97e-19-R18-Multicarrier - Version 0.0.9
RAN

3GPP TSG-RAN Meeting #97-e RP-222672

Electronic Meeting, September 12 - 16, 2022

Agenda item: 9.3.1.2

Source: Moderator (NTT DOCOMO, INC.)

Title: Moderator's summary for discussion [97e-19-R18-Multicarrier]

Document for: Discussion and Decision

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1 Introduction

This contribution summarizes the following email discussion in AI 9.3.1.2 regarding Multi-carrier enhancements for NR.

Table 1:

[97e-19-R18-Multicarrier]	RP-222066, 2148, 2180, 2244, 2251, 2304, 2360, 2130, 2131	Hiroki Harada, DoCoMO	

2 References

[1] RP-222066 Views on scope for Multi-carrier enhancements WI Qualcomm Incorporated

[2] RP-222148 Discussion on Multi-carrier enhancements for NR WI vivo

[3] RP-222180 Clarification on UL CA configuration for multi-carrier enhancements Apple

[4] RP-222244 Discussion on target scenarios for Rel-18 UL Tx switching in NR Multi-carrier enhancements WI CMCC

[5] RP-222251 Revised WID on Multi-carrier enhancements NTT DOCOMO, INC.

[6] RP-222252 Status report for WI: Multi-carrier enhancements for NR NTT DOCOMO, INC.

[7] RP-222304 On the scenario of NR Multi-carrier enhancements WI China Telecom, China Unicom

[8] RP-222360 On the status of Rel-18 multi-carrier enhancements work in RAN WG1 Samsung Electronics Benelux BV

[9] RP-222130 New WID: NR CA band combinations with dual SUL bands in Rel-18 CMCC

[10] RP-222131 Motivation on NR CA band combinations with dual SUL bands in Rel-18 CMCC

3 Discussions on the WID update(s)

In [5], the rapporteur proposed to update the WID as below according to the outcome of RAN4 discussion on the number of TAGs for UL Tx switching.

In [7], following proposal was made and it seems the update in [5] could align with the proposal.

Table 3:

Proposal 2: *Based on RAN4 agreement, add in the WID that the number of TAGs is limited to up to 2 for both 2 bands sw*

In [1], following proposed update was provided, and it seems the update in [5] could align with the proposal 1 but the proposal 2 is not covered.

Proposal 1: We propose to align the WID with the RAN4 understanding as above and limit the number of TAGs to

Regarding the proposal 2 in [1], RAN1 made following conclusion at RAN1#109-e meeting.

In summary, there are following proposals for WID update(s).

- Proposal 1: Clarify that the number of TAGs is limited to up to 2 for both 2 bands switching and more than 2 bands switching cases
  - Proposed by: Rapporteur, China Telecom, China Unicom, Qualcomm
- Proposal 2: Remove the limitation that the work on 2 bands multi-TAG is to be done in RAN4 only
  - Proposed by: Qualcomm

3.1 Initial round discussion

The moderator would like to ask companies to provide feedback if any on the above summary and following alternative proposals for WID update.

3.1.1 1st round Feedback for Proposal 3.1

Proposal 3.1

Alt.1:

- **Clarify that the number of TAGs is limited to up to 2 for both 2 bands switching and more than 2 bands switching cases**
- **Remove the limitation that the work on 2 bands multi-TAG is to be done in RAN4 only**
- **Apply the proposed WID update in [1]**

Alt.2:

- **Clarify that the number of TAGs is limited to up to 2 for both 2 bands switching and more than 2 bands switching cases**
- **Apply the proposed WID update in [5]**

Alt.3:

- **No update for the WID**

Feedback Form 1: 1st round Feedback form for Proposal 3.1

1 – Nokia Corporation Generally we'd be OK with any of the alternatives as in our understanding all the cases should in the end lead to the same end result, but the fact that this discussion is taking place makes us somewhat prefer updating the WID according to Alt1. We understand the RAN1 working assumption of "**the number of TAGs should be limited to up to 2**" being in accordance to the original intent of the WID, while at the time we didn't see the necessity to write such a specific detail to the WID. However, given the confusion around this question it maybe better to update the WID. The guidance for RAN4 work only for multiple TAGs, our understanding was, and still is, that there is no functional specification impact in other WGs, but there could be e.g. a need for new UE capability definition in RAN2 or some question that RAN1 needs to answer to RAN4 so the restriction should be understood loosely. As there maybe a tendency for literal interpretation of the WID we'd be OK to remove the RAN4-only restriction in the WID.
2 – LG Electronics France We prefer Alt.1 since it makes the scope clearer

3 – Apple France

Our preference is Alt 1 to explicitly list the two key updates concerning multiple TAGs

4 – Qualcomm Incorporated

We prefer Alt.1 for the reasons given in [1]

5 – Ericsson LM

We are supportive of Alt 1.

Considering the discussions so far and observing the difficulties to progress on this subject, we see revising the WID to indicate max number of TAGs should be limited to 2, would help the progress of WGs.

On removing the limitation to RAN4 WG only, we are supportive since we have observed that when originally the related discussion took place in RAN1, some companies expressed the discussion was within RAN4 expertise and RAN1 could get involved in the discussion unless it was requested by RAN4. That preference was concluded in RAN1. However, when the topic was discussed in RAN4, it was not possible to reach consensus to even send an LS to RAN1 to ask whether there is RAN1 impact or not. Although in our view the support of 2-TAGs for 2-bands should not have any RAN1 impact, we believe the current WoW is not constructive. The WGs should be given the possibility to discuss the technical aspects of the issue, if needed. Removing the restriction to RAN4 only seems to serve the purpose, and hence we are supportive.

6 – Spreadtrum Communications

We support Alt1.

7 – E-surfing Digital

China Telecom:

Firstly, we support to add 2-TAG limitation in the WID to make it clearer.

Secondly, on removing the limitation that the work on 2-band multi-TAG is to be done in RAN4 only, our understanding is as follows:

1) Technically, we agree no or minor specification update is expected in RAN1. Also, in order to discuss the release independent aspect for 2-band 2-TAG scenario later in RAN4, RAN1 spec impact is not preferred.

2) As usual business, it is no harm to send LS to RAN1 to let RAN1 confirm that no/minor spec impact is needed.

With these, we are ok with **Alt. 1** or a new **Alt. 4** as below (which is also aligned the RAN1#109-e conclusion as mentioned by moderator):

Alt. 4:

- **Clarify that the number of TAGs is limited to up to 2 for both 2 bands switching and more than 2 bands switching cases**
- **For the work on 2 bands 2-TAG, RAN1 discussion can be triggered by RAN4 LS**

8 – Samsung Electronics Co.

We prefer Alt.1.

We support to limit the number of TAGs to up to 2 for both 2 bands switching and more than 2 bands switching cases (1st bullet point common to Alt.1 and Alt.2)

Our understanding is that RANP at the time of approval of the WID did not provide a mandate for functional specification impact from the multiple TAG feature to RAN1 core specs. If it is necessary to remove the RAN4 only restriction for purpose of discussing need/details of the UE capability (38.306/331) signaling, then we can support the proposal (2nd bullet point)

9 – ZTE Corporation

Prefer Alt. 3 or Alt. 2

For the number of TAGs, the RAN4 agreement on limiting to up to 2 TAGs is in accordance with the WID. We don't see much need to incorporate more details in the WID. While, we could be also ok if it is the majority view.

For removing RAN4 work only, it is not clear why we need to revisit the conclusion made in last RAN plenary. If any discussion in other WG(s) is deemed necessary, it can be triggered by LS.

10 – CATT

We prefer Alt 3.

For up to two TAGs, we do not see the need to capture the details in the WID and it is expected that WG would anyway continue the work based on the agreements.

For removing the limitation that the work on 2 bands multi-TAG is to be done in RAN4 only, we also do not see the need. We do not think that it prevents exchanging LS between WGs.

If there is a need to help the progress, we think it is sufficient to adopt Alt 4 as proposed by CT as conclusion in RAN plenary.

11 – vivo Communication Technology

Prefer alt2. We are fine with modifying the WID to capture the number of TAGs. Regarding the restriction on RAN4 work only, this was agreed at the last RAN meeting and it does not prohibit RAN4 from sending LS to inform RAN1 of their agreement or requests for updates. It is not clear why the note needs to be removed, as usual business, RAN4 can trigger a LS if needed.

We are also fine with alt3.

12 – Intel Deutschland GmbH

We are fine with either Alt. 1 or Alt. 2. We share similar view as other companies that RAN4 should be the main WG to work on the 2 TAG case.

13 – MediaTek Inc. We support Alt1 since it makes WI scope clear.
14 – HUAWEI TECHNOLOGIES Co. Ltd. We prefer Alt.2. 1. Limiting the number of TAGs to up to 2 is aligned with RAN4 agreement. 2. Regarding removing the note that the work on 2 bands multi-TAG is to be done in RAN4 only, the note itself is agreed when setting the scope in RAN for 2 bands, and thus we don't see any reason to remove it. Removing it is up-scoping, since it means other working groups need to work on it also.
15 – LG Uplus We prefer Alt.3.
16 – DOCOMO Communications Lab. We are fine with Alt.1 as RAN4 could not send LS due to the restriction in the WID description.

3.1.2 1st round Feedback for Proposal 3.2

Proposal 3.2

Companies are also encouraged to provide any other possible WID update if any.

Feedback Form 2: 1st round Feedback form for Proposal 3.2

3.2 Initial round summary

Based on the initial round discussion, companies' views could be summarized as below.

- For Proposal 3.1
  - Support Alt.1 as in [1]: Nokia, LG, Apple, Qualcomm, Ericsson, Spreadtrum, China Telecom, Samsung, Intel, MediaTek, DOCOMO (11)
    - To help the progress of WGs
    - To make the scope clearer
    - Update of the WID did not provide a mandate for functional specification impact from the multiple TAG feature to RAN1 spec, and it is ok if removing the restriction is for the purpose of discussing need/details of UE capability (Samsung)
  - Support Alt.2 as in [5]: ZTE, vivo, Intel, Huawei (4)

    - It was RAN agreement when setting the scope for 2 bands, and removing it means up-scoping as other WGs need to work on it
    - If any discussion in other WG is deemed necessary, it can be triggered by LS
- Support Alt.3 (no update): ZTE, CATT, vivo, LG Uplus (4)
    - Also ok if majority prefer Alt.2 (ZTE)
    - Anyway WG continues the work based on agreements
- Support Alt.4 (clarify that for the work on 2 bands 2-TAG, RAN1 discussion can be triggered by RAN4 LS): China Telecom, CATT (2)
    - There should be no harm to send LS to RAN1 to let RAN1 confirm that no/minor spec impact is needed

Based on above, it seems most of companies agree that RAN4 can ask RAN1/2 to provide their feedback regarding UL Tx switching with 2-TAGs by sending LS according to the current WID description (RAN agreement) and RAN1 conclusion. However, RAN4 could not send LS due to the current WID description. So, it would be constructive to clarify that sending LS from RAN4 to other WG regarding UL Tx switching with 2-TAGs is not prohibited. It can be noted in the meeting report as there seems concern/objection to Alt.1.

Following compromised proposal from moderator is provided.

Updated proposal 3.1:

- **Clarify that the number of TAGs is limited to up to 2 for both 2 bands switching and more than 2 bands switching cases**
- **Apply the proposed WID update in [5]**
- **Capture following conclusion in the meeting report of RAN#97-e.**
    - **Conclusion: for the work on UL Tx switching with 2 TAGs, RAN1/2 discussion can be triggered by RAN4 LS**

For Proposal 3.2, there is no input and hence it can be closed.

3.3 Intermediate round discussion

The moderator would like to ask companies to provide feedback if any on the initial round summary and following proposal for WID update.

3.3.1 2nd round Feedback for Proposal 3.1

Updated proposal 3.1:

- **Clarify that the number of TAGs is limited to up to 2 for both 2 bands switching and more than 2 bands switching cases**
- **Apply the proposed WID update in [5]**
- **Capture following conclusion in the meeting report of RAN#97-e.**
  - **Conclusion: for the work on UL Tx switching with 2 TAGs, RAN1/2 discussion can be triggered by RAN4 LS**

Feedback Form 3: 2nd round Feedback form for updated proposal 3.1

1 – Nokia Corporation We find the updated proposal 3.1 reasonable. Even if the WID states RAN4, it doesn't forbid the tasked WG to trigger action in another WG, if needed. This should be clear even without the conclusion, but given the August RAN4 discussion that took place, it seems we (unfortunately) should also capture the conclusion as proposed by the moderator.
2 – Samsung Research America We support the FL updated proposal 3.1.
3 – OPPO We are fine with the updated Proposal 3.1.
4 – New H3C Technologies Co. We are fine with this proposal
5 – Spreadtrum Communications We support the FL updated proposal 3.1
6 – CATT We think the updated proposal is a reasonable compromise and thus we support the proposal.
7 – China Telecommunications We support the updated proposal 3.1 from moderator. For 2-TAG limitation, in our understanding, it is not only a detailed parameter. It impacts operators' deployment scenario, UE implementation as well as RAN4 workload. If Tx switching across 3 or 4 bands with more than 2 TAGs is considered, the timing relationship would be very complicated. So, we think it is helpful to capture the 2-TAG limitation in the WID as proposed by moderator.

8 – vivo Communication Technology Support the proposal
9 – Intel Deutschland GmbH We are fine with updated Proposal 3.1
10 – ZTE Corporation We are fine with the proposal.
11 – ZTE Corporation We are fine with the proposal.
12 – NTT DOCOMO INC. [as DOCOMO] We support the updated proposal 3.1.
13 – LG Electronics France We are fine with the proposal
14 – MediaTek Inc. We support the updated proposal.
15 – Ericsson LM We share the same view as Nokia as we explained in the initial round. Hence, we are supportive of the proposal.
16 – HUAWEI TECHNOLOGIES Co. Ltd. At least for the case with 2 bands, the note in the WID explicitly says that the work is limited to RAN4, as commented before up-scoping should not be allowed to extend the work to RAN1/2. Therefore, the conclusion should be modified as below: **Conclusion: for the work on UL Tx switching across 3 or 4 bands with 2 TAGs, RAN1/2 discussion can be triggered by RAN4 LS**

3.4 Intermediate round summary

Summary of intermediate round feedbacks for updated proposal 3.1:

- Fine with the updated proposal 3.1: Nokia, Samsung, OPPO, New H3C, Spreadtrum, CATT, China Telecom, vivo, Intel, ZTE, DOCOMO, LG, MediaTek, Ericsson (14)
- Modify the conclusion as "for the work on UL Tx switching across 3 or 4 bands with 2 TAGs, RAN1/2 discussion can be triggered by RAN4 LS": Huawei (1)

Moderator's suggestion: The updated proposal 3.1 seems agreeable to most of companies.

Conclusion in Wednesday GTW: the following proposal was agreed, and the discussion on WID update can be closed.

- **Clarify that the number of TAGs is limited to up to 2 for both 2 bands switching and more than 2 bands switching cases**
- **Apply the proposed WID update in [5]**
- **Capture following conclusion in the meeting report of RAN#97-e.**
  - **Conclusion: for the work on UL Tx switching with 2 TAGs, RAN1/2 discussion can be triggered by RAN4 LS. No RAN1 spec impact is expected.**

4 Discussions on objective 1: multi-cell PUSCH/PDSCH scheduling

In [2], following proposals for multi-cell PUSCH/PDSCH scheduling were made.

Proposal 1. RAN plenary provides guidance to RAN1 to complete the work on time. Proposal 2. The design of mul

In [8], following proposals for multi-cell PUSCH/PDSCH scheduling were made.

Proposal: RAN to provide following guidance to RAN1 for their work on multi-cell scheduling: No extension/enhar

The moderator would like to note that RAN1 status report in RP-221886 from RAN1 chair described the situation of this WI in RAN1 as below. Hence, the rapporteur proposed to increase the RAN1 TU for each meeting in Q4 (from 0.5 TU to 1 TU), but RAN chair provided the guidance that no TU increase will be allowed at RAN#97-e for existing Rel-18 items. Therefore, the moderator believes it is worth discussing proposals above for potential down-scoping.

Tabl

Adequate progress in RAN1#110 across all topics for single meeting cycle. However, completing the work item in Q4 (as

4.1 Initial round discussion

The moderator would like to ask companies to provide feedback if any on each of following proposals. If you disagree with a certain down-scoping proposal, please provide the reason for the importance and how it can be proceeded within the quite limited TU.

4.1.1 1st round Feedback for Proposal 4.1

Proposal 4.1

- **Deprioritize any optimization for unlicensed spectrum operation for designing the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

Feedback Form 4: 1st round Feedback form for Proposal 4.1

1 – LG Electronics France We don't agree to deprioritize unlicensed spectrum opration since additional specification work load for unlicensed band is limited compared to its benefits for unlicensed spectrum
2 – NTT DOCOMO INC. Support this proposal considering the limited TU.
3 – Lenovo (Beijing) Ltd We agree to deprioritize unlicensed spectrum operation in Rel-18. Although additional standardization effort on it might be limited dependent on detailed discussion, it is better to deprioritize unlicensed spectrum for time being.
4 – VODAFONE Group Plc We agree to deprioritize considering the limited TU
5 – Apple France We agree to deprioritize any optimization for unlicensed spectrum operation with multi-cell PUSCH/PDSCH scheduling
6 – OPPO We support the proposal from moderator.
7 – Nokia Germany We support the proposal. **One question for clarification**: The proposal reads as 'Deprioritize ***any optimization*** for unlicensed spectrum operation...' - is this not only for optimization here, or is the intend to go one step further and '*Deprioritize* ~~**any optimization for**~~ *unlicensed spectrum operation for designing the multi-cell PUSCH/PDSCH*

scheduling in Rel-18' - i.e. deprioritize (i.e. do not support) unlicensed spectrum operation overall. Nokia could be fine with such even stronger proposal / decision as well.

8 – Ericsson LM

We support the proposal with the clarification that the proposal does not imply the feature is not supported for operation on unlicensed, while the proposal implies that any optimization for operation on unlicensed is down prioritized.

9 – Spreadtrum Communications

We support the intention of the proposal to save time without more specific considering of unlicensed band. However, we are afraid of the "optimization" in the proposal would lead to problems such as: whether DCI formats can contain the LBT related fields, if yes what type of these fields are, etc.

