar to how the first and second bullets are formulated for progress. Re 'Study RF requirements..', we share similar view as OPPO that it is not clear to include RAN1 for this specific study on RF requirements.

4 – CATT

We are fine with most part of the propsed conclusion. We have minor wording suggestion to the following bullet, as a single solution is not sufficient to deal with inter-gNB and inter-UE interference.

Study inter-gNB and inter-UE CLI and identify ~~a~~ solutions to manage them

5 – Motorola Mobility UK Ltd.

By looking at companies' input, we think, the conclusion can be to include at least the sub-band non-overlapping full duplex case in the study and can propose continued discussion for other cases.

Given that a handful of companies prefer to include a full duplex IAB in the scope, RAN should continue discussion whether the full duplex IAB needs to be included in the study.

6 – Apple France

We share similar view as OPPO that full-duplex work, if eventually included in Rel-18, shall start as a study item, not a work item. Given that it seems majority think the same way, we suggest the moderator's proposal takes this aspect.

7 – LG Uplus

Regarding working logistics, **we should go to a WI stage with reasonable scope in Rel-18 time due**. This feature is essential to us for 5G-Advanced service.

We support moderator's proposal.

Regarding RF requirement bullet, our understanding is that some measurement scheme could be needed to resolve inter-operator CLI on a certain level SINR. Hence, RAN4-led and RAN1 seems reasonable.

8 – Beijing Xiaomi Electronics

We are generally fine with the proposal with moderator's proposal. We share the same views with companies that non-sub-band overlapping full duplex should included in the study since there is already a consensus on this case. The other two can be further studied. Further, we are supportive to the modification from CATT.

9 – China Mobile Com. Corporation

Thanks for the summary. We are fine with most parts.

Regarding the **interference management part**, we want to clarify some understandings based on current recommendation. In the study phase, our understanding is that RAN1 will have some evaluations on the system performance to identify the performance gain. In the evaluation, we think some assumptions on the capability of self-interference and inter-operator CLI will be needed in RAN1. There are two options for RAN1.

- Option 1: RAN4 first study the RF requirements for the self-interference and the inter-operator CLI, and after RAN4 make the conclusion on the RF requirement, RAN1 can perform system level evaluation based on the conclusion.
- Option 2: RAN1 can perform evaluation based on some assumptions on the self-interference and the inter-operator CLI cancellation capability (or RAN4 may recommend RAN1 some possible requirement levels at the beginning), at the same time RAN4 can study the RF requirements for the self-interference and the inter-operator CLI. After RAN4 make the conclusion on the RF requirement,

RAN1 can further make conclusion on evaluation results and performance gains based on RAN4's conclusion.

It is not clear to us which of the options will be assumed based on the current recommendation.

Regarding the **working plan**, we prefer to SI + WI in Rel-18.

In our view,

- In the leading SI phase, a thorough study for both subband non-overlapping duplex operation and subband overlapping/full overlapping duplex operation (only focus on isolated scenario for the latter case) can be performed.
- In the following WI phase to be started delayed during Rel-18, narrow down the scope to specify a subset of use cases and technology components with high commercial interest as identified in the SI phase, e.g., focus on subband non-overlapping duplex operation.

10 – Intel Corporation (UK) Ltd

On duplex enhancement approaches, while the proposed conclusion seems reasonable, we would like to emphasize that, as a feature, dynamic/flexible TDD (already specified) should be the natural baseline for any duplexing enhancements. In this regard, on cross-link interference management, a key first step would be to study for dynamic/flexible TDD before pursuing more advanced duplexing schemes.

On the objective "Study RF requirements considering the self-interference and the inter-operator CLI [RAN4-led, RAN1]", we share the view from Oppo and others that RAN1 should not be listed as a responsible WG.

On SI vs. WI, we think a SI would be appropriate to conduct these potential objectives.

On the question raised by CMCC on dependency between RAN4 and RAN1 studies, we agree this needs to be addressed for study of enhanced duplex schemes.
Further, in our view, it would not be efficient/desirable to have iterative studies/updates to prior studies in RAN1 based on conclusions from RAN4, and thus, Option 1 is preferred.
("Option 1: RAN4 first study the RF requirements for the self-interference and the inter-operator CLI, and after RAN4 make the conclusion on the RF requirement, RAN1 can perform system level evaluation based on the conclusion.")

11 – TELECOM ITALIA S.p.A.

We are generally fine with the summary.

We see a strong need to enable dynamic TDD / flexible frame structure (not only on paper as it is currently).

This activity should be a separate Work Item: Solutions to manage inter-operator CLI and allow changes in the regulation

12 – BT plc

As a network operator, we would agree that there is a need for flexibility in the frame structure, but this would be dependent on successfully managing CLI between networks.

We would therefore support work on CLI as a priority activity.