10 – Samsung Electronics Co.

We are OK with the proposal from Moderator. Also support the update from Nokia.

11 – ZTE Corporation

According to Chair's guidance, no TU increase for existing R18 items is expected. So, we'd like to clarify whether the down-scoping is under assumption of no increase of TU for this WI. If it is the case, we suggest to first discuss whether any down-scoping is needed for multi-cell scheduling and then discuss the detailed proposals in this section. In our view, the overall progress is in general ok and down-scoping may not be necessary, unless companies can reach consensus for down-scoping of a particular enhancement for multi-cell scheduling in RAN#97-e.

For Proposal 4.1, we are ok to deprioritize unlicensed spectrum operation for multi-cell scheduling.

12 – Qualcomm Incorporated

In our view, multi-cell PUSCH/PDSCH scheduling on unlicensed spectrum scheduled by a DCI format transmitted on licensed spectrum does not require major optimization and should be supported in Rel-18. Therefore, we propose to update the proposal as follows.

Deprioritize any optimization ~~for unlicensed spectrum operation~~ for designing a DCI format for unlicensed spectrum for ~~the~~ multi-cell PUSCH/PDSCH scheduling in Rel-18.

13 – CATT

We support the proposal considering limited TU.

14 – vivo Communication Technology

Based on the Chairman's guidance, no increased TU for the R18 project, therefore we support this proposal. we are also fine with the proposal from Nokia.

15 – Intel Deutschland GmbH

We are fine to deprioritize the unlicensed spectrum for multi-cell scheduling given the limited TU. We can also be fine not to support unlicensed spectrum or multi-cell scheduling.

16 – New H3C Technologies Co.

We support this proposal

17 – HUAWEI TECHNOLOGIES Co. Ltd.

In general we think it is not good to do down-scoping, since we made great effort to finalize the Rel-18 scope and we should try our best to complete it. If companies want to do down scoping discussion, we should have an overall picture for all Rel-18 items and this shall not be done for a particular topic. As to very detailed solution/feature level down-scoping, this seems business as usual and can be discussed case by case, but actually better to do this in WGs discussion instead of RAN here, since it usually depends on very detailed discussion on the pros and cons.

If we really want some discussion here, for this proposal 4.1, we are fine with it.

1. Unlicensed band is not the target use case for multi-carrier scheduling, since most spectrum resources on unlicensed bands are contiguous and may span a wide range of up to 100 MHz.

2. Scheduling multiple unlicensed carriers via a single mc-DCI can be much less efficient, since the probability of simultaneous LBT success on multiple scheduled carriers is much smaller.

3. The complexity to support unlicensed operations can be pretty high since additional aspects like LBT needs to be considered.

18 – MediaTek Inc.

We support Proposal 4.1. We also support Nokia's update to deprioritize (i.e., do not support) unlicensed spectrum operation overall considering NR-U is not widely used for now.

19 – LG Uplus

We support this proposal.

20 – China Mobile Com. Corporation

We agree to deprioritize unlicensed spectrum operation for multi-cell PUSCH/PDSCH scheduling considering the limited TU.

21 – China Unicom

We agree to deprioritize unlicensed spectrum operation in the proposal.

22 – CableLabs

We support Nokia's suggested modification on the proposal

4.1.2 1st round Feedback for Proposal 4.2

Proposal 4.2

- **Type-1 and enhanced Type-2 HARQ-ACK codebooks are not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

Feedback Form 5: 1st round Feedback form for Proposal 4.2

1 – LG Electronics France We propose to support Type-1 codebook
2 – NTT DOCOMO INC. Support considering the limited TU.
3 – Lenovo (Beijing) Ltd Support.
4 – Apple France We are fine with the proposal considering the limited time left.
5 – Nokia Germany We are fine, considering the limited time left to complete the WI.
6 – Ericsson LM We support the proposal. Considering the remaining work, it is reasonable to focus on the most practical/used codebook, i.e. dynamic HARQ-ACK code book.
7 – Spreadtrum Communications We support the proposal.
8 – Samsung Electronics Co. We expect the specification of Type-1 codebook for multi-cell scheduling to be similar to that for Rel-17 multi-slot scheduling if only same SCS is supported for co-scheduled cells. Therefore, we can suggest the following modification. We can also be OK with not supporting Type-1 CB for multi-cell scheduling if the majority prefers although we think that would be an unnecessary limitation. **− Type-1 <u>(at least for different SCS for co-scheduled cells)</u> and enhanced Type-2 HARQ-ACK codebooks are not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

9 – ZTE Corporation

We have similar comment in general as for Proposal 4.1 above.

For Proposal 4.2, we are ok to deprioritize enhanced Type-2 HARQ-ACK codebook since it is mainly for unlicensed spectrum operation.

For type-1 HARQ-ACK codebook, which is the typical codebook type implemented in practical network, we do NOT support to deprioritize. In addition, the spec efforts could be minor considering the HARQ timing indicator is agreed as a common information to all the co-scheduled cells.

10 – ZTE Corporation

We have similar comment in general as for Proposal 4.1 above.

For Proposal 4.2, we are ok to deprioritize enhanced Type-2 HARQ-ACK codebook since it is mainly for unlicensed spectrum operation.

For type-1 HARQ-ACK codebook, which is the typical codebook type implemented in practical network, we do NOT support to deprioritize. In addition, the spec efforts could be minor considering the HARQ timing indicator is agreed as a common information to all the co-scheduled cells.

11 – Qualcomm Incorporated

We do not think that Type-1 HARQ-ACK codebook itself should be excluded. As pointed out in [2], support of Type-1 HARQ-ACK codebook would require a significant effort only if it was together with different SCS/carrier types/duplex modes for co-scheduled cells by a DCI format. However, this should not mean that the whole Type-1 HARQ-ACK codebook has to be excluded when multi-cell scheduling for some of the carriers of CA configuration is configured.

Instead of excluding Type-1 HARQ-ACK codebook, we propose that RAN should provide a guidance to RAN1 according to the following: **Case 2-1/Case 2-2 listed below are supported; and Case 2-3/Case 2-4 listed below are not supported.**

- Case 2-1: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells including the scheduling cell and same carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) is used among all the co-scheduled cells including the scheduling cell.
- Case 2-2: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells not including the scheduling cell and same carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) is used among all the co-scheduled cells which may be same or different carrier type to the scheduling cell.
- Case 2-3: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells including the scheduling cell and different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) is used among the co-scheduled cells including the scheduling cell.
- Case 2-4: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells not including the scheduling cell and different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) is used among the co-scheduled cells.

We are OK with deprioritizing enhanced Type-2 HARQ-ACK codebook, if supporting it would make specific optimizations necessary.

12 – CATT

We are not fine to exclude Type-1 HARQ-ACK codebook which is an unnecessary restriction. We are open to consider further restriction to avoid complicating Type-1 HARQ-ACK codebook design.

We are fine to exclude eType-2 HARQ-ACK codebook.

13 – OPPO

We prefer to keep Type-1 codebook in the scope, at least allowing RAN1 to decide whether/how to proceed with Type-1. On the other hand, we support to de-prioritize the enhanced Type-2 codebook.

14 – vivo Communication Technology

We are fine with the proposal considering the limited TU. Type-1 HARQ-ACK codebook would require large efforts especially for mixed SCS case, but it would require less effort for same SCS case thus we are also fine with the proposal from Samsung.

15 – Intel Deutschland GmbH

We think it is essential to support Type 1 HARQ-ACK CB for multi-cell scheduling. Our view is that additional spec impact on the support of Type 1 HARQ-ACK CB for multi-cell scheduling can be minor, at least for same SCS case.

We are fine to deprioritize enhanced Type-2 HARQ-ACK codebooks

16 – New H3C Technologies Co.

we are fine with this proposal.

17 – HUAWEI TECHNOLOGIES Co. Ltd.

In general, we think it is better to leave to WG discussions to decide whether/how to specify this kind of detailed feature, instead of discussing in RAN here, since the decision should be based on detailed discussion on the pros and cons depending on what mechanisms to adopt.

If we really want to do some discussion here, we don't agree to do down-scoping of Type-1 HARQ-ACK codebook.

1. Type 1 HARQ-ACK codebook is supported since Rel-15 and it is more robust compared to other codebook type, so not good to preclude it directly.

2. Additional work load can be minimized since there is way to adopt simpler solution to address the SLIV pruning issue.

We are fine to do down-scoping of enhanced Type-2 HARQ-ACK codebook, since enhanced Type-2 HARQ-ACK codebook is mainly for unlicensed, and as reply to proposal 4.1 even unlicensed itself will be deprioritized and thus ok not to do the optimization for HARQ-ACK codebook for it.

18 – MediaTek Inc.

We support the Proposal 4.2 as we do not see strong necessity to support Type-1 and enhanced Type-2 HARQ-ACK codebooks for this feature.

19 – China Mobile Com. Corporation

We prefer to keep Type-1 HARQ-ACK codebooks for the multi-cell PUSCH/PDSCH scheduling in Rel-18. As one type of typical HARQ-ACK codebook applied to practical scenarios, Type-1 HARQ-ACK codebook is more robust compared to dynamic HARQ-ACK codebooks. Besides, Type-1 HARQ-ACK codebook requires less spec effort at least for the same SCS case according to most company's opinions. And we are fine to deprioritized the enhanced Type-2 HARQ-ACK codebooks.

4.1.3 1st round Feedback for Proposal 4.3

Proposal 4.3

- **Configuring more than one scheduling cell for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

Feedback Form 6: 1st round Feedback form for Proposal 4.3

1 – LG Electronics France

We agree with the proposal

2 – NTT DOCOMO INC.

One clarification question for this proposal; scheduling cell in this proposal intends scheduling cell which transmits DCI format 0_X/1_X and/or legacy DCI format. More specifically, we are fine to support this proposal if the scheduling cell is for DCI format 0_X/1_X, otherwise, we think it is premature to agree on this proposal. In our view, it is beneficial to support self-carrier scheduling by legacy DCI for each co-scheduled cell considering that a UE may not support cross-carrier scheduling by legacy DCI.

3 – Lenovo (Beijing) Ltd

We are supportive of this proposal since this issue is a bit controversial in RAN1. Considering the quite limited TU in Q4, we support this down-scoping.

4 – Nokia Germany

We agree with DOCOMO here.

We support the restriction for a scheduled cell using MC-DCI formats 0_X/1_X, but for the combination of MC-scheduling and single cell scheduling, the single-cell (legacy) DCI format self scheduling should still be supported.

5 – Apple France

We support the proposal. To clarify, we think the restriction on the number of scheduling cells applies to both multi-cell scheduling and single-cell scheduling DCI. This is aligned with the existing CA framework where there is at most one scheduling cell (except for DSS enhancements).

6 – OPPO

We support the proposal, and agree with Apple's comment. The planned TU's do not seem to be sufficient to support the study for a general DSS framework.

7 – Ericsson LM

We suggest following update:

- Configuring more than one scheduling cell **for multi-DCI based scheduling** for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18

With the update we are OK with the proposal.

8 – Spreadtrum Communications

We support the proposal.

9 – Samsung Electronics Co.

We support the proposal and agree with comments from Apple. We can consider the following clarification:

− **Configuring more than one scheduling cell for each scheduled cell, for any DCI format, is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18**

Also, similar to the views by Lenovo and OPPO, we think that the allocated TUs to also support multiple scheduling cells for a scheduled cell are not sufficient, the feature is not essential for multi-cell scheduling, and a use-case is not clear (a UE/gNB directly support cross-carrier scheduling if the UE/gNB support multi-cell scheduling).

10 – ZTE Corporation

We have similar comment in general as for Proposal 4.1 above.

For Proposal 4.3, we agree with DOCOMO/Nokia/Ericsson, and support the update from Ericsson.

11 – Qualcomm Incorporated

We do not support the proposal. We agree with DOCOMO that there are cases where configuring more than one scheduling cell for each scheduled cell offers significant benefits (in particular for FR1-FR2 CA). Such scenarios/solutions should not be excluded by RAN.

12 – CATT

We are fine with the proposal.

13 – Intel Deutschland GmbH

We are fine with the proposal.

14 – New H3C Technologies Co.

we are fine with this proposal.

15 – HUAWEI TECHNOLOGIES Co. Ltd.

In general, we think it is better to leave to WG discussions to decide whether/how to specify this kind of detailed feature, instead of discussing in RAN here, since the decision should be based on detailed discussion on the pros and cons depending on what mechanisms to adopt.

Specially, we don't agree with proposal 4.3 here.

1. The difference for single DCI compared to legacy DCI is that it will schedule PDSCH for multiple cells, therefore it is expected that the impact would be much more serious if single DCI cannot be transmitted. Therefore, if the PDCCH resources on scheduling cell are congested, multiple cells may fail to be scheduled. Allowing more than one scheduling cell can reduce the impact much.

2. Regarding the concern on the additional work load, RAN1 can try to minimize it by reusing some existing mechanism as much as possible, e.g. reuse R17 SCell schedule PCell for the case of scheduling single DCI and legacy DCI in different cell, and reuse self-scheduling mechanisms for monitoring single DCI on multiple cells.

16 – MediaTek Inc.

We support Proposal 4.3, and agree with Apple's comment that this is aligned with the existing CA framework where there is at most one scheduling cell (except for DSS enhancements).

17 – China Mobile Com. Corporation

We are fine with the updated proposal from Ericsson, configuring more than one scheduling cell for DCI format 0_X/1_X for each scheduled cell should not be supported.

18 – LG Uplus

We support proposal 4.3. However, we could study the benefit of multi-cell scheduling later.

4.1.4 1st round Feedback for Proposal 4.4

Proposal 4.4

- **New PDCCH monitoring limits compared to Rel-17 is not introduced for the multi-cell PUSCH/PDSCH scheduling in Rel-18, and UE's blind decoding budget is not changed from Rel-17 to support the multi-cell PUSCH/PDSCH scheduling.**

Feedback Form 7: 1st round Feedback form for Proposal 4.4

1 – NTT DOCOMO INC. Support this proposal.
2 – Lenovo (Beijing) Ltd Two clarification questions: (1) What does **New PDCCH monitoring limits** mean here? (2) Does "UE's blind decoding budget" imply UE's blind decoding budget per scheduled cell?
3 – Apple France Even though we may be fine with the principle intended in the proposal, we feel the proposal is a bit unclear in the context of the options being proposed so far. There have been different proposals on how BDs/CCEs are counted (e.g. counted towards the scheduling cell, one or multiple of the scheduled cell, etc), and how BD/CCE limits are applied (per scheduled cell, or other options). It is not clear which options falls within the scope of this proposal, and which options are excluded. We prefer this to be discussed with other details of BD/CCE counting mechanism in RAN1.
4 – OPPO We support the intention, while we do share the views from other companies that the proposal wording needs more clarifications.
5 – Nokia Germany We agree with the intention of the proposal, but as others commented already some further clarifications may be needed. Therefore, as Apple suggested, better to be handled in RAN1 when discussing on how to count the BD/CCE limits.
6 – Ericsson LM No need for RAN to agree to above proposal. This should be discussed in RAN1. MC-DCI scheduling introduces new DCI sizes and consequently additional BD candidates and how to account for them must be worked out at WG level.
7 – Samsung Electronics Co. We support the proposal. There is no need to change the Rel-17 PDCCH monitoring limits due to multi-cell scheduling (i.e., same M^max,slot,u_PDCCH, C^max,slot,u_PDCCH, M^total,slot,u_PDCCH, and

C^total,slot,u_PDCCH as in Rel-17 – no new UE hardware capabilities for multi-cell scheduling). Then, the proposal may be simplified as follows:

~~New PDCCH monitoring limits compared to Rel-17 is not introduced for the multi-cell PUSCH/PDSCH scheduling in Rel-18, and~~ UE's blind decoding budget per scheduled/scheduling cell is not changed from Rel-17 to support the multi-cell PUSCH/PDSCH scheduling.

Also, OK to continue discussion in RAN1, together with how to count BD/CCE towards the limits, if a majority prefers so.

8 – ZTE Corporation

We have similar comment in general as for Proposal 4.1 above.

For Proposal 4.4, we suggest to continue the discussion in RAN1 considering the detailed scheme for DCI size and BD/CCE budget is not clear yet.

9 – Qualcomm Incorporated

We agree with other companies that the proposal is quite unclear. We think RAN1 should discuss all the details including BD/CCE budget, DCI size budget, and UE behavior of handling them.

10 – CATT

We agree with the intention of the proposal and also think some rewording would be needed.

11 – vivo Communication Technology

We are fine with the direction but the proposal is not clear. We think more discussions are needed in RAN1.

12 – Intel Deutschland GmbH

We somehow understand the intention but share similar view as other companies that more clarification is needed on the proposal.

13 – New H3C Technologies Co.

we are fine with this proposal

14 – MediaTek Inc.

We think Proposal 4.4 is not clear enough as the BD/CCE counting logic of Rel-18 multi-carrier scheduling can be quite different from Rel-17 and before. For Rel-17 and before, the BD/CCE limit is counted on each scheduled cell since the scheduling of each cell is independent while now the scheduling of multiple cells is combined into one DCI. We hence want to echo with Apple/Nokia/Ericsson that we prefer this to be further discussed in RAN1.

15 – HUAWEI TECHNOLOGIES Co. Ltd.

We are fine with no new PDCCH monitoring limits compared to Rel-17 considering indeed it would introduce much additional work. However, it is not clear to us whether the last part of the proposal "**and UE's blind decoding budget is not changed from Rel-17 to support the multi-cell PUSCH/PDSCH scheduling**" is acceptable or not, depending on what does "UE's blind decoding budget" mean here, does it mean the maximum number of CCE/PDCCH candidates? With this last sentence, does it mean how to count the BD/CCE cannot be changed also?

16 – China Mobile Com. Corporation

We support the intention of the proposal, the total BD/CCE budget should not be changed in order not to impact UE's capability. And we are fine to further discuss BD/CCE budget together with the mechanism of BD/CCE counting in RAN1.

4.1.5 1st round Feedback for Proposal 4.5

Proposal 4.5

Companies are encouraged to provide any other potential down-scoping proposal or proposal making further progress for the multi-cell PUSCH/PDSCH scheduling if any.

Feedback Form 8: 1st round Feedback form for Proposal 4.5

1 – NTT DOCOMO INC.

If no optimization is required even if SCell schedules multiple cells including P(S)Cell, we are fine to support such scenario, otherwise, it should be precluded from the WI scope in Rel-18.

2 – Lenovo (Beijing) Ltd

From our side, we think below aspects can be considered for further down-scoping:

(1) Different SCS among co-scheduled cells is not supported.

(2) Simultaneous configuration of multi-cell PDSCH scheduling and multi-PDSCH scheduling.

3 – Apple France

We think the following can be de-prioritized:

- simultaneous configuration of multi-cell scheduling and multi-slot scheduling for the same or different cell within a PUCCH group

- simultaneous configuration of multi-cell scheduling and multi-TRP for a scheduled cell

4 – OPPO

Agree with Apple's down-scoping list.

5 – Nokia Germany

The following could be de-prioritized:

- different SCS / mixed numerology (see Lenovo above, still FFS in RAN1)
- multi-PDSCH scheduling (see Lenovo & Apple above)
- support for sidelink scheduling (for DCI format 1_X)
- support for SUL (for DCI format 1_X)

6 – Nokia Germany

Nokia update - M-TRP missing from the list (as Apple & OPPO pointed out), so our full list would be:

- different SCS / mixed numerology (as noted by Lenovo , still FFS in RAN1)
- multi-PDSCH scheduling (as by Lenovo, Apple & OPPO above)
- multi-TRP support (as noted by Apple, OPPO)
- support for sidelink scheduling (for DCI format 1_X)
- support for SUL (for DCI format 1_X)

7 – Ericsson LM

We propose to focus the design on the case where the co-scheduled cells have the same SCS.

8 – Spreadtrum Communications

We support to deprioritize the following list

- different SCS / mixed numerology
- multi-PDSCH scheduling
- multi-TRP support

9 – Samsung Electronics Co.

Support the latest update from Nokia. An editorial suggestion is to change “multi-PDSCH scheduling” to “multi-slot PDSCH or PUSCH scheduling”. Also, to avoid ambiguity, prefer to use the wording from Apple, and “simultaneous configuration of…” can be replaced by “configuration of both …”.

10 – ZTE Corporation

We support the following list to be de-prioritizied from Nokia. In addition, two-stage DCI should also be precluded.

- multi-TRP support (as noted by Apple, OPPO)
- support for sidelink scheduling (for DCI format 1_X)
- support for SUL (for DCI format 1_X)

11 – Qualcomm Incorporated

As described in our comment to 4.1.3, Case 2-3/Case 2-4 below should not be supported.

- Case 2-3: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells including the scheduling cell and different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) is used among the co-scheduled cells including the scheduling cell.
- Case 2-4: A DCI format 0-X/1-X on a scheduling cell can schedule multiple cells not including the scheduling cell and different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) is used among the co-scheduled cells.

12 – vivo Communication Technology

We think the following aspects can be further down-scoping:

(1) sScell scheduling Pcell. There are two scheduling cells for Pcell when sScell scheduling Pcell is configured, which is contradictory with proposal 4.3 of supporting only one scheduling cell. Even if two scheduling cells can be considered in R18 mc, if this feature is combined with mc-scheduling on a Scell, there will be 3 PDCCH sources for scheduling Pcell, i.e., legacy DCI on Pcell for self-scheduling, legacy DCI on sScell to schedule Pcell and mc-DCI on sScell to schedule Pcell, additional work is inevitable in R18 mc-scheduling. Considering the limited TU, we suggest precluding sScell scheduling Pcell.

(2) Different SCS among co-scheduled cells is not supported (same proposal as Lenovo)

(3) Simultaneous configuration of multi-cell scheduling and multi-slot scheduling. (same proposal as Apple)

13 – MediaTek Inc.

We support the last update from Nokia to preclude "different SCS/multi-slot scheduling/multi-TRP/Sidelink/SUL" for this feature.

14 – China Mobile Com. Corporation

We agree with the down-scope list form Apple.

- multi-slot PDSCH/PUSCH scheduling
- multi-TRP for a scheduled cell

15 – CableLabs

We support Nokia suggestion

4.2 Initial round summary

Based on the initial round discussion, companies' views could be summarized as below.

- For Proposal 4.1
  - Support the proposal: DOCOMO, Lenovo, Vodafone, Apple, OPPO, Nokia, Ericsson, Spreadtrum, Samsung, ZTE, CATT, vivo, Intel, New H3C, Huawei, MediaTek, LG Uplus, CMCC, China Unicom, CableLabs (19)

    - Even fine with stronger proposal to deprioritize (i.e., do not support) unlicensed spectrum operation (Nokia, Spreadtrum, Samsung, vivo, Intel, MediaTek, CableLabs)
    - The proposal does not imply the feature is not supported for operation on unlicensed, while any optimization is deprioritized (Ericsson)
    - Suggest to first discuss whether any down-scoping is needed for multi-cell scheduling (ZTE, Huawei)
  - Not support the proposal: LG
    - Additional specification workload is limited compared to its benefits for unlicensed
  - Modify the proposal: Qualcomm
    - Deprioritize any optimization for designing a DCI format for unlicensed spectrum for multi-cell PUSCH/PDSCH scheduling in Rel-18 (Qualcomm)

Based on above, it seems majority of companies agree to deprioritize any optimization for unlicensed spectrum operation for designing the multi-cell PUSCH/PDSCH scheduling in Rel-18. In addition, many companies would share the concern on limited TUs and would see the necessity of down-scoping for multi-cell scheduling. Although there are several companies who are fine to not support unlicensed spectrum operation in Rel-18, there are other multiple companies who are fine to just deprioritize optimization for unlicensed such as in DCI design. Therefore, the moderator would like to suggest agreeing on the proposal 4.1 as it is or modified proposal suggested by Qualcomm.

Updated proposal 4.1:

- **Alt.1: Deprioritize any optimization for unlicensed spectrum operation for designing the multi-cell PUSCH/PDSCH scheduling in Rel-18.**
- **Alt.2: Deprioritize any optimization for designing a DCI format for unlicensed spectrum operation for multi-cell PUSCH/PDSCH scheduling in Rel-18.**

- For Proposal 4.2
  - Support the proposal: DOCOMO, Lenovo, Apple, Nokia, Ericsson, Spreadtrum, vivo, New H3C, MediaTek (9)
    - Also fine with the proposal from Samsung (vivo)
  - Not support the proposal for Type-1 HARQ codebook (but ok for enhanced Type-2 HARQ codebook): LG, Samsung, ZTE, Qualcomm, CATT, OPPO, Intel, Huawei, CMCC (9)
    - Exclude at least for different SCS for co-scheduled cells (Samsung)
    - Required spec effort is minor in case of same SCS/carrier type

        - Suggest to first discuss whether any down-scoping is needed for multi-cell scheduling (ZTE)
        - Instead of excluding type 1, case 2-3/2-4 should be excluded (Qualcomm)

Based on above, all companies would be ok to exclude enhanced Type-2 HARQ codebook, while there are multiple companies suggesting to not exclude Type-1 HARQ codebook. The companies argued that required spec effort is minor unless mixed SCS/carrier type/duplex modes for co-scheduled cells by a DCI format is considered. Correspondingly, some companies proposed to exclude Type-1 HARQ codebook only for such mixed case or to exclude such mixed case itself. Therefore, the moderator would like to provide the updated proposal below for intermediate round discussion.

Updated proposal 4.2:

- **Enhanced Type-2 HARQ-ACK codebook is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**
- **Type-1 HARQ-ACK codebook is supported only for the case where co-scheduled cells by a DCI format 1_X have same SCS/carrier type/duplex mode.**

- For Proposal 4.3
    - Support the proposal: LG, Lenovo, Apple, OPPO, Spreadtrum, Samsung, CATT, Intel, New H3C, MediaTek, LG Uplus (11)
        - Clarify that the proposal is for any DCI format (Samsung)
    - Not support the proposal: DOCOMO, Nokia, Ericsson, ZTE, Qualcomm, Huawei, CMCC (7)
        - It is beneficial to configure different scheduling cell for DCI 0_X/1_X and for legacy DCI format
        - It is ok if the proposal is updated as "configuring more than one scheduling cell for multi-cell DCI based scheduling" for each scheduled cell is not supported" (Ericsson, ZTE, CMCC)
        - Impact for multiple scheduling cells can be minimized by reusing some existing mechanisms such as R17 SCell scheduling PCell (Huawei)

Based on above, it seems all companies are fine with the proposal at least for DCI 0_X/1_X, while there are different views on configuring different scheduling cell for DCI 0_X/1_X and for legacy DCI format. In addition, there are comments on how to minimize the effort to support configuring different scheduling cell for DCI 0_X/1_X and for legacy DCI format, such as reusing Rel-17 SCell to PCell scheduling and limiting the scheduling cell for legacy DCI format to self-carrier when configuring different scheduling cell for DCI 0_X/1_X and for legacy DCI format. Therefore, the moderator would like to check whether the updated proposal below can address the workload concern while supporting beneficial operation. If 2nd bullet is not acceptable, only 1st bullet can be agreed and further discussion in WG is necessary for 2nd bullet point.

Updated proposal 4.3:

- **Configuring more than one scheduling cell for DCI format 0_X/1_X for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**
- **Configuring one scheduling cell for DCI format 0_X/1_X for each scheduled cell while configuring another scheduling cell for legacy DCI format for each scheduled cell is supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18 with following condition.**
    - **Scheduling cell for legacy DCI format for each scheduled cell is limited to either self-carrier or the same scheduling cell as for DCI format 0_X/1_X**

- For Proposal 4.4
    - Support the proposal: DOCOMO, Samsung, New H3C (3)
        - There is no need to change Rel-17 PDCCH monitoring limits i.e., same M^max,slot,u_PDCCH, C^max,slot,u_PDCCH, M^total,slot,u_PDCCH and C^total,slot,u_PDCCH as in Rel-17
        - Proposal can be simplified to "UE's blind decoding budget per scheduled/scheduling cell is not changed from Rel-17" (Samsung)
    - Support the intension, but …: Apple, OPPO, Nokia, CATT, vivo, Intel, Huawei, CMCC (8)
        - It is not clear which options are excluded
        - Rewording/clarification are necessary
        - RAN1 discussion is preferable
    - Not support the proposal: Lenovo, Ericsson, ZTE, Qualcomm, MediaTek (5)
        - What does "new PDCCH monitoring limits" mean?
        - What does "UE's blind decoding budget" mean? Does it imply UE's blind decoding budget per scheduled cell? Does it mean the maximum number of CCE/PDCCH candidates? Does it mean how to count the BD/CCE cannot be changed?
        - It should be discussed in RAN1

Based on above, it seems more clarification for the proposal is at least necessary, and there are already many companies who prefer to discuss this proposal in RAN1. Given this situation, the moderator thinks the proposal 4.4 can be dropped at this meeting for further discussion in RAN1.

- For Proposal 4.5
    - No optimization or excluding for the case where SCell schedules multiple cells including P(S)Cell: DOCOMO, vivo (2)

- Different SCS among co-scheduled cells is excluded: Lenovo, Nokia, Ericsson, Spreadtrum, Samsung, vivo, MediaTek, CableLabs (8)
- Configuration of both multi-cell PDSCH scheduling and multi-slot PDSCH scheduling is excluded: Lenovo, Apple, OPPO, Nokia, Spreadtrum, Samsung, vivo, MediaTek, CMCC, CableLabs (10)
- Configuration of both multi-cell scheduling and multi-TRP for a scheduled cell is excluded: Apple, OPPO, Nokia, Spreadtrum, Samsung, ZTE, MediaTek, CMCC, CableLabs (9)
- Support for sidelink scheduling for DCI format 1_X is excluded: Nokia, Samsung, ZTE, MediaTek, CableLabs (5)
- Support for SUL for DCI format 0_X is excluded: Nokia, Samsung, ZTE, MediaTek, CableLabs (5)
- Different carrier type among co-scheduled cells is excluded: Qualcomm (1)

Based on above, there are 7 additional proposals for potential down-scoping and it is worth checking whether there is any concern/objection for each proposal in the next round discussion.

Updated proposal 4.5:

- **Followings are excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.**
  - **SCell schedules multiple cells including P(S)Cell**
  - **Different SCS among co-scheduled cells**
  - **Different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) among co-scheduled cells**
  - **Configuration of both multi-cell PDSCH scheduling and multi-slot PDSCH scheduling for the same or different cell within a PUCCH group**
  - **Configuration of both multi-cell PDSCH/PUSCH scheduling and multi-TRP for a scheduled cell**
  - **Support for sidelink scheduling for DCI format 1_X**
  - **Support for SUL for DCI format 0_X**

4.3 Intermediate round discussion

The moderator would like to ask companies to provide feedback if any on the initial round summary and following updated proposals.

4.3.1 2nd round Feedback for Proposal 4.1

Updated proposal 4.1:

- **Alt.1: Deprioritize any optimization for unlicensed spectrum operation for designing the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

– **Alt.2: Deprioritize any optimization for designing a DCI format for unlicensed spectrum operation for multi-cell PUSCH/PDSCH scheduling in Rel-18.**

Feedback Form 9: 2nd round Feedback form for updated proposal 4.1

1 – Apple France

In our view, Alt 2 is a bit ambiguous because it is difficult to say what is considered as optimization and what is not, so it may not provide much guidance to RAN1 as expected. We think the main work load related to unlicensed operation is the handling related to LBT operation. How to handle LBT will need to be discussed/decided if we decide to support it. There can be different options, and it is not clear which is considered as baseline and which is considered optimization. In this sense, we do not think deprioritizing optimization help RAN1 much. If RAN plenary is to make a decision to down-scope, it is better to be either support or not support unlicensed operation. In addition, if we do not support enhanced Type-2 HARQ-ACK codebook as in Proposal 4.2, this also makes unlicensed spectrum operation crippled. So we should be consistent in our decision.

2 – Samsung Research America

Prefer Alt-1. The concern with Alt-2 is that it may still not avoid non-trivial RAN1 discussions. We are OK to revisit scheduling on unlicensed spectrum during maintenance if straightforward to support.

3 – Samsung Research America

Prefer Alt-1. The concern with Alt-2 is that it may still not avoid non-trivial RAN1 discussions. We are OK to revisit scheduling on unlicensed spectrum during maintenance if straightforward to support.

4 – OPPO

We support Alt-1, and share the same thinking as Apple on Alt-2. Maybe the proponents of Alt-2 can clarify what part of unlicensed spectrum operation, except those in DCI format and HARQ-ACK codebook, is essential to one DCI scheduling multiple cells and therefore deserves the extra WG efforts.

5 – Qualcomm Incorporated

We support Alt.2. Given that concern was the additional DCI formats, once additional work on those formats is set aside, we don't know what concern remains. This is about scheduling multiple cells, unclear what the concern form Apple and Samsung is. Perhaps the companies with concerns could add some background regarding those.

Then regarding the question from OPPO, if we understood the question correctly, our response is the following. One scenario of interest is cross-carrier scheduling of UL. Given that sending the UL grant and sending the UL both have to go through LBT in unlicensed, there is a 'double point of failure'. Therefore, traditionally it has been seen beneficial to enable cross-carrier scheduling unlicensed UL from a licensed carrier. This way, at least the UL grant can be sent without depending on LBT. Given that the wide bandwidth available in unlicensed often calls for multi-CC UL operation, this would mean cross-carrier scheduling of multiple UL CCs, which directly fits with the currently discussed objective in our view.

6 – New H3C Technologies Co.

we support alt.1

7 – Spreadtrum Communications

We support Alt 1. Due to LBT mechanism, it is very hard to do multi-carrier scheudling on multiple unlicensed carriers.

8 – Lenovo (Beijing) Ltd

We prefer Alt 1.

For Alt 2, we agree the use case of using a DCI on licensed cell to schedule multiple cells including both licensed cells and unlicensed cells or unlicensed cells only is very useful and important especially considering there are wide bandwidth in unlicensed spectrum. This point is also reflected in our RAN1 contributions.

What we are a bit worry about is LBT type, CAPC and CPE indication in DCI format 0_X design for multiple unlicensed cells as well as possible multi-channel operation and CWS adjustment. We can't estimate how much standardization effort it needs in RAN1.

Since only 0.5TU is allocated for the whole Rel-18 MCE in Q4, it is reasonable to deprioritize any optimization in DCI format for unlicensed spectrum in Q4 2022 and consider unlicensed spectrum operation in maintenance phase if the support of unlicensed spectrum requires minor standardization effort.

9 – NTT DOCOMO INC.

We tend to agree with Apple. We prefer Alt.1 but also fine not to support unlicensed operation at all to avoid the additional discussion for sure, e.g., DCI field, enhanced type 2 HARQ-ACK codebook and/or channel access related discussion.

10 – Intel Deutschland GmbH

We prefer Alt.1. For the support of multi-cell scheduling under unlicensed spectrum, we may also need to avoid any optimization of the unlicensed operation, e.g., LBT, on top of DCI format design. As mentioned in the first round, we can also consider not to support multi-cell scheduling for unlicensed spectrum.

11 – vivo Communication Technology

We prefer alt1, as we understand the impact due to unlicensed band operation is not limited to DCI design aspects only.

12 – ZTE Corporation

Prefer Alt 1. Alt 2 still requires extra discussion in RAN1, and we agree with Apple that Alt 2 needs further clarification about what should be optimized and what is not.

13 – Nokia Germany

We prefer Alt. 1, following the Apple arguments.

14 – LG Electronics France

We understand Alt.2 doesn't mean a DCI format will not support unlicensed spectrum but it means optimization will be deprioritized. Under this understanding, we can agree with alt.2

15 – HUAWEI TECHNOLOGIES Co. Ltd.

We prefer Alt.1, which is clearer and includes Alt.2 also. Alt.2 is not really helpful if limited TU is really the concern. From standard effort perspective, DCI design is only one of the aspects and not the main aspect if unlicensed needs to be considered also.

16 – MediaTek Inc.

We prefer Alt. 1, but can also live with Alt. 2.

17 – VODAFONE Group Plc

Prefer Alt. 1

18 – VODAFONE Group Plc

Prefer Alt. 1

19 – CATT

We still prefer Alt. 1 to make sure the overall workload is manageable.