13 – Spreadtrum Communications

We are fine with the proposed conclusion in principle. Just two suggestions. We think the bullet "RF requirements considering the self-interference and the inter-operator CLI" is talking about the gNB side. Suggest to make it clear by changing it to "Study RF requirements considering both the self-interference and the inter-operator CLI at gNB side [RAN4-led,RAN1]".

And some of the interference management solutions studied in the "Interference management" part will be also applicable to dynamic/flexible TDD. So we prefer to combine the two bullets: "Continue discussion about the need for CLI enhancement on dynamic/flexible TDD" and "Study inter-gNB and inter-UE CLI and identify a solution to manage them".

14 – NEC Corporation

We are fine with the summary.

On SI vs. WI, we think a SI would be better as some evaluation could be done first.

15 – vivo Communication Technology

1. We think this should be SI.
2. Regarding the interference management objectives, we have some concerns as following

Interference management: Organize the study as follows.

- Study inter-gNB and inter-UE CLI and identify a solution to manage them [RAN1-led, RAN2/RAN4] [vivo] it is not clear why RAN4 is list here for studying of inter-gNB and inter-UE CLI solutions, we think it should be mainly RAN1 and RAN2 study.
- Study RF requirements considering the self-interference and the inter-operator CLI [RAN4-led, RAN1] [vivo]As we commented in previous round, we have strong opinion to not touch the UE RF requirement for the study of gNB side full duplex. We think UE RF requirement should be excluded in this bullet.
- Study co-existence with the legacy UE [RAN4]

16 – NTT DOCOMO INC.

Thank you very much for the summary and we are fine with the conclusion.

Regarding SI or WI, we prefer SI, so that based on the SI results, candidate solution(s) for the WI can be considered.

17 – ZTE Corporation

We are generally ok to go with the direction suggested by moderator.

One high-level comment from our perspective, since full duplex is likely to be a marker for 5G-Adv, it is suggested to have a comprehensive study of it from the beginning so that we can figure out its potential useful scenarios, use cases, potential solutions and potential gain. All these outcomes of this SI can be used for future use and can even be reference for future deployment.

Following this logic, we support to study all the potential scenarios, i.e., Macro, Micro, IAB, Hetnet, small cell, and even indoor hotspot. The simulation information for all these scenarios can be crucial for discussion in work item phase.

Regarding the following bullet, it seems "inter-gNB" interference management also requires RAN3 expertise. We propose to add RAN3 in this bullet as well.

- *Interference management: Organize the study as follows.*
- *Study inter-gNB and inter-UE CLI and identify a solution to manage them [RAN1-led, RAN2/RAN4/**RAN3**]*

Regarding whether it should be a SI or WI, we think it is clear that companies need more time to conduct the study, especially considering that coordination between RAN1, RAN4 and probably RAN2/RAN3 is needed. Thus, a SI is more appropriate.

18 – LG Electronics Inc.

Thanks for the summary. We are fine with the moderator's proposal for conclusion.

Regarding duplex enhancement approach, we respect majority view. On the other hand, we think it is better to have more comprehensive discussion in those approaches rather than to try hasty selection in this email discussion.

19 – China Telecommunications

We are generally fine with the proposal. Regarding SI or WI, about the full duplex evolution, we think SI is appropriate to have thorough study about the identified schemes. Following WI can have narrower scope depending on the SI outcome maybe in later release. About CLI enhancement on dynamic/flexible TDD, whether it should be separate WI in Rel-18 or in the same SI may needs further discussion.

20 – ROBERT BOSCH GmbH

Thank you for the summary and the discussions.

We are fine with most of the study. We only wanted to add studying duplex enhancement at special UEs (not only gNB), e.g., vehicular UEs.

21 – Panasonic Corporation

Although we can support the proposal, we also prefer to agree "sub-band non-overlapping full-duplex scheme".

22 – China Unicom

In addition to the scenarios mentioned in the moderator recommendation, we strongly suggest to include one more scenario for scenario 1, in which two gNBs in the same area configured with different TDD DL/UL configurations in the same carrier, and one of the gNBs has configured with more UL slots for UL capacity boosting, as similar scenarios proposed by other companies. This is a practical deployment for 5G commercial network.

23 – Telekom Deutschland GmbH

As a network operator we agree with BT and TIM and see CLI as a feature which should be regarded in Rel. 18. Beside the increased flexibility without the need of inter-operator agreements of the TDD frame structure is might further enhance the flexibility within a network. E.g. in small cells or campus networks might hive another TDD UL/DL ratio than the surrounding macro sites.

24 – SHARP Corporation

We agree with companies that "study for sub-band non-overlapping full duplex" can be mentioned in the proposed conclusion.

25 – Futurewei Technologies

We are fine with the moderator conclusions. The sub-band non-overlapping FD seems to be agreed by almost all companies and therefore it should be included in the scope. Regarding SI vs WI, we note that are many CLI combinations and scenarios to be considered, and therefore a SI is necessary first to further narrow down the scope of WI.