20 – Ericsson LM

We are supportive of Alt 1. **Note that Alt 1 implies that the DCI includes the field for channel access procedures similar to the legacy DCI.**

In our view, the specification already supports transmission on multi-carriers/cells in form of CA or Wideband operation. Including the field in DCI for indicating the channel access procedures similar to legacy should be sufficient. Whether the LBT fails or not on any of the cells, is a known issue and has been addressed how to be handled since Rel-16 and it is a new topic that needs different handling, or a reason for exclusion.

21 – CableLabs

We prefer Alt 1

22 – China Mobile Com. Corporation

We prefer Alt 1. Considering Alt 2, limiting DCI design alone for unlicensed spectrum operation still needs extra discussion in RAN1.

4.3.2 2nd round Feedback for Proposal 4.2

Updated proposal 4.2:

- **Enhanced Type-2 HARQ-ACK codebook is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**
- **Type-1 HARQ-ACK codebook is supported only for the case where co-scheduled cells by a DCI format 1_X have same SCS/carrier type/duplex mode.**

Feedback Form 10: 2nd round Feedback form for updated proposal 4.2

1 – Nokia Germany

We fully support the 1st bullet.

On the second bullet, there could still be cases that could create issues with the agreed HARQ-ACK timing (of the reference PDSCH) and PDSCH scheduled on other cells e.g. for sub-slot based PUCCH configuration (creating similar issues as different SCS). So to be on the save side, maybe it would be possible to rule out / down-prioritize different SCS/ different carrier type / different duplex mode here and check carefully the remaining cases (where some further restrictions may be required). So we suggest the 2nd bullet to be reworded as the inverse / negative statement:

*Type-1 HARQ-ACK codebook is **not** supported ~~**only**~~ for the case where co-scheduled cells by a DCI format 1_X have ~~**samea**~~ **different** SCS/carrier type/duplex mode **in Rel-18**.*

2 – Apple France

We are fine with the first bullet. We would still prefer to not support Type-1 HARQ-ACK codebook due to very limited remaining time and focus on just dynamic HARQ-ACK codebook.

3 – Samsung Research America

Fine with the proposal. Can also accept the update from Nokia.

4 – OPPO

We are fine with the proposal from moderator. The revision from Nokia looks better for a RANP decision, since it still leaves a chance for RAN1 to decide whether to support Type-1 HARQ codebook for the case with the same SCS/carrier type/duplex mode (we hope RAN1 can do so), to make the whole proposal a bit closer to Apple's position.

5 – New H3C Technologies Co.

we are fine with this proposal with Nokia modificaiton

6 – Qualcomm Incorporated

We can accept the moderator's proposal.

Regarding the change proposed by Nokia, we would prefer to keep the original 'positive' formulation to make it clear what is being agreed to be done. But we think Nokia has a good point, which should be addressed. We think that the following addition, if acceptable, could achieve that:

”co-scheduled cells by a DCI format 1_X have same SCS/carrier type/duplex mode/ PDSCH/PUSCH mapping type”

7 – Spreadtrum Communications

We prefer to exclude Type-1 HARQ-ACK codebool, since two main issues of Type-1 HARQ-ACK codebook for multi-carrier scheduling is K1 set and SLIV rows. They are not released much even under same SCS/carrier type/duplex.

For progress, we can live with Nokia’s version and leave the decision of type-1 HARQ-ACK CB to RAN1.

8 – CATT

We are fine with the proposal. We also prefer the positive statement as in the current proposal. To address the comments from Nokia, maybe we can add an FFS additional restriction.

9 – NTT DOCOMO INC.

[Moderator]

2nd bullet will be updated as below.

Type-1 HARQ-ACK codebook is supported only for the case where co-scheduled cells by a DCI format 1_X have same SCS/carrier type/duplex mode in Rel-18.

[Additional restriction(s) can be discussed in RAN1]

10 – NTT DOCOMO INC.

[Moderator]

2nd bullet will be updated as below.

Type-1 HARQ-ACK codebook is supported only for the case where co-scheduled cells by a DCI format 1_X have same SCS/carrier type/duplex mode in Rel-18.

[Additional restriction(s) can be discussed in RAN1]

11 – Lenovo (Beijing) Ltd

We support the first bullet.

For the second bullet, we support the revision of Nokia.

Whether to support Type-1 HARQ-ACK codebook for same SCS/carrier type/duplex can be discussed in RAN1.

12 – vivo Communication Technology

Support the 1st bullet of the proposal, and we are fine with Nokia’s updates on the 2nd bullet.

13 – NTT DOCOMO INC.

We support this proposal and also agree with Nokia’s point that there still exists some possibility which may require additional discussion for type1 HARQ-ACK codebook. So we are also fine with Nokia’s revision.

14 – NTT DOCOMO INC.

We support this proposal and also agree with Nokia's point that there still exists some possibility which may require additional discussion for type1 HARQ-ACK codebook. So we are also fine with Nokia's revision.

15 – Intel Deutschland GmbH

In general, we are fine with the proposal 4.2.

For the support of Type 1 HARQ-ACK codebook, this highly depends on the discussion on scheduling restriction in Proposal 4.5. If RAN agree not to support different SCS, or different carrier types (or only support licensed spectrum), the second bullet can be simply updated as "Type-1 HARQ-ACK codebook is supported for multi-cell PUSCH/PDSCH scheduling in Rel-18."

Further, for duplex mode, our view is that Type-1 HARQ-ACK codebook can be supported without optimization even for mixed TDD/FDD scenario.

16 – ZTE Corporation

We support the proposal, and also fine with moderator's further update on the second bullet.

For Type-1 HARQ-ACK codebook, we prefer to at least agree to support for the most typical cases. Nokia's update may make the proposal meaningless considering it has already proposed to preclude co-scheduled cells with a different SCS/carrier type/duplex mode in Proposal 4.5.

17 – LG Electronics France

We are fine with the 1st sentence but NOT fine with the 2nd sentence since the extension of K1/SLIV set (as done for R17 multi-PDSCH scheduling) would, anyhow, be necessary even for the case with same SCS/carrier type/duplex mode.

Given that, there is no reason to limit the usage of Type-1 CB since it is basic codebook type and beneficial to reduce the increase of multi-cell DCI overhead, compared to Type-2 CB requiring DAI signaling overhead in multi-cell DCI.

18 – HUAWEI TECHNOLOGIES Co. Ltd.

We are fine with the updated proposal 4.2, although as we replied in the first round this can be up to WG discussions.

Regarding the issue raised by Nokia on type-1 HARQ-ACK codebook, if really needed we think the updated version from the moderator is sufficient, i.e. whether any other restriction needed can be up to RAN1 discussions.

19 – MediaTek Inc.

We support the 1st bullet. For the 2nd bullet, we prefer Nokia's version but can also accept moderator's version.

20 – Ericsson LM We support 1st bullet and 2nd bullet (we are fine with the updates from Nokia).
21 – CableLabs Okay with the proposals
22 – China Mobile Com. Corporation We support the 1st bullet of the proposal, and for the 2nd bullet, we can live with Nokia's updates on the proposal.
23 – China Mobile Com. Corporation We support the 1st bullet of the proposal, and for the 2nd bullet, we can live with Nokia's updates on the proposal.

4.3.3 2nd round Feedback for Proposal 4.3

Updated proposal 4.3:

- **Configuring more than one scheduling cell for DCI format 0_X/1_X for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**
- **Configuring one scheduling cell for DCI format 0_X/1_X for each scheduled cell while configuring another scheduling cell for legacy DCI format for each scheduled cell is supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18 with following condition.**
  - **Scheduling cell for legacy DCI format for each scheduled cell is limited to either self-carrier or the same scheduling cell as for DCI format 0_X/1_X**

Feedback Form 11: 2nd round Feedback form for updated proposal 4.3

1 – Apple France We are not fine with the 2nd its sub-bullet. As commented in the initial round, we think that the restriction on the number of scheduling cells applies to both multi-cell scheduling and single-cell scheduling DCI. We don't see the need to relax the restriction and moreover, with very limited remaining time, we should avoid adding such cases.
2 – Samsung Research America We are OK with the first bullet, but we cannot accept the second bullet. We do not understand how the moderator could propose the second bullet based on the input from the first round – if anything, the opposite proposal should have been made. In any case, the second bullet is a

material up-scoping of the WI and is not agreeable at this time.

We would like to make again our previous suggestion. If not possible to agree, the issue should be left to RAN1 for further discussion of whether to support, including for the corresponding specification impact.

− Configuring more than one scheduling cell for any DCI format ~~0_X/1_X~~ for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.

~~Configuring one scheduling cell for DCI format 0_X/1_X for each scheduled cell while configuring another scheduling cell for legacy DCI format for each scheduled cell is supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18 with following condition.~~

~~Scheduling cell for legacy DCI format for each scheduled cell is limited to either self-carrier or the same scheduling cell as for DCI format 0_X/1_X~~

3 – OPPO

We are ok to the 1st bullet, but not the 2nd one. In our view, the 2nd bullet can be considered as a generalization of Rel-17 DSS, i.e., Rel-17 DSS UE can have only PCell to be scheduled by both itself and another sSCell, while moderator's proposal seems to say Rel-18 UE can have multiple cells like PCell in Rel-17 DSS. This looks like a big up-scoping. The spirit of this discussion is intended for down-scoping, so we agree with other companies that any up-scoping should not be decided here.

4 – New H3C Technologies Co.

we support 1st bullet

5 – Qualcomm Incorporated

We agree with the moderator's proposal.

In our view, the compromise being made is by taking both the first and second bullets. Therefore we would not agree with taking the first bullet only.

6 – Spreadtrum Communications

We are fine with the 1st bullet, but not the 2nd one considering the limit TU.

7 – Lenovo (Beijing) Ltd

We support the 1st bullet and the 2nd bullet.

For RAN1 progress, we can accept 1st bullet only.

8 – vivo Communication Technology

Support the 1st bullet of the proposal, but we do not support the 2nd bullet. We think the CCS framework where there is only one scheduling cell for each scheduled cell should be used as a baseline especially considering the limited TU. Any extension to allow multiple scheduling cells for a scheduled cell would lead to high UE complexity and additional RAN1 discussion/work. The 2nd bullet can be revised as below or simply removed from the proposal.

Configuring one scheduling cell for DCI format 0_X/1_X for each scheduled cell while configuring another different scheduling cell for legacy DCI format for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18 ~~with following condition~~.

~~Scheduling cell for legacy DCI format for each scheduled cell is limited to either self-carrier or the same scheduling cell as for DCI format 0_X/1_X~~

9 – NTT DOCOMO INC.

We support the moderator's proposal to agree on both 1st and 2nd bullet, but fine to agree on only 1st sub-bullet at this point.

10 – Intel Deutschland GmbH

We are fine with the updated proposal 4.3.

11 – Intel Deutschland GmbH

We are fine with the updated proposal 4.3.

12 – ZTE Corporation

We support the updated proposal 4.3.

For the second bullet, we think it should be supported because there may be minor or no spec impact depending on further discussion in RAN1. For example, if the DCI size and BD/CCE budget of DCI format 0_X/1_X is counted in one of the co-scheduled cells, there is no impact of the DCI size and BD/CCE budget for the other co-scheduled cells. Therefore, the other co-scheduled cells can use legacy scheduling via cross carrier scheduling or self-scheduling.

13 – Nokia Germany

We support both bullets of the updated proposal 4.3.

Similar as ZTE (in this round, above) and HW (in the first round), we think the second bullet to be essential for the operation to enable at least some PDCCH load balancing across serving cells though MC-DCI scheduling combined with single cell (legacy) DCI self-scheduling.

14 – LG Electronics France

We support the 1st bullet but do NOT support the 2nd bullet since it is obviously out of scope (due to no description on such new mechanism with dual scheduling cells in WID) and should be a separate WI considering potential impacts/works.

Basically, we think that legacy cross-CC scheduling should be the prerequisite for R18 multi-cell scheduling since the scheduled cell by multi-cell DCI is, anyhow, to be cross-CC scheduled from the scheduling cell.

So, we propose the following update.

Updated proposal 4.3:

l **Configuring more than one scheduling cell for any DCI format ~~0_X/1_X~~ for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

~~l **Configuring one scheduling cell for DCI format 0_X/1_X for each scheduled cell while configuring another scheduling cell for legacy DCI format for each scheduled cell is supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18 with following condition.**~~

~~**Scheduling cell for legacy DCI format for each scheduled cell is limited to either self-carrier or the same scheduling cell as for DCI format 0_X/1_X**~~

15 – HUAWEI TECHNOLOGIES Co. Ltd.

We support the second bullet but not the first bullet.

Firstly, the second bullet should be supported. From standard effort perspective, as replied in the first round, the specification impact can be minimized by adopting some simple mechanisms, e.g. reusing Rel-17 SCell schedule PCell mechanisms for this case. From benefits perspective, it can avoid the system performance degradation if single DCI cannot be transmitted on the scheduling cell due to blocking. Note that the impact would be much more serious if single DCI cannot be transmitted.

Secondly, we think more than one scheduling cell for DCI format 0_X/1_X for each scheduled cell should be supported also. As replied in the first round, the impact would be much more serious if single DCI cannot be transmitted, since multiple cells may fail to be scheduled. Also the specification impact can be minimized also.

16 – MediaTek Inc.

We are fine with the first bullet, but NOT fine with the second bullet. Same thought as Apple, we think the limit of one scheduling cell for each scheduled cell should be kept, otherwise we do not get a downscope on this issue, but an upscope.

17 – CATT

We are fine with the first bullet but not fine with the second bullet which increases the work in RAN1.

18 – Ericsson LM

We support the 1st bullet.

19 – CableLabs

ok with 1st proposal

20 – China Mobile Com. Corporation

We are fine with the first bullet.

But for the second bullet, it's early to agree on this proposal. If DCI format 0_X/1_X and legacy DCI format(s) simultaneously monitored on different scheduling cells, there are be two scheduling cells for a single scheduled cell at the same time, the BD/CCE limit handling and other issues still need further discussion.

4.3.4 2nd round Feedback for Proposal 4.5

Updated proposal 4.5:

- **Followings are excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.**
  - **SCell schedules multiple cells including P(S)Cell**
  - **Different SCS among co-scheduled cells**
  - **Different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) among co-scheduled cells**
  - **Configuration of both multi-cell PDSCH scheduling and multi-slot PDSCH scheduling for the same or different cell within a PUCCH group**
  - **Configuration of both multi-cell PDSCH/PUSCH scheduling and multi-TRP for a scheduled cell**
  - **Support for sidelink scheduling for DCI format 1_X**
  - **Support for SUL for DCI format 0_X**

Feedback Form 12: 2nd round Feedback form for updated proposal 4.5

1 – Apple France We are fine with listed aspects to be excluded
2 – Samsung Research America Generally OK with the proposal. For the next-to-last bullet, is the intention ”Configuration of a SAI field in DCI format 0_X”?
3 – OPPO We support the exclusion list from the moderator. For the next-to-last bullet, maybe it is good enough to just say ”**Support for <u>any</u> sidelink scheduling ~~for DCI format 1_X~~**”.
4 – New H3C Technologies Co. we are fine with this proposal
5 – New H3C Technologies Co. we are fine with this proposal
6 – Qualcomm Incorporated We are ok with the proposal.

7 – NTT DOCOMO INC.

[Moderator]

2nd last sub-bullet will be updated to ”Support for any sidelink scheduling”.

8 – Lenovo (Beijing) Ltd

We support this proposal and is OK with the update from Moderator.

9 – vivo Communication Technology

Support the proposal in general, but we think an additional sub-bullet could be added to preclude Pcell from using mc-DCI to schedule multiple cells when a Scell is configured to schedule Pcell. Specifically, if this case is allowed, there could be up to 3 sources of PDCCH for scheduling Pcell, i.e., mc-DCI on Pcell, legacy DCI on Pcell and legacy DCI from sScell, which leads to high complexity. Moreover, it also violates the principle agreed in R17 that Pcell cannot schedule other Scell when the sScell scheduling Pcell feature is configured.

Followings are excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.

- **SCell schedules multiple cells including P(S)Cell**
- **Pcell schedules multiple cells by DCI format 0-X/1-X when a sScell is configured to schedule Pcell.**
- **Different SCS among co-scheduled cells**
- **Different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) among co-scheduled cells**
- **Configuration of both multi-cell PDSCH scheduling and multi-slot PDSCH scheduling for the same or different cell within a PUCCH group**

10 – vivo Communication Technology

Please ignore the previous comment as it was not complete.

Support the proposal in general, but we think an additional sub-bullet could be added to preclude Pcell from using mc-DCI to schedule multiple cells when a Scell is configured to schedule Pcell. Specifically, if this case is allowed, there could be up to 3 sources of PDCCH for scheduling Pcell, i.e., mc-DCI on Pcell, legacy DCI on Pcell and legacy DCI from sScell, which leads to high complexity. Moreover, it also violates the principle agreed in R17 that Pcell cannot schedule other Scell when the sScell scheduling Pcell feature is configured.

Followings are excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.

- **SCell schedules multiple cells including P(S)Cell**
- **Pcell schedules multiple cells by DCI format 0-X/1-X when a sScell is configured to schedule Pcell.**

- **Different SCS among co-scheduled cells**
- **Different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) among co-scheduled cells**
- **Configuration of both multi-cell PDSCH scheduling and multi-slot PDSCH scheduling for the same or different cell within a PUCCH group**
- **Configuration of both multi-cell PDSCH/PUSCH scheduling and multi-TRP for a scheduled cell**
- **Support for sidelink scheduling for DCI format 1_X**
- **Support for SUL for DCI format 0_X**

11 – NTT DOCOMO INC.

We are fine with the list for down-scoping in general. We prefer to discuss further for 4th sub-bullet in RAN1, i.e., the simultaneous support of multi-cell scheduling and multi-slot scheduling, but fine to include if we are the only company supporting this feature.

12 – Intel Deutschland GmbH

We are generally fine with the proposal for down-scoping.

For different carrier type, we think mixed FDD and TDD should be supported for multi-carrier scheduling. We do not see additional specification impact to support this as this can reuse the existing CA framework. We are fine not to support different carrier types for licensed or unlicensed, FR1 or FR2-1 or FR2-2.

For Different SCS among co-scheduled cells, we suggest to add ”different SCS among scheduling and co-scheduled cells”

For the simultaneous support of multi-cell scheduling and multi-slot scheduling, we share similar view as NTT DOCOMO and think it is beneficial to support.

13 – ZTE Corporation

We are fine with the proposed list except for the first bullet.

Similar to Rel-17 DSS SCell schedules P(S)Cell, we see clear benefits to support SCell schedules multiple cells including P(S)Cell in DSS scenario. We suggest continuing discussing this aspect in RAN1.

14 – Nokia Germany

We are fine with the proposed list and the moderator update on the sidelink formulation, but as Intel pointed out the combination of TDD and FDD should not create any complications really. So maybe possible to limit the down-scoping to FR1/FR2, licensed or unlicensed - by the following reformulation to the 4th bullet (with removing the FDD / TDD restriction) could be done:

Combination of licensed or unlicensed serving cells, FR1 or FR2-1 or FR2-2 cells among co-scheduled cells

15 – LG Electronics France

Our view is as follows:

SCell schedules multiple cells including P(S)Cell: Support

Different SCS among co-scheduled cells: NOT support. Better to leave it to RAN1 since it is premature before discussing further complexity/impacts by supporting different SCS, compared to same SCS case.

Different carrier type (FDD or TDD, licensed or unlicensed, FR1 or FR2-1 or FR2-2) among co-scheduled cells: We are open to it.

Configuration of both multi-cell PDSCH scheduling and multi-slot PDSCH scheduling for the same or different cell within a PUCCH group: NOT support. Better to leave it to RAN1 since the multi-slot PDSCH scheduling is basic feature in FR2-2 operation, so should not be similarly treated as CBG-based PDSCH.

Configuration of both multi-cell PDSCH/PUSCH scheduling and multi-TRP for a scheduled cell: We are open to it.

Support for sidelink scheduling for DCI format 1_X: We are open to it.

Support for SUL for DCI format 0_X: OK for the case of multi-cell scheduling by DCI 0_X. But, for the case of single-cell scheduling by DCI 0_X, it seems there is no reason to exclude SUL indication even in that case.

16 – HUAWEI TECHNOLOGIES Co. Ltd.

1. We have strong concern on the last bullet to preclude SUL.

There is no extra effort to support this field included in the single-DCI, which is completely different from support of different SCSs, carrier types, mixture of multi-TRP, multi-slot scheduling etc.

Based on the inputs in the first round, we don't see any technical reasons provided to exclude SUL, many companies even just made wrong comments to propose to preclude SUL for DCI format 1_X (DL scheduling).

2. Regarding the third bullet on carrier type, we also think FDD/TDD can be removed.

17 – MediaTek Inc.

We support the proposal. Also fine with the additional exclusion proposed by vivo.

18 – Ericsson LM

We are fine with the down-scoping list by Moderator with updates from Nokia on 3rd sub-bullet by Moderator

19 – China Mobile Com. Corporation

We are generally fine with the proposal for down-scoping.

4.4 Intermediate round summary

Summary of intermediate round feedbacks for the updated proposal 4.1:

- Fine with Alt.1: Samsung, OPPO, New H3C, Spreadtrum, Lenovo, DOCOMO, Intel, vivo, ZTE, Nokia, Huawei, MediaTek, Vodafone, CATT, Ericsson, CableLabs, CMCC (17)
- Fine with Alt.2: Qualcomm, LG, MediaTek (3)
- Neither:
  - Exclude unlicensed spectrum operation support in Rel-18: Apple, DOCOMO, Intel (3)

Moderator's suggestion: Whether Alt.1 can be acceptable to all can be checked quickly.

Alt.1

- **Deprioritize any optimization for unlicensed spectrum operation for designing the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

Summary of intermediate round feedbacks for updated proposal 4.2:

- Fine with the updated proposal 4.2: Samsung, OPPO, Qualcomm, CATT, DOCOMO, Intel, ZTE, Huawei, MediaTek, Ericsson, CableLabs (11)
- Fine with 1st bullet, prefer to continue discussing 2nd bullet in RAN1: Nokia, Samsung, OPPO, New H3C, Spreadtrum, Lenovo, vivo, DOCOMO, LG, MediaTek, Ericsson, CMCC (12)
- Fine with 1st bullet, prefer to exclude Type-1 HARQ-ACK codebook support in Rel-18: Apple (1)

Moderator's suggestion: Whether the updated proposal 4.2 can be acceptable to all can be checked quickly.

- **Enhanced Type-2 HARQ-ACK codebook is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**
- **Type-1 HARQ-ACK codebook is supported only for the case where co-scheduled cells by a DCI format 1_X have same SCS/carrier type/duplex mode in Rel-18.**
  - **Additional restriction(s) can be discussed in RAN1**

Summary of intermediate round feedbacks for the updated proposal 4.3:

- Fine with 1st bullet only: Apple, OPPO, New H3C, Spreadtrum, Lenovo, vivo, DOCOMO, LG, MediaTek, CATT, Ericsson, CableLabs, CMCC (13)
- Fine with both 1st and 2nd bullets: Qualcomm, Lenovo, DOCOMO, Intel, ZTE, Nokia (6)
- Fine with 2nd bullet only: Huawei (1)

Moderator's suggestion: Only 1st bullet of the updated proposal 4.3 would be possible for now and can be checked quickly.

- **Configuring more than one scheduling cell for DCI format 0_X/1_X for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**
- ~~**Configuring one scheduling cell for DCI format 0_X/1_X for each scheduled cell while configuring another scheduling cell for legacy DCI format for each scheduled cell is supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18 with following condition.**~~
    - ~~**Scheduling cell for legacy DCI format for each scheduled cell is limited to either self-carrier or the same scheduling cell as for DCI format 0_X/1_X**~~

Summary of intermediate round feedbacks for the updated proposal 4.5:

- Fine with the updated proposal 4.5: Apple, Samsung, OPPO, New H3C, Qualcomm, Lenovo, vivo, DOCOMO, MediaTek, CMCC (10)
    - 2nd last sub-bullet can be updated to "Support for any sidelink scheduling": OPPO, Lenovo (2)
    - Also exclude the case where PCell schedules multiple cells by DCI format 0_X/1_X when a sSCell is configured to schedule PCell: vivo, MediaTek (2)
    - Also exclude the case with different SCS among scheduling and co-scheduled cells: Intel (1)
- Fine with the updated proposal 4.5 except for …
    - 1st bullet: ZTE (1)
    - 2nd bullet: LG (1)
    - 3rd bullet (FDD or TDD part): Intel, Nokia, Huawei, Ericsson (4)
    - 4th bullet: DOCOMO, Intel, LG (3)
    - 7th bullet: LG, Huawei (2)

Moderator's suggestion: the updated proposal 4.5 seems agreeable (except for removed parts), and it would be good if 1st and 2nd bullets can also be agreed if time allows.

- **Followings are excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.**

- **~~SCell schedules multiple cells including P(S)Cell~~**
- **~~Different SCS among co-scheduled cells~~**
- **Different carrier type (~~FDD or TDD,~~ licensed or unlicensed, FR1 or FR2-1 or FR2-2) among co-scheduled cells**
- **~~Configuration of both multi-cell PDSCH scheduling and multi-slot PDSCH scheduling for the same or different cell within a PUCCH group~~**
- **Configuration of both multi-cell PDSCH/PUSCH scheduling and multi-TRP for a scheduled cell**
- **Support for any sidelink scheduling**
- **~~Support for SUL for DCI format 0_X~~**

Conclusion in Wednesday GTW: the following proposals were agreed, and the final round discussion can focus on the remaining parts in the proposal 4.5.

Updated proposal 4.1:

- **Deprioritize any optimization for unlicensed spectrum operation for designing the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

Updated proposal 4.2:

- **Enhanced Type-2 HARQ-ACK codebook is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**
- **Type-1 HARQ-ACK codebook is supported only for the case where co-scheduled cells by a DCI format 1_X have same SCS/carrier type/duplex mode in Rel-18.**
  - **Additional restriction(s) can be discussed in RAN1**

Updated proposal 4.3:

- **Configuring more than one scheduling cell for DCI format 0_X/1_X for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

Updated proposal 4.5:

- **Followings are excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.**
  - **SCell schedules multiple cells including P(S)Cell**

- **Different SCS among co-scheduled cells**
- **Different carrier type (licensed or unlicensed, FR1 or FR2-1 or FR2-2) among co-scheduled cells**
- **Configuration of both multi-cell PDSCH/PUSCH scheduling and multi-TRP for a scheduled cell**
- **Support for any sidelink scheduling**

4.5 Final round discussion

The moderator would like to ask companies to provide feedback if any on the intermediate round summary and following updated proposal.

4.5.1 3rd round Feedback for Proposal 4.5

Updated proposal 4.5:

- **Followings are excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.**
  - **PCell schedules multiple cells by DCI format 0_X/1_X when sSCell is configured to schedule PCell**
  - **Configuration of both multi-cell PDSCH scheduling and multi-slot PDSCH scheduling for the same or different cell within a PUCCH group**
  - **Support for SUL for DCI format 0_X scheduling multiple cells**

Feedback Form 13: 3rd round feedback for proposal 4.5

1 – OPPO

We are fine with the full exclusion list proposed by moderator.

Regarding to the last sub-bullet on SUL, RAN #96 agreed the following (Ref RP-221880) for UL-Tx switching in the same WI:

"**UL CA framework where UL CA is performed between NULs according to current RAN4 specifications should not be changed**". If we understand the situation correctly, UL CA is not built on SUL and DCI format 0_X is designed for UL CA, which makes the last sub-bullet natural. The guidance seems already there even if the last sub-bullet is removed, unless the above-mentioned RAN #96 agreement is re-interpreted in a different way, e.g., it is applicable to UL-Tx switching only while the opposite principle is applied to one DCI scheduling multiple cells.

2 – Samsung Research America

- Fine in principle with the first bullet – suggest a more general statement as below:

A cell schedules multiple cells by DCI format 0_X/1_X when another cell is configured to schedule the cell.

- We support the second bullet (e.g. to simplify HARQ-ACK codebook design).

- We request a clarification for the third bullet – is the intention to preclude scheduling of PUSCH on SUL (e.g. by RRC) or is it only to preclude DCI format 0_X including an SUL field? We are OK with the second interpretation but we would prefer RAN1 to decide for the first interpretation.

3 – Lenovo (Beijing) Ltd

1st bullet: Support the wording from Moderator. It is clear enough.

For Samsung's wording, we think it excludes the scheduling possibility that a SCell schedules multiple cells not including itself while PCell is configured to cross-carrier schedule it.

2nd bullet: Support for simplifying the HARQ-ACK codebook design.

3rd bullet: We support the intention. It is better to further clarify it implies no SUL indicator in DCI format 0_X.

4 – CATT

We are fine with the first two bullets.

For the 3rd bullet, we are fine to leave it for further discussion in RAN1.

5 – HUAWEI TECHNOLOGIES Co. Ltd.

We have strong concern on the last bullet.

1. For the case of UEs configured with SUL without dynamic switching between SUL and NUL (i.e. by RRC), actually there is no any additional thing needs to do, thus for sure this case shall be supported.

2. For the case of UEs configured with SUL with dynamic switching between SUL and NUL (i.e. by UL/SUL indicator), the work is just exactly the same as tens of other fields, i.e. to determine which type the SUL filed to go, we don't see any reason to preclude this particular single field. It is very obvious that the standard effort is very small.

3. SUL is already deployed in the practical network and SUL is in the scope of the WID, we don't see any reason to preclude it.

6 – China Mobile Com. Corporation

We are OK with the first 2 bullets. We have concern on the last bullet. We do not agree to exclude the support for SUL for DCI format 0_X scheduling multiple cells

7 – vivo Communication Technology

We are fine with the first two bullets. Samsung's more generic wording on the 2nd bullet is also fine for us.

We do not see 3rd bullet provide meaningful scope reduction for the feature, there should be simple solutions to support SUL. Suggest to leave the 3rd bullet to RAN1 decision.

8 – NTT DOCOMO INC.

We support 1st and 3rd bullet. For the 2nd bullet, we prefer to leave it to RAN1 discussion. We share the same view as LGE in the previous round that multi-slot scheduling is essential feature especially for high frequency band operation to fully utilize the resources of such bands. Though some companies showed a concern on complexity of HARQ-ACK codebook design, we believe it can be simplified, e.g., the number of sub-codebooks for type2 HARQ-ACK codebook is still 2, and the additional work would be quite limited.

9 – Intel Deutschland GmbH

We still have concern for the 2nd bullet. We share similar view as NTT DOCOMO and think it is important to support multi-PDSCH and multi-cell PDSCH scheduling by different DCI for same or different serving cells. Otherwise, given the multi-slot PDCCH monitoring as defined for FR2-2, some slots are not used for PDSCH transmission if single-slot PDSCH scheduling is configured, which would degrade the performance substantially.

We are fine with other two bullets.

10 – China Telecommunications

We are fine with the first two bullets. The third bullet should be removed, since SUL can be easily supported for multi-cell PDSCH/PUSCH scheduling without additional standardization efforts.

11 – Nokia Germany

We support all three bullets.

12 – Apple France

We support the proposal

13 – Ericsson LM

We support first bullets by Moderator.

We could be OK with second bullet, but reviewing the concern where it seems the complications is for HARQ-ACK codebook generation. One way would be to exclude that case instead of disallowing the joint configuration as the following:

- **It is not expected that the HARQ-ACK bit(s) carried by a PUCCH to include HARQ-ACK information bit(s)for PDSCH(s) scheduled by a multi-cell DCI together with HARQ-ACK bit(s) for PDSCH(s) scheduled by a multi-slot DCI.**

No preference on the last bullet, but regardless it seems the clarifications mentioned by Samsung are needed.

14 – VODAFONE Group Plc

We also think SUL scenarios should not be precluded from the work

15 – MediaTek Inc.

We support the proposal.

16 – MediaTek Inc.

We support the proposal.

17 – LG Electronics France

We are fine with the 1st and 3rd sub-bullets but NOT fine with the 2nd sub-bullet.

As commented in the intermediate round, the R17 multi-slot scheduling is basic feature for FR2-2 operation, thus it should not be similarly treated as CBG-based PDSCH.

We think R18 multi-cell scheduling in FR1 and R17 multi-slot scheduling in FR2, would be natural combination for FR1+FR2 CA operation.

Regarding Samsung's question on the 3rd sub-bullet, our understanding is that SUL indicator is absent if DCI schedules multiple cells but present if the DCI schedules only one cell (no intention to preclude PUSCH scheduling on SUL).

18 – ZTE Corporation

Fine with the first bullet. We don't support the suggested update from Samsung considering it contradicts with the second bullet of Updated proposal 4.3 discussed in intermediate round, which was suggested to further discuss in RAN1.

Fine with the second bullet.

Support the third bullet. We share similar view with OPPO that UL CA is not built on SUL and DCI format 0_X is designed for UL CA. If SUL operation is supported for multi-cell scheduling, it may imply simultaneous transmission of SUL + non-corresponding NUL or SUL+SUL is supported. Then, it would cause similar issues as discussed for Tx switching.

- Regarding LG's comment, if SUL is only applicable to the case of single-cell scheduling by DCI 0_X, we are wondering why not simply to support SUL by legacy DCI.

- For Samsung's clarification, we suggest to preclude mutli-cell scheduling operation together with SUL. At this point, we are also ok to first conclude on precluding DCI format 0_X including the UL/SUL indicator field and further discuss other cases in RAN1. Here, we'd like to highlight that it seems companies are proposing UL CA with dual SULs where each serving cell only contains an SUL while with no NUL according to the the proposed RAN4 WID in Proposal 6.1/6.2. In such case, we are not sure whether simultaneous transmission of PUSCH on two SULs is allowed or not even if DCI format 0_X does not include an UL/SUL indicator field. That's the reason we suggest to preclude mutli-cell scheduling operation together with SUL to save more RAN1 discussion.

19 – China Unicom We are okay with first two bullets. But we have concern on the last bullet, it should be removed. The standard effort to support SUL for single DCI is very small, and there is no reason to exclude it.
20 – China Unicom We are okay with first two bullets. But we have concern on the last bullet, it should be removed. The standard effort to support SUL for single DCI is very small, and there is no reason to exclude it.

4.6 Final round summary

Summary of Final round feedbacks for the updated proposal 4.5:

- Fine with the 1st sub-bullet: OPPO, Lenovo, CATT, CMCC, vivo, DOCOMO, Intel, China telecom, Nokia, Apple, Ericsson, MediaTek, LG, ZTE, China Unicom (16)
  - Modify to "A cell schedules multiple cells by DCI format 0_X/1_X when another cell is configured to schedule the cell": Samsung (1)
- Fine with the 2nd sub-bullet: OPPO, Samsung, Lenovo, CATT, CMCC, vivo, China telecom, Nokia, Apple, Ericsson, MediaTek, ZTE, China Unicom (13)
  - Not fine: DOCOMO, Intel, LG (3)
  - Modify to "It is not expected that the HARQ-ACK bit(s) carried by a PUCCH to include HARQ-ACK information bit(s) for PDSCH(s) scheduled by a multi-cell DCI together with HARQ-ACK bit(s) for PDSCH(s) scheduled by a multi- slot DCI.": Ericsson (1)
- Fine with the 3rd sub-bullet: OPPO, DOCOMO, Intel, Nokia, Apple, MediaTek, LG, ZTE (8)
  - Clarify it excludes DCI format 0_X including an SUL field: Samsung, Lenovo, Ericsson (3)
  - Not fine: CATT, Huawei, CMCC, vivo, China telecom, Vodafone, China Unicom (7)

Based on above, only 1st sub-bullet is acceptable to all for now. Therefore, the moderator suggests RAN chair to check the following updated proposal for agreement. Other sub-bullets can be further discussed in RAN1.

Updated proposal 4.5:

- **Following is excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.**
  - **PCell schedules multiple cells by DCI format 0_X/1_X when a sSCell is configured to schedule PCell**

Following conclusion was made after the final round.