26 – HUAWEI TECHNOLOGIES Co. Ltd.

RAN4 mainly addresses adjacent-channel co-existence, while this duplex enhancement function will have impact on co-channel coexistence as well, so RAN1 should be involved for such co-existence study. We did not see why such co-existence study is limited to UE, our view is that co-existence study with legacy BS is also needed. We therefore suggest below revision: "Study **co-channel and adjacent-channel** co-existence with the legacy ~~UE~~ **system** [RAN1, RAN4]."

27 – KDDI Corporation

Generally, we support the proposed conclusion. Regarding working plan of this feature, we prefer to SI + WI in Rel-18.

28 – HUAWEI TECHNOLOGIES Co. Ltd.

We also supports operator (TIM, BT, DT, China Unicom) request to treat dynamic TDD/ flexible frame structure as high priority scenario.

29 – Qualcomm Korea

For duplex mode: FDD should not be considered. It is hard to justify the latency/coverage gain.

For duplex enhancement at UE: In our view, full duplex mode at UE is feasible for fixed wireless devices (e.g., CPE) with large spatial antenna isolation. Also, in FR2 beam isolation can improve the isolation and make full duplex operation more practical. So, we suggest including duplex enhancement at UE in the scope of study. Also as commented by other companies, the SI should investigate whether full duplex UE is feasible or not and under what conditions. We shouldn't restrict the study phase to gNB from day 1.

For duplex enhancement approaches: All 3 schemes should be in the scope of study. Partial/full overlapping of DL/UL subbands is feasible especially in FR2 with well separated panels and high beamforming gain. CLI enhancement on dynamic/flexible TDD can be captured within the scope of interference management on inter-gNB CLI.

We agree with the moderator views on the organization of interference management. The study should consider both FR1 and FR2. In our view, existing R16 CLI framework may not work in FR2 in absence of QCL indication for the measurement RS. The second sub-bullet should capture clutter echo as well. RAN1 should also consider solution to manage such interference scenarios. For example, clutter echo may require some beam restrictions to avoid or mitigate interference from such reflections.

o Study RF requirements and mitigation techniques for self-interference, clutter echo and the inter-operator CLI [RAN4-led, RAN1]

For deployment scenarios: Macro, micro, and small cell layouts should be considered. In addition, IAB node should be included in the scope.

30 – VODAFONE Group Plc

We agree with the views expressed by BT, TIM and DT.

31 – Ericsson France S.A.S

We have the following input on the conclusions.

· This topic should only be a SI in Rel-18. There are just too many aspects that need to be investigated first in a study before even considering a work item.

· It is important to restrict the study to a reasonable scope by only considering sub-band non-overlapping duplex enhancements in this study.

· On CLI enhancements for dynamic TDD, we once again caution that we should not re-do what has already been done in prior study and work items.

· Regarding sequencing of work, we think Option 1 in CMCC's response above is more efficient, i.e., RAN4 first studies the RF requirements for the self-interference and the inter-operator CLI, and after RAN4 makes the conclusion on the RF requirement, RAN1 can perform system level evaluation based on the conclusion.

32 – CEWiT

We are fine with the moderator's proposal. However, we feel that inter-gNB and inter-UE CLI might not have a single solution and needs to be managed separately.

33 – Fraunhofer HHI

We are ok with a first study focusing on TDD-only.

We agree that Duplex enhancements gNBs are to be in the scope of the study, but encourage to keep some basic duplex enhancements for UEs in the scope as well, in particular to achieve the latency reduction targets identified as valuable enhancements benefits and where FD@UE would be very beneficial.

Regarding the three identified full duplex schemes, Fraunhofer views **subband non-overlapping** and **sub-band overlapping** as the two candidates to be studied within the scope, while full overlapping might remain as an enhancement feature for later studies.

Subband non-overlapping full duplex has many similarities with dynamic/flexible TDD, wherein the sub-band non-overlapping FD maybe operated by the same gNB. The CLI framework including detection re-porting and mitigation should cover FD and dynamic/flexible TDD in a unified approach.

We agree on the proposed responsibilities in RAN WGs to study inter-gNB and inter-UE CLI [RAN1-led, RAN2/RAN4], Study RF requirements considering the self-interference and the inter-operator CLI [RAN4-led, RAN1]and to study co-existence with the legacy UE [RAN4].

3.2 Moderator summary of final round

The moderator would like to thank all for active participation and constructive discussion. Below is the final summary that can be used as the basis for further discussion.

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:

   a) 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.
   b) Continue discussion about the need for CLI enhancement on dynamic/flexible TDD.

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

   a) Study inter-gNB and inter-UE CLI and identify solutions to manage them [RAN1]
   b) Study RF requirements considering the self-interference and the inter-operator CLI at gNB [RAN4]
   c) 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.