Conclusion:

- **Following is excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.**
    - **PCell schedules multiple cells by DCI format 0_X/1_X when a sSCell is configured to schedule PCell**

5 Discussions on objective 2: multi-carrier UL Tx switching

At the RAN#96 meeting, target scenarios for the objective 2: multi-carrier UL Tx switching were discussed and following RAN guidance was made. According to the RAN guidance further check on the additional scenarios need to be done at RAN#97-e meeting.

In [4], following proposal was made regarding the additional scenarios.

Proposal: Include the following scenarios for UL Tx switching across 4 different bands in Rel-18 MC enhancement

In [7], following observations and proposal were made regarding the additional scenarios.

Observation 1: *Dual-SUL band and simultaneous transmission across 2 bands in {SUL band + corresponding NUL band*

In [9] and [10], new WID on NR Inter-band CA band combinations with dual SUL bands was also proposed. The discussion on this proposed WID is summarized in section 6.

On the other hand, in [8], following observation was made regarding the additional scenarios.

Table 12:

Observation: For multi-carrier UL operation, the motivation and use case of the additional scenarios identified in

In [3], following observations and proposal were made regarding the clarification on UL CA configuration for UL Tx switching with more than 2 bands.

Observation 1*: Under UL Tx switching, the UL configuration is kept unchanged as initially RRC configured.* ***Observation***

In summary, there are following proposals for Rel-18 UL Tx switching.

- Proposal 1: RAN1/2/4 shall work also on following additional scenarios for Rel-18 UL Tx switching
    - {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}

- Simultaneous transmission across 2 bands in {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s) (excluding simultaneous transmission between SUL and corresponding NUL)
- Proposed by: CMCC, China Telecom, China Unicom
- Concerned by: Samsung

- Proposal 2: Clarify whether the 3 or 4 band UL CA feature needs to be first with the side condition that at most 2 bands concurrent UL transmission in order to support the UL Tx switching scheme across up to 3 or 4 bands
  - Proposed by: Apple

5.1 Initial round discussion

The moderator would like to ask companies to provide feedback if any on above summary and each of following proposals. It would be helpful to facilitate the discussion if you provide your understandings on what needs to do in RAN1/2/4 and how is the amount of the additional work if additional scenarios are to be supported, considering the workload concern on this WI as discussed in section 4.

5.1.1 1st round Feedback for Proposal 5.1

Proposal 5.1

- **If Rel-18 UL Tx switching is supported, RAN1/2/4 shall work on defining necessary mechanisms and requirements for UL Tx switching across 3 or 4 different bands including the scenarios with {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}.**

Feedback Form 14: 1st round Feedback form for Proposal 5.1

1 – LG Electronics France In general, we agree Rel-18 UL TX switching should support more than 2 (3 or 4) bands. On the other hand, if the proposal includes UL TX switching over two SUL carriers, we think it needs another discussion.
2 – Apple France We are open to considering more than 1 SUL band for the case of 4 bands if there is an interest from operators to include such scenarios.

3 – Qualcomm Incorporated

We don't support adding these scenarios. These scenarios contradict the original arguments why SUL was added in the first place.

4 – Ericsson LM

Further clarifications of the scenario is needed. Due to the concerns regarding the completion of WI in time, it is not clear if the support of such scenarios for UL Tx switching, is straightforward and would not impact at least RAN4.

5 – E-surfing Digital

China Telecom:

We fully support the Proposal 5.1.

On the scenario:

As explained in our tdoc RP-222304, for the low and medium bands in FR1, typically the channel bandwidth for each band is narrow (e.g., with 5 to 10MHz in one band), and there are also legacy RAT(s) deployed, so it is beneficial to extend the number of SUL bands for the purpose of both coverage and capacity improvement.

On the workload:

Based on the SR in RP-222252, it is clear that all the agreements already achieved in RAN1/2/4 are band type agnostic. We don't think the inclusion of 2-SUL scenario will impact the progress of the WI.

Technically, the most complicated scenario in the WI is CA option 2 (with no intent to de-prioritize CA option 2, and it is of course important to keep CA option 2 in the WI as well). With the support of CA option 2, there is no difficulty from workload perspective to support other scenarios.

Regarding E///'s comment (**Comment # 4**):

If we take a look at the RAN4 LS and WF, all the agreements made in RAN4 are applicable to 2-SUL scenario, so we don't quite understand the comment that "it is not clear if the support of such scenarios for UL Tx switching, is straightforward and would not impact at least RAN4."

In addition, any RAN4 band combination specific requirements are discussed separately in RAN4 spectrum WIs, and not in this WI. This is the same approach for CA and CA+SUL band combinations.

6 – ZTE Corporation

Based on Chair's guidance, no TU increase for existing R18 items is expected. It is confusing for us that it is proposing for down-scoping of the WI due to limited TU in section 4 on one hand, while proposing for up-scoping in this section on the other hand. In our view, adding new scenarios is not realistic considering the already high workload of this WI.

As discussed in the last RAN plenary, introducing two SUL bands would cause lots of RAN1/2/4 impact efforts. Before agreeing on the new scenario, it's better to first to clarify the confusions.

- Inter-band UL CA with one SUL band is not supported yet in RAN4. This should be first discussed before supporting more SUL bands for inter-band UL CA.

- What's the motivation to introduce more than 1 SUL considering that SUL is mainly for coverage enhancement? What's the difference from supporting 3/4 bands CA- Option 1?
- Whether simultaneous transmission between two SUL bands are supported or not? What's the difference from supporting 3/4 bands CA- Option 2?
- A lot of the UE behaviour are defined under the conditions of intra-band/inter-band CA or SUL band combinations in RAN1/RAN2 specs. It is not clear which one the new scenario will fall into.
- It is not clear how to define intra-band and inter-band if NUL and SUL can be overlapped in the same physical band (intra-band?). RAN4 requirements also need to be discussed and defined.

7 – CATT

We are fine with the proposal considering the clear demand from operators and limited WG impact, if any, for the additional cases.

8 – Intel Deutschland GmbH

Our view is that additional RAN1 specification impact is needed to support for dual SUL scenario for Rel-18 multi-carrier Tx switching. Given the limited TU and controversy during past RAN1 discussion, it is not preferable to include dual SUL in the scope.

9 – New H3C Technologies Co.

we are fine with this proposal

10 – HUAWEI TECHNOLOGIES Co. Ltd.

Our view is that the above mentioned scenarios are not precluded in Rel-18 multi-carrier enhancement WI, per the agreements made in RAN#96. We are fine with the above proposal 5.1 if companies would like to make it even clearer. At the same time, we will not agree to any proposal that explicit excludes the above mentioned scenarios.

Reasons are given as below:

1. It is agreed in RAN#96 that "Mechanisms/requirements should not introduce restrictions on what were already supported in current specifications for UL Tx switching". In our view, the above mentioned scenarios are already supported by RAN1/2 specification since Rel-15. One example RAN1 agreement is as below:

Agreement (RAN1#92b)

Priority rule for SUL

- For simultaneous uplink transmissions that are power-limited, when one or multiple serving cell(s) are configured with both UL and SUL carriers
  - Existing priority rule based on signals/channels content
  - In case transmissions with the same priority level on the two UL carriers,

the UL carrier which is configured for PUCCH has higher priority

2. There are requests on the above mentioned scenarios by operators to boost the UL performance per the contributions (i.e. RP-222244 & RP-222304) submitted under 9.3.1.2 for Rel-18 multi-carrier.

3. There is no additional RAN1&2 impacts to support the above mentioned scenarios since common mechanism can be used, specifically by reusing the current CA framework where the same UE behaviors across serving cells, e.g. power sharing across cells and UL Tx chain sharing across cells, are applied to both the case without SUL and the case with SUL.

4. RAN4 spectrum work (e.g. band combination) is usually done per the request from operators in release independent way. For other issues that may involve RAN4, e.g. switching mechanism and/or UE memory issue, there is no additional RAN4 impact for the above mentioned scenarios either since as usual common mechanisms are applied to both the case without SUL and the case with SUL.

5. The most complicated and time consuming part for Rel-18 UL Tx switching is actually the support of UL Tx switching with option 2 (dual UL), not the support of the above mentioned scenarios. Per the discussion in RAN1, it is obvious that option 2 (dual UL) would need much more standard effort, especially the UE memory issue with 4 candidate solutions listed with a large amount of FFS points. So if companies have concern on the completion of the work, then option 2 should be the one to be checked.

11 – Nokia Corporation

We do not support these scenarios. UL Tx switching as designed in Rel-16/17 has three flavours, EN-DC, CA and SUL. The integration of CA and SUL would lead to a 4th UL Tx switching flavour that would require additional specification effort and cause additional branch to the specs. Furthermore the point of two SUL cells in a CA config is unclear. Finally, it is not clear if such a configuration is possible as per the functional specifications without considering UL Tx switching.

12 – vivo Communication Technology

We are fine to consider this scenario based on operators' demand.

Regarding the specifciation impacts, we think at least no issue for the case without simultanoues transmisisons on two UL carriers. Supporting simultanoues transmission on two UL carriers is more complex but we see no fundamental difference between UL CA case and dual SUL case. Therefore we think the overall workload is managable.

We would like to also highlight that adoption of this scenairo shall not change the basic assumption for the Tx swtiching feature, i.e. there is up to 2Tx simultanoues transmission from UE perspective.

13 – China Mobile Com. Corporation

We support the scenario in proposal 5.1.

As discussed in our contribution RP-222244 [4], some existing LTE bands with some relative narrow bandwidth will be refarmed to NR in near future. For these bands, e.g. n34(15MHz) and n39(30MHz), refarming

to NR TDD is not so attractive, since the gain is limited compared to n41 with more than 100MHz bandwidth. SUL is a promising technique for these types of bands, since from the BS perspective, SUL only requires receiver, which can reduce about 70% equipment cost compared to TDD CA according to our analysis.

In our view, there are two sub-cases in this scenario and should be supported in Rel-18.: {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}.

² **Inter-band UL CA Option 1 (i.e., switched UL) for {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}**

l **Note: switching across any band in this scenario is not precluded**

² **Inter-band UL CA Option 2 (i.e., dual UL) for {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}**

l **Note: Simultaneous UL transmission across 2 NUL bands or 2 SUL bands**

To Qualcomm

SUL is not only introduced to improve coverage, but also improve the capacity especially at cell edge.

To ZTE:

On the TU issue, Tx switching across 3 or 4 bands are already included in the approved WID. In last RAN plenary meeting, the agreement was to provide guidance to Q3 discussion, not down scoping in Rel-18. So the proposed scenario in 5.1 is already included in Rel-18.

On the comments to RAN1/2/4 impact efforts, we do not agree with the comments. Firstly, we do not propose to specify inter-band UL CA between NUL and SUL band. Secondly, the motivation to introducing more than 1 SUL bands is explained in our contribution RP-222244 [4]. Compared to CA, SUL only require receiver at BS side. Compared to CA, it reduces about 70% equipment cost according to our analysis.

14 – MediaTek Inc.

We support the proposal.

15 – LG Uplus

We are open to this proposal. The preference depends on work load. In our understanding, there would be no heavy work since Rel-15 specification almost defines the protocol about the relevant SUL band combination in RAN1/2. However, if it is revealed that the work load is very heavy, we don't want to push this proposal.

16 – DOCOMO Communications Lab.

We are open to consider the scenario based on operator's demand, while we have a concern on the workload of this WI due to limited TUs in general. The additional workload due to this scenario should be considered to make a decision.

17 – China Unicom We support the Proposal 5.1. Considering the spectrum refarming scenarios in lower frequency band, dual UL should also be supported in the scope. We share same view with othe companies on the workload is managable.
18 – Samsung Electronics Co. Like others' view, we also have a concern on the limited TU for the entire WI (multi-cell scheduling + UL Tx switching)
19 – VODAFONE Group Plc We are generally open to these scenarios if the workload is deemed manageable

5.1.2 1st round Feedback for Proposal 5.2

Proposal 5.2

- **If Rel-18 UL Tx switching is supported, RAN1/2/4 shall work on defining necessary mechanisms and requirements for UL Tx switching across 3 or 4 different bands including the scenarios with simultaneous transmission across 2 bands in {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s) (excluding simultaneous transmission between SUL and corresponding NUL).**

Feedback Form 15: 1st round Feedback form for Proposal 5.2

1 – LG Electronics France In general, we are fine with the proposal, while further clarification seems necessary related to SUL band related description. For example, the proposal seems to describing SUL-NUL band pair should be always included in one of the simultaneous transmission.
2 – Apple France We support the proposal
3 – Qualcomm Incorporated Similar to 5.1, we don't support adding this scenario. If simultaneous transmission is being considered, it should be in the context of UL CA, not in the context of SUL. The whole design concept of SUL was built around no simultaneous data transmissions across any UL CCs.
4 – Ericsson LM We share same view as Qualcomm. The support of simultaneous transmission in case of UL CA, can be done in Rel-18 similarly to Rel-17 that was not in the context of SUL. Any deviation requires additional work that we can't see it is feasible, considering that feature is not yet even supported to be specified.

5 – E-surfing Digital

China Telecom:

We fully support the Proposal 5.2.

Regarding Qualcomm and Ericsson comments (**Comment #3 and #4**), we agree that the simultaneous transmission is considered in the context of UL CA. The scenario in Proposal 5.2 is just based on UL CA, and one SUL band can be configured in each cell on top of UL CA.

So, we don't understand what's the issue here.

6 – ZTE Corporation

We have similar comments as for Proposal 5.1. We also share the same view as Qualcomm and Ericsson.

In addition to the clarification questions in Proposal 5.1, if simultaneous transmission between SUL and non-corresponding NUL is supported, it's not clear to us what's the UE behavior of UCI multiplexing. Is simultaneous transmission of PUCCH and PUSCH across SUL and non-corresponding NUL also supported or not? Besides, as we commented in Proposal 6.1, this proposal will require more RAN4 work. It is preferred not to extend the scope of this WI at this stage.

7 – CATT

We are fine with the proposal considering the limited WG impact, if any, for the additional case.

8 – Intel Deutschland GmbH

We understand the intention of the proposal. However, we agree with other companies that clarification is needed.

9 – New H3C Technologies Co.

we are fine with this proposal

10 – HUAWEI TECHNOLOGIES Co. Ltd.

Our view is that the above mentioned scenarios are not precluded in Rel-18 multi-carrier enhancement WI, per the agreements made in RAN#96. We are fine with the above proposal 5.2 if companies would like to make it even clearer. At the same time, we will not agree to any proposal that explicit excludes the above mentioned scenarios.

As to the reasons, they are quite similar as the ones replied to proposal 5.1, thus will not be repeated here.

11 – Nokia Corporation

Similar to our response to 5.1, we see the integration of CA and SUL in the UL Tx switching context adding a 4th UL Tx Switching flavour, when SUL was specifically designed for UE to transmit on one uplink at a time.

12 – vivo Communication Technology Simiarly comments as for proposal 5.1 We are fine to consider this scenario based on operators' demand, and we think the overall workload is managable. We would like to also highlight that adoption of this scenairo shall not change the basic assumption for the Tx swtiching feature, i.e. there is up to 2Tx simultanoues transmission from UE perspective.
13 – China Mobile Com. Corporation We support this scenario. Simultaneous transmission between SUL and NUL is precluded in this proposal. We don't see why this scenario cannot be supported.
14 – MediaTek Inc. We support the proposal.
15 – LG Uplus We support this proposal. We would like to study at least one SUL band combination for 3 or 4 band switching, where we consider a SBFD (Subband non-overlap full duplex) band in full duplex as a SUL band. We guess the RF characteristics of a SBFD band seems quite similar a SUL band in device point of view.
16 – DOCOMO Communications Lab. We are open to consider the scenario based on operator's demand, while we have a concern on the workload of this WI due to limited TUs in general. The additional workload due to this scenario should be considered to make a decision.
17 – China Unicom We support this proposal.
18 – Samsung Electronics Co. same comment as in section 5.1.1: Like others' view, we also have a concern on the limited TU for the entire WI (multi-cell scheduling + UL Tx switching)
19 – VODAFONE Group Plc We are generally open to these scenarios if the workload is deemed manageable

5.1.3 1st round Feedback for Proposal 5.3

Proposal 5.3

– **Clarify whether the 3 or 4 band UL CA feature needs to be first with the side condition that at most 2 bands concurrent UL transmission in order to support the UL Tx switching scheme across up to 3 or 4 bands**

Feedback Form 16: 1st round Feedback form for Proposal 5.3

1 – Qualcomm Incorporated

It is unclear to us what the term 'side condition' means. If 3 or 4 band UL CA is introduced, it can be either as a regular CA band combination, or an UL Tx switching band combination. Neither of these would have 'side conditions' per our understanding. However; whether to introduce both the regular UL CA version and UL Tx switching version at the same time or at different times is indeed a question that would have to be discussed. For now, we would like to clarify first what 'side condition' means.

2 – Ericsson LM

We share the same view as Qualcomm. The proposal needs more clarification.

3 – Apple (UK) Limited

The proposal is meant for companies (especially the WID objective proponent companies) to clarify whether 3- or 4-band UL CA feature needs to be introduced first in order to support UL Tx switching schemes across up to 3 or 4 bands. If the 3- or 4-band UL CA feature would be introduced, we would like to make sure it is not meant for 3-band or 4-band simultaneous transmission, but only with at most 2-band concurrent transmission which is what we meant the side condition. If the objective is only intended for dual-SUL combinations, but not for inter-band UL CA, then the clarification is only needed for dual-SUL combinations.

4 – E-surfing Digital

While we understand the issue raised by Apple, we think the details can be discussed further in RAN4 considering that the following agreements were reached in RAN4 August meeting:

- No need to define RF requirements for UL CA with UL simultaneous transmission on 3 and 4 bands in the WI.
- For the next meeting, encourage analysis/identification of the RAN4 RF requirements needed for this WI.

5 – E-surfing Digital

China Telecom (the same comment as in comment #4, with company name added):

While we understand the issue raised by Apple, we think the details can be discussed further in RAN4 considering that the following agreements were reached in RAN4 August meeting:

- No need to define RF requirements for UL CA with UL simultaneous transmission on 3 and 4 bands in the WI.
- For the next meeting, encourage analysis/identification of the RAN4 RF requirements needed for this WI.

6 – ZTE Corporation

Considering the WID is only for UE with up to 2 Tx, it seems natural that only at most 2 bands concurrent UL transmission is allowed for Rel-18 Tx switching. We think such clarification may not be needed.

7 – Intel Deutschland GmbH

It is not clear to us the intention of the proposal. Some further clarification is needed.

8 – HUAWEI TECHNOLOGIES Co. Ltd.

Regarding the UE capability, it should be very clear from the WID that the UE only supports up to 2 Tx simultaneous transmission and there should be no ambiguity on the UE capability. Then in order to enable Rel-18 UL Tx switching across 3 or 4 bands, 3 or 4 bands should be configured by RRC signaling in advance, but at most 2 bands can do concurrent UL transmission where concurrent transmission is subject to UE capability, e.g. UE capability ”dualUL”. Note that this doesn’t mean that UE has to support 3 or 4 band UL CA, i.e. UE doesn’t need to support 3 or 4 concurrent UL transmission.

9 – Nokia Corporation

We understand the problem of defining >2 band band combinations. The practicalities could be discussed in RAN4, e.g. if there should be a statement that band combinations with >2 bands are still supposed to limit the simultaneous Ul transmissions on two bands at a time. It should be given that a UE should be able to support a >2 band combination with UL Tx swithcing while nor required to support simultaneous Tx on all the bands in the band combo. It is not entirely obvious though that this needs to be reflected in the band combination itself.

10 – vivo Communication Technology

If we understood correctly, the proposal emphasis again the restriction from the WID ”UL Tx switching schemes across up to 3 or 4 bands **with restriction of up to 2 Tx simultaneous transmission**”. If this is the moderator’s intention, we are fine to take it considering we are now discussing additional scenarios and there is no halm to emphasis again.

11 – China Mobile Com. Corporation

If the proposal of 3 or 4 band UL CA means simultaneous transmission on 3 or 4 UL bands, then we think it is precluded from Rel-18 WI since up to 2Tx concurrent transmission is assumed at UE side.

12 – MediaTek Inc.

This is RAN4 discussion, and we don’t see any need for RAN-P decision/guidance.

13 – LG Uplus

To us, this proposal seems same as the original WID objective. Some clarification is needed.

14 – DOCOMO Communications Lab.

We think it is already clear that what we are discussing is UL Tx switching schemes across up to 3 or 4 bands with up to 2 bands concurrent transmission, and 3 or 4 bands UL CA without the side condition are not the scope of this WI.

15 – Samsung Electronics Co.

We think ”at most 2 bands concurrent UL transmission” is clear in current WID.

5.1.4 1st round Feedback for Proposal 5.4

Proposal 5.4

Companies are encouraged to provide any other potential down-scoping proposal or proposal making further progress for the multi-carrier UL Tx switching if any.

Feedback Form 17: 1st round Feedback form for Proposal 5.4

1 – ZTE Corporation

We suggest to focus ONLY on the following scenarios based on the guidance endorsed in RAN#96.

- Inter-band UL-CA Option 1 (i.e., switched UL) and Option 2 (i.e., dual UL) without SUL band
- Inter-band UL CA Option 1 (i.e., switched UL) for {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s)
  - UL CA framework where UL CA is performed between NULs according to current RAN4 specifications should not be changed
  - Note: switching across any band in this scenario is not precluded
- Intra-band two contiguous aggregated carriers within one non-SUL band out of 3 or 4 bands

All other scenarios including mixture of Inter-band UL-CA Option 1 and Option 2 should not be discussed in WGs.

2 – HUAWEI TECHNOLOGIES Co. Ltd.

In general we think it is not good to do down-scoping, since we made great effort to finalize the Rel-18 scope and we should try our best to complete it. If companies want to do down scoping discussion, we should have an overall picture for all Rel-18 items and this shall not be done for a particular topic. If the main worry here is about the TU for Rel-18 UL Tx switching, then UL Tx switching with option 2 (dual UL) should be the one to check, since it is the most complicated and time consuming part for Rel-18 UL Tx switching.

In addition, looking at the discussions and progress in working groups, the following proposal can be considered to make further progress for Rel-18 UL Tx switching:

• Convert study phase to normative work phase for Rel-18 UL Tx switching with option 1 (switched UL)

• Continue the study for Rel-18 UL Tx switching with option 2 (dual UL)

Reasons are given as below:

1. Observations agreed in RAN1 show that gains can be achieved obviously with 2Tx switching among 3 or 4 bands compared with Rel-17

2. The concern on the potential increasing switching period is not there per the agreement in RAN4, since the same value of switching period in Rel-16/17 can be reused for Tx switching across 3 or 4 bands

3. The main remaining issue for UL Tx switching is whether/how to manage a modest size of UE memory, however it is mainly for UL Tx switching with option 2 (dual UL).

Based on the above 3 points, we think it is time to convert study phase to normative work phase for Rel-18 UL Tx switching with option 1 (switched UL).

However, for option 2 it is observed that more study is still needed due to the following two reasons:

1. The main concern regarding UE complexity still needs further study, 4 candidate options with a large amount of FFS points are identified for UE memory issue

2. Option 2 (dual UL) has much more complexity than Option 1 (switched UL) which results in more specification impacts and more complicated handling of UE memory size.

5.2 Initial round summary

Based on the initial round discussion, companies' views could be summarized as below.

- For Proposal 5.1
  - Support the proposal: China Telecom, CATT, New H3C, Huawei, vivo, CMCC, MediaTek, China Unicom (8)
    - There are some low/medium bands with narrow bandwidth each in FR1 and it is beneficial to extend the number of SUL bands for coverage and capacity improvement
    - Agreements made in RAN1/2/4 are band type agnostic and the support of the scenario would not impact the progress.
    - The most complicated part is dual UL, and hence it should be checked first if there is concern on the completion of the work.
  - Open to the proposal: Apple, LG Uplus, DOCOMO, Vodafone (4)
    - OK if the workload is manageable
  - Not support the proposal: LG, Qualcomm, Ericsson, ZTE, Intel, Nokia, Samsung (7)
    - If the proposal includes UL Tx switching over two SUL carriers, it needs another discussion
    - Scenarios contradict with the original arguments why SUL was added
    - Further clarification is necessary on whether the support of the scenario does not impact RAN4
    - Adding new scenarios with two SUL bands would cause lots of RAN1/2/4 impacts/efforts, and clarifications are necessary

    - It is not clear if configuration with two SUL cells in a CA is possible as per the functional specifications without considering UL Tx switching

Based on above, although companies' views are split, there are operator's requests for the scenario with specific examples. The moderator thinks concerns on the workload due to limited TUs are valid, while supporting companies explained that additional impacts/efforts due to this scenario from UL Tx switching perspective could be limited. So, it may be possible to consider this scenario for UL Tx switching in Rel-18 if RAN4 can work on defining CA band combinations with two SUL bands as proposed in section 6. The moderator would like to suggest discussing further on the proposal as there is different understandings/views on whether/how large RAN1/2/4 impacts are to be caused by this scenario in terms of UL Tx switching. The RAN4 impacts due to proposed new WID as discussed in section 6 can be separately discussed.

- For Proposal 5.2
  - Support the proposal: Apple, China Telecom, CATT, New H3C, Huawei, vivo, CMCC, MediaTek, LG Uplus, China Unicom (10)
    - The scenario is based on UL CA and one SUL band is configured in a cell on top of UL CA
  - Some clarification is necessary: LG, Intel (2)
  - Open to the proposal: DOCOMO, Vodafone (2)
    - OK if the workload is manageable
  - Not support the proposal: Qualcomm, Ericsson, ZTE, Nokia, Samsung (5)
    - Simultaneous transmission should be considered in the context of UL CA not SUL, and SUL concept was built around no simultaneous transmissions across any UL CCs.
    - If simultaneous transmission between SUL and non-corresponding NUL is supported, there would be some additional works.

Based on above, the situation is similar to that for proposal 5.1, but slightly different. There may be no concern except for workload if simultaneous transmission between SUL and non-corresponding NUL is also excluded as well as between SUL and corresponding NUL from the scenario (i.e., no simultaneous transmission between SUL and any NUL). As scenarios with one SUL in 3 or 4 bands for switched UL and scenarios with 3 or 4 NUL bands for dual UL are already considered in Q3, supporting additional scenario with excluding simultaneous transmission between SUL and any NUL may not require large additional workload. Therefore, the moderator would like to check if the updated proposal below is acceptable or not.

Updated proposal 5.2:

- **If Rel-18 UL Tx switching is supported, RAN1/2/4 shall work on defining necessary mechanisms and requirements for UL Tx switching across 3 or 4 different bands including the scenarios with simultaneous transmission across 2 NUL bands in {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s) (excluding simultaneous transmission between SUL and any NUL).**

- For Proposal 5.3
    - Support the proposal: Apple (1)
    - More clarification on the proposal is necessary: Qualcomm, Ericsson, Intel, vivo, LG Uplus (5)
    - Details should be discussed in RAN4: China Telecom, Nokia, MediaTek (3)
    - The proposed clarification is not necessary: ZTE, Huawei, CMCC, DOCOMO, Samsung (5)

Based on above, it is not necessary to continue the discussion at this meeting and the proposed clarification can be discussed in RAN4 (or RAN1/2) if necessary.

- For Proposal 5.4
    - Focus only on the scenarios discussed in Q3 and any other scenarios including mixture of switched UL and dual UL are excluded: ZTE
    - If there is concern on workload/limited TU, the support of dual UL should be checked: Huawei
    - Convert study phase to normative work phase for Rel-18 UL Tx switching with switched UL, while continue study for dual UL: Huawei

Based on above, it is worth checking companies views on following proposals in the next round discussion.

Updated proposal 5.4-1:

- **If Rel-18 UL Tx switching is supported, scenarios with mixing switched UL and dual UL (i.e., supporting dual UL only for some band pair(s) in the band combination of 3 or 4 bands) are excluded.**
    - **Note: it means the complexity reduction option 1 in RAN1 working assumption made at RAN1#110 is excluded.**

Updated proposal 5.4-2:

- **Rel-18 UL Tx switching is supported at least for switched UL case with 3 or 4 bands**
    - **Note: scenarios without SUL and scenarios with one SUL band are at least included and scenarios with two SUL bands are under discussion in Proposal 5.1**

5.3 Intermediate round discussion

The moderator would like to ask companies to provide feedback if any on the initial round summary and following updated proposals.

5.3.1 2nd round Feedback for Proposal 5.1

Proposal 5.1

- **If Rel-18 UL Tx switching is supported, RAN1/2/4 shall work on defining necessary mechanisms and requirements for UL Tx switching across 3 or 4 different bands including the scenarios with {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}.**

Feedback Form 18: 2nd round Feedback form for Proposal 5.1

1 – Apple France As commented in the initial round, we are fine to consider more than 1 SUL band based on the interest from multiple operators
2 – Samsung Research America We still have a concern on the limited number of TUs available for the entire WI (multi-cell scheduling + UL Tx switching).
3 – New H3C Technologies Co. we are fine with this proposal
4 – Qualcomm Incorporated We would have to repeat the same comment as before. SUL was designed to target a perceived link budget challenge. We do not understand how that link budget challenge can be addressed by switching across more and more bands. We think that aggregating 3 or 4 bands matches the goals of carrier aggregation, and further improving link budget is with more simultaneous transmission, not with more switching. In addition, SUL was supposed to address the case where the operator has no usable low band spectrum because those are occupied by LTE and cannot be freed up. We don't understand how more and more spectrum occupied by LTE should became available for SUL. If it is other type spectrum that is becoming available, why it should not be used and aggregated as TDD?
5 – China Telecommunications We support Proposal 5.1. On the scenario:

As summarized by moderator, there are operator's requests for the scenario with specific examples. For example, LTE TDD band with narrow BW re-farmed to SUL, FDD band with narrow BW and DL-heavy traffic in legacy RATs.

On the workload:

In Rel-15 specification, for UL CA, configuring one NUL band + one SUL band in each cell is supported.

In Rel-18 Tx switching discussion, from baseband perspective, the number of switching cases for CA option 2 is the upper bound, and all other scenarios are simpler than CA option 2. From RF perspective, the Tx switching behavior is the same no matter it is called as a FDD or SUL band.

On the relation with RAN4 band combination specific requirement:

It is well known that introduction of RAN1/2 features and RAN4 requirements are separate discussions.

For example, in Rel-18, RAN4 has just started to define requirement for UL 4Tx transmission based on RAN1 Rel-15 spec, and in the meantime, RAN1 has started the work for more than 4 Tx in Rel-18.

6 – China Telecommunications

We support Proposal 5.1.

On the scenario:

As summarized by moderator, there are operator's requests for the scenario with specific examples. For example, LTE TDD band with narrow BW re-farmed to SUL, FDD band with narrow BW and DL-heavy traffic in legacy RATs.

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In Rel-15 specification, for UL CA, configuring one NUL band + one SUL band in each cell is supported.

In Rel-18 Tx switching discussion, from baseband perspective, the number of switching cases for CA option 2 is the upper bound, and all other scenarios are simpler than CA option 2. From RF perspective, the Tx switching behavior is the same no matter it is called as a FDD or SUL band.

On the relation with RAN4 band combination specific requirement:

It is well known that introduction of RAN1/2 features and RAN4 requirements are separate discussions.

For example, in Rel-18, RAN4 has just started to define requirement for UL 4Tx transmission based on RAN1 Rel-15 spec, and in the meantime, RAN1 has started the work for more than 4 Tx in Rel-18.

7 – HUAWEI TECHNOLOGIES Co. Ltd.

Our view is that the above mentioned scenarios are not precluded in Rel-18 multi-carrier enhancement WI, per the agreements made in RAN#96. We are fine with the above proposal 5.1 if companies would like to make it even clearer. At the same time, we will not agree to any proposal that explicit excludes the above mentioned scenarios.

Regarding the concern on RAN1/2/4 impacts mentioned in the moderator summary, our view is as below as replied in the first round:

1. There is no additional RAN1&2 impacts for the above mentioned scenarios since common mechanism can be used, specifically by reusing the current CA framework where the same UE behaviors across serving cells, e.g. power sharing across cells and UL Tx chain sharing across cells, are applied to both the case without SUL and the case with SUL.

2. RAN4 spectrum work (e.g. band combination) is usually done per the request from operators in release independent way. For other issues that may involve RAN4, e.g. switching mechanism and/or UE memory issue, there is no additional RAN4 impact for the above mentioned scenarios either since as usual common mechanisms are applied to both the case without SUL and the case with SUL.

Some companies keep saying there might be RAN1 and RAN2 impacts, but actually no specific impacts can be illustrated by these companies. In this case, we don't see there is justification on additional impacts.

Regarding the concern on the overall available TU or workload,

1. As analyzed above, the support of the above mentioned scenarios won't increase additional workload.

2. The most complicated and time consuming part for Rel-18 UL Tx switching is actually the support of UL Tx switching with option 2 (dual UL), instead of the support of the above mentioned scenarios. Per the discussion in RAN1, it is obvious that option 2 (dual UL) would need much more standard effort, especially the UE memory issue with 4 candidate solutions listed with a large amount of FFS points. So if companies have concern on the completion of the work, then option 2 should be the one to be checked.

Some additional reasons for our views are given as below also:

1. It is agreed in RAN#96 that "Mechanisms/requirements should not introduce restrictions on what were already supported in current specifications for UL Tx switching". In our view, the above mentioned scenarios are already supported by RAN1/2 specification since Rel-15. One example RAN1 agreement is as below:

Agreement (RAN1#92b)

Priority rule for SUL

- For simultaneous uplink transmissions that are power-limited, when one or multiple serving cell(s) are configured with both UL and SUL carriers
    - Existing priority rule based on signals/channels content
    - In case transmissions with the same priority level on the two UL carriers,

the UL carrier which is configured for PUCCH has higher priority

2 There are requests on the above mentioned scenarios by operators to boost the UL performance per the contributions (i.e. RP-222244 & RP-222304) submitted under 9.3.1.2 for Rel-18 multi-carrier.

8 – vivo Communication Technology

We are fine with the proposal.

9 – Intel Deutschland GmbH

We are not sure if such up-scoping of dual SUL can be feasible without increasing TU particularly given that the current scopes without dual SUL require additional TU.

10 – ZTE Corporation

First of all, the proposed scenario is not included in the agreed target scenarios according to the the decision in RAN#96. To add this scenario is up-scoping and should be avoided considering the limited TU.

As we commented in the first round, lots of clarifications are required once we agreed this scenario. All these would consume lots of RAN1/2/4 time and could cause large RAN1/2/4 impacts. We think it is misleading to claim the specs are band agnostic. As discussed in RAN#96, we should avoid using "band agnostic". If we follow the misleading "band-agnostic" claim, one can also claim the current specs support many features which haven't been discussed before (e.g. full duplex even at UE side) but this is not the case. Before introducing a new type of band combination, we should clarify in the current specs about the UE behavior and add corresponding restriction to the specs. One example is that a lot of the UE behaviour defined in RAN1/RAN2 specs depends on different types of band combination , e.g., under the conditions of intra-band/inter-band CA or SUL band combinations. Therefore, it cannot be claimed that the current specs are "band-agnostic" in this perspective. If inter-band CA with two SUL bands is supported, it's not clear whether the UE behavior over the two SUL bands should follow SUL band combination or inter-band CA band combination, or how to define intra-band or inter-band especially when the NUL and SUL overlaps in the same frequency band. Given that RAN4 specs clearly define SUL band combinations whenever there is any SUL band, our view is that one cannot claim this new scenario belongs to inter-band CA band combination/operation if two SUL bands are introduced. Also, when we introduce this new type of band combinations, proponents have to clarify whether simultaneous transmission is supported in different combinations including NUL+NUL, NUL+SUL, SUL+SUL and the corresponding specs changes are needed to clarify this. Like the copied spec texts below, UE behavior should be clarified for the new scenario with two SUL bands.

"For intra-band and inter-band CA operations, a UE can simultaneously transmit more than one SRS resource configured by SRS-PosResource on different CCs, subject to UE's capability

For intra-band and inter-band CA operations, a UE can simultaneously transmit more than one SRS resource configured by SRS-PosResource and SRS-Resource on different CCs, subject to UE's capability.

...

In case of intra-band contiguous carrier aggregation, or in inter-band or intra-band non-contiguous CA band combination if simultaneous SRS and PUCCH/PUSCH transmissions are not supported by UE, the UE is not expected to be indicated with a SRS transmission from a carrier and to be configured or scheduled with a PUSCH/UL DM-RS/UL PT-RS/PUCCH transmission from a different carrier in the same symbol.

In case of intra-band contiguous carrier aggregation, or in inter-band CA band combination if simultaneous SRS and PRACH transmissions are not supported by UE, or in case of intra-band non-contiguous CA band combination if the UE is not configured with higher layer parameter intraBandNC-PRACH-simulTx-r17, the UE shall not transmit simultaneously SRS resource(s) from a carrier and PRACH from a different carrier."

Regarding Huawei's claim on RAN1 agreement on support of this scenario, support of CA with SUL was discussed in Rel-15 and no consensus has been reached in RAN1. No explicit agreement can be found on such support. The agreement Huawei quoted is merely mentioning the condition of this configuration, but there is no agreement on such configuration is supported. In any case, there were a lot of examples that a

feature hasn't been captured in the spec even there were some related agreements. In some cases, the WG just stopped discussing it because there is no consensus on supporting it in further details. So, it would be more constructive that we don't waste time on the past agreements and focus on the current discussion about what clarifications are needed in the specs if this new scenario is introduced.

11 – LG Electronics France

We are still not sure if multiple SUL bands scenario should be supported, but open to the further discussion

12 – China Mobile Com. Corporation

We support proposal 5.1.

To Qualcomm: UL switching between 1T and 2T or, 2T and 2T was introduced for both CA and SUL. There is no restriction in the spec on the goals of deploying SUL.

We also would have to repeat the same comments that compared to TDD, SUL can reduce about 70% equipment cost based on our anlysis. According to our 5G network statistics, the throughput gap between DL and UL are reducing compared to 4G. However, the TDD configurations of 5G are the same as 4G due to the co-existence between 4G and 5G. Hence, for the low bands with relative smaller bandwidth, refarming to SUL is promising to meet the 5G service development with low cost. We are confused that why companies question the demand on the scenarios proposed by operators.

To ZTE:

The scenario is already included in Rel-18 WI. In RAN#96, the guidance is to focus on the listed three scenarios in Q3. This scenarios is not an upscoping at all.

As proponent, we already clarified that there are two cases for this scenario. We do not understand why companies continue to ask for clarification on the UL simultaneous transmisison.

² **Inter-band UL CA Option 1 (i.e., switched UL) for {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}**

l **Note: switching across any band in this scenario is not precluded**

² **Inter-band UL CA Option 2 (i.e., dual UL) for {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}**

l **Note: Simultaneous UL transmission across 2 NUL bands or 2 SUL bands**

13 – NTT DOCOMO INC.

[as DOCOMO]

We think at least simultaneous transmission between 1) SUL and SUL and 2) SUL and any NUL seems controversial for not based on the discussion on the proposal 5.1/5.2. So, considering specific operator's requests and the discussion for the updated proposal 5.2, one possible compromise would be to apply the following limitations similar to in the updated proposal 5.2.

" ~ the scenarios with {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band} where simultaneous transmissions between SUL and SUL and between SUL and any NUL are excluded. "

14 – NTT DOCOMO INC.

[as DOCOMO, correcting typo]

We think at least simultaneous transmission between 1) SUL and SUL and 2) SUL and any NUL seems controversial for now based on the discussion on the proposal 5.1/5.2. So, considering specific operator's requests and the discussion for the updated proposal 5.2, one possible compromise would be to apply the following limitations similar to the updated proposal 5.2.

" ~ the scenarios with {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band} where simultaneous transmissions between SUL and SUL and between SUL and any NUL are excluded. "

15 – MediaTek Inc.

We support the proposal.

16 – Nokia Corporation

We agree with ZTE that the functional support for integrating SUL and CA in general has not been discussed in general, and in the context of UL Tx switching it will add another UL Tx switching flavour that didn't exist before. Given the WI has 1 quarter remaining, we should aim at reducing the target scenarios that require extra work but don't seem to be well justified to stand a chance in completing the WI in the budgeted time.

17 – CATT

We agree with the proposal.

18 – Ericsson LM

From our perspective, it is important to distinguish two aspects in this discussion:

- Dual-SUL scenario is of interest for operators
- How to address the request by operators

In our view, the controversy is in "how" to address operators' need", than "whether to address operators' need".

On "how", we disagree with the assessment that there is no impact on other WGs by reusing CA framework for dual-SUL scenario.

For example, the priority rule agreed in RAN1#92b does not work for 2-SUL by reusing CA framework as claimed by proponents.

- For priority rules in UL CA, the UL carriers can belong to two PUCCH groups. That means if we just reuse CA framework, 2 SUL can belong to two PUCCH group. One can clearly observe that the existing priority rule doesn't work. This is one example to show that there are aspects needs further investigations.

- For priority rules, the spec states ”In case of same priority order and for operation with carrier aggregation, the UE prioritizes power allocation for transmissions on the primary cell of the MCG or the SCG over transmissions on a secondary cell. In case of same priority order and for operation with two UL carriers, the UE prioritizes power allocation for transmissions on the carrier where the UE is configured to transmit PUCCH. If PUCCH is not configured for any of the two UL carriers, the UE prioritizes power allocation for transmissions on the non-supplementary UL carrier.” what is the behavior if there are two cells each of which has a SUL?

- **I**n addition to the above RAN1/RAN2 changes for the proposed scenario, the Pcmax is not defined in the RAN4 specification for this scenario.

Hence, on “how” to address operators need properly, the need for any work/investigation in RAN1/RAN2 seems reasonable.

Therefore, we cannot be supportive of this proposal without acknowledging that it requires additional work as compared to other focused scenarios in previous RAN plenary.

5.3.2 2nd round Feedback for Proposal 5.2

Updated proposal 5.2:

- **If Rel-18 UL Tx switching is supported, RAN1/2/4 shall work on defining necessary mechanisms and requirements for UL Tx switching across 3 or 4 different bands including the scenarios with simultaneous transmission across 2 NUL bands in {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s) (excluding simultaneous transmission between SUL and any NUL).**

Feedback Form 19: 2nd round Feedback form for updated proposal 5.2

1 – Apple France We are fine with the updated proposal (to not include simultaneous transmission on SUL and any NUL)
2 – Samsung Research America We are open to this proposal, e.g., limit to across 2 NUL bands. We would still prefer to keep the supported scenarios to those prioritized for Q3 in RAN#96, but can support the updated proposal 5.2 if majority view of companies.
3 – New H3C Technologies Co. we are fine with this proposal
4 – Qualcomm Incorporated Similar view as Samsung. We are not supportive of this proposal but can accept it as a compromise.

5 – China Telecommunications

Thanks moderator for the great efforts and the Updated proposal 5.2.

In the initial round, companies commented that SUL band and its corresponding NUL band cannot be transmitted simultaneously. But SUL band and the non-corresponding NUL band can be transmitted simultaneously following the existing CA specification.

If additional restriction on the non-simultaneous transmission under CA framework is to be introduced, it will require additional specification work, and it is not preferred from workload management perspective.

6 – HUAWEI TECHNOLOGIES Co. Ltd.

Thank you very much for the great effort from the moderator!

We don't support the updated proposal 5.2, which excludes simultaneous transmission of NUL and SUL from different serving cells.

Reasons are given as below:

1. It is agreed in RAN#96 that "Mechanisms/requirements should not introduce restrictions on what were already supported in current specifications for UL Tx switching". In our view, simultaneous transmission of NUL and SUL from different serving cells are already supported by RAN1/2 specification since Rel-15. One example RAN1 agreement is as below:

Agreement (RAN1#92b)

Priority rule for SUL

- For simultaneous uplink transmissions that are power-limited, when one or multiple serving cell(s) are configured with both UL and SUL carriers
    - Existing priority rule based on signals/channels content
    - In case transmissions with the same priority level on the two UL carriers,

the UL carrier which is configured for PUCCH has higher priority

2. There are requests on simultaneous transmission of NUL and SUL from different serving cells by operators to boost the UL performance per the contributions (i.e. RP-222304) submitted under 9.3.1.2 for Rel-18 multi-carrier.

3. There is no additional RAN1&2 impacts for simultaneous transmission of NUL and SUL from different serving cells since common mechanism can be used, specifically by reusing the current CA framework where the same UE behaviors across serving cells, e.g. power sharing across cells and UL Tx chain sharing across cells, are applied to both the case without SUL and the case with SUL.

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3. There is no additional RAN1&2 impacts for simultaneous transmission of NUL and SUL from different serving cells since common mechanism can be used, specifically by reusing the current CA framework where the same UE behaviors across serving cells, e.g. power sharing across cells and UL Tx chain sharing across cells, are applied to both the case without SUL and the case with SUL.

9 – vivo Communication Technology

We prefer the original proposal 5.2. In our view, the most of the UL CA design can be reused to support the simutanous transmission of an SUL and an NUL from differnt cells.

10 – Intel Deutschland GmbH

We can be fine to support the proposal.

11 – ZTE Corporation

Similar as above, we still have concerns to add new scenario considering the limited TU.

The updated proposal is essentially to support dual UL only for some band pair(s) in the band combination of 3 or 4 bands, i.e., a mixture of switched UL and dual UL, which would require additional spec efforts including clarification on the specs about simultaneous transmission similar to the concerns in proposal 5.1. Hence, we disagree that this is just a simple extension. Also, this somehow contradicts with the Updated proposal 5.4-1 below. Therefore, we should focus only on agreed scenarios in RAN#96 and do not add this new scenario.

12 – LG Electronics France

We are fine with the proposal

13 – NTT DOCOMO INC.

[as DOCOMO]

We are fine with the updated proposal 5.2.

Based on the discussion so far, companies have different views on potential RAN1/2/4 impacts to support the simultaneous transmission between SUL and non-corresponding NUL irrespective of UL Tx switching. In such case, usually a study in WG(s) is required while it is not in the current scope of this WI. Therefore, unless companies could converge on ”no/minor RAN1/2/4 impacts to support the simultaneous transmission between SUL and non-corresponding NUL”, it would be better to not add it for now. In addition, even without simultaneous transmission between SUL and any NUL, the support of UL Tx switching with 3 or 4 bands including 1 SUL band with simultaneous transmission between NULs could be beneficial compared with switched UL (no simultaneous transmission between NULs) for such scenario.

14 – China Mobile Com. Corporation

We support the proposal. We do not understand the comments from ZTE. Does ZTE assume that in one band combination, switching is only allowed between dual UL transmissions? Depending on the different bands and UE capabilities, e.g. some bands do not support UL MIMO, some UL CA combinations lead to large MSD, restricting the switching cases will make the feature less attractive and useless in practice.

15 – Nokia Corporation

We see the proposal as a SUL enhancement rather than UL Tx Switching enhancement. In the context of UL Tx Switching this adds a combination of SUL and CA to UL Tx Switching cases, something that obviously was not there before. Thus this proposal doesn’t fall under CA-based nor under SUL-based UL Tx Switching, but creates yet another UL Tx Switching branch to the specification. Given the limited time left with the WI we do not support adding another UL Tx Switching branch.

16 – MediaTek Inc.

We are fine with the proposal.

17 – CATT

We agree with the proposal.

18 – Ericsson LM

We think the compromised proposal by Moderator, addresses one of the controversial issue as we explained previously. However, as Nokia rightly pointed out, it is a new flavor of scenarios for UL Tx switching. On the other hand, the compromised proposal doesn’t reflect the original proponents’ preferences.

We have to acknowledge that the extension of UL Tx switching is not perceived straightforward by all companies. Given the situation, how the expected work could be feasible in the limited remaining time when already there are many open issues on the table?

Therefore, we think it is realistic to focus on the scenarios agreed in last plenary and give them a chance to be completed, if possible.

19 – Ericsson LM

We think the compromised proposal by Moderator, addresses one of the controversial issue as we explained previously. However, as Nokia rightly pointed out, it is a new flavor of scenarios for UL Tx switching. On the other hand, the compromised proposal doesn't reflect the original proponents' preferences.

We have to acknowledge that the extension of UL Tx switching is not perceived straightforward by all companies. Given the situation, how the expected work could be feasible in the limited remaining time when already there are many open issues on the table?

Therefore, we think it is realistic to focus on the scenarios agreed in last plenary and give them a chance to be completed, if possible.

5.3.3 2nd round Feedback for Proposal 5.4-1

Updated proposal 5.4-1:

- **If Rel-18 UL Tx switching is supported, scenarios with mixing switched UL and dual UL (i.e., supporting dual UL only for some band pair(s) in the band combination of 3 or 4 bands) are excluded.**
  - **Note: it means the complexity reduction option 1 in RAN1 working assumption made at RAN1#110 is excluded.**

Feedback Form 20: 2nd round Feedback form for updated proposal 5.4-1

1 – Ericsson LM

Thanks Moderator for the great efforts. It is not clear to us how to interpret this proposal.

What is meant by "**mixing** switched UL and dual UL"?

Also, it is not clear how to understand the note when checking Option 1 in WA (copied below).

WA: Option 1: UE is allowed to support only some of concurrent UL cases (band pairs)

· FFS: at least one band pair should be supported as in Rel-17

· FFS: for both 3 and 4 bands cases or only for 4 bands case

· FFS: potential capability/RRC signaling

Appreciate additional clarifications!

2 – Apple France

We think that this proposal is more relevant for discussion in RAN1 and there is no immediate need to exclude such scenarios in RAN plenary

3 – Samsung Research America

We prefer to discuss UE complexity reduction techniques (Options 1-4 from RAN1#110) in RAN1. It seems premature to discard Option 1 as by RANP decision. Support for switchedUL vs. dualUL should capability-wise be left as UE feature implementation choice for the given NR band combination. It seems unreasonable to force an either dualUL for all or switchedUL for the relevant NR band combination.

4 – New H3C Technologies Co.

we needn't exclude any option in RAN plenary level and leave this issue to RAN1 for further discussion.

5 – Qualcomm Incorporated

Although we see that the proposal could provide some simplification at the conceptual level, it seems quite restrictive from the UE implementation perspective. So we would prefer no agreement on this proposal at this point.

6 – China Telecommunications

Thanks moderator for the great efforts. Sorry that currently we don't agree with the Updated proposal 5.4-1.

In the RAN4 LS to RAN1 in R4-2214464, the following agreement was captured:

For concurrent UL transmission on 2 bands:

For UL Tx switching across 3 and 4 bands, the support of concurrent UL transmission on 2 (out of 3 or 4) bands at least requires UL CA support on the corresponding band pair(s) by the UE.

It means that the support of concurrent UL transmission on 2 bands is not only based on the switching cases discussed in RAN1, but also based on the UE RF ability. So we'd prefer to discuss the 4 options for complexity reduction in WG level.

7 – HUAWEI TECHNOLOGIES Co. Ltd.

We also prefer to leave the down-selection of the candidate solutions for UE memory issue to WG discussions, since there are still many FFS points for each candidate solution, at this stage it is not clear which option(s) are better. On the other hand, the complexity reduction option 1 and option 4 are specific to UL-CA option 2 (dualUL), as we commented above, the major complexity is due to UL-CA option 2 (dualUL) instead of option 1 (switched UL), and thus if companies think workload is an issue, how to reduce the discussion for option 2 (dualUL) shall be discussed in this plenary.

By the way, if the motivation is to preclude any so called scenario of mixing switched UL and dual UL, then the complexity reduction option 4 in RAN1 WA (precluding switching between some band pairs, e.g. precluding switching between A and B from a BC of band A, B, C with dual UL) results in the same scenario and should be precluded as well.

8 – Intel Deutschland GmbH

We do not support the proposal. It is too early to exclude Option 1 in RAN WG without thorough investigation. Our view is that Option 1 in RAN1 working assumption is essential for complexity reduction,

especially for CA option 2. In this case, only a subset of switching cases need to be included, depending on UE capability.

9 – vivo Communication Technology

Similar as other companies, we prefer to leave such details to RAN1.

10 – ZTE Corporation

We prefer to adopt the proposal.

In Rel-16/17, the UE can only be configured by either switched UL or dual UL. Mixing switched UL and dual UL is a new Tx switching scenario and would require additional spec efforts to define a mixed Tx switching table. Since there was no mixed mode in Rel-16/17 Tx switching , it is expected a lot of issues will appear if such new scenario is allowed. Considering the limited TU, we suggest to focus on the supported Tx switching scenarios only.

11 – NTT DOCOMO INC.

[as DOCOMO]

We prefer to discuss down-selection of complexity reduction option(s) in RAN1 based on the working assumption made at RAN1#110.

12 – LG Electronics France

We think this issue should be discussed in RAN1 with more technical details.

13 – LG Electronics France

We think this issue should be discussed in RAN1 with more technical details.

14 – China Mobile Com. Corporation

Thanks for moderator's great efforts. We do not support this proposal. Whether to support UL CA with simultaneous transmission is up to UE capability. Due to the implementation difficulties for different bands, only supporting dual UL for all band pairs is too restrictive.

15 – Nokia Corporation

Similar to ZTE, we support the proposal as a way to reduce the combinations we need to work on in the last quarter of the WI.

16 – MediaTek Inc.

We object the updated proposal. There is no justification to such assumption (i.e., the UE must support dualUL on all the 3 or 4 bands). This will significantly jeopardize the chances of implementing UL Tx switching for 3 or 4 bands due to the extra complexity by forcing dualUL on all the on all the 3 or 4 bands.

In R16, the UE reports the supports switchedUL or dualUL per band combination. As a basic illustrative example, if we take 4 bands (A, B, C & D), in R16, the UE can report switchedUL for {A, B} band combination and dualUL for {C, D} band combination. For R18 Tx switching, the UE should be able report TX switching between the 4 bands (A, B, C & D) with the switchedUL option for {A, B} band combination and dualUL for {C, D} band combination.

17 – CATT

We agree with the comments from MediaTek and do not agree with the proposal.

5.3.4 2nd round Feedback for Proposal 5.4-2

Updated proposal 5.4-2:

- **Rel-18 UL Tx switching is supported at least for switched UL case with 3 or 4 bands**
  - **Note: scenarios without SUL and scenarios with one SUL band are at least included and scenarios with two SUL bands are under discussion in Proposal 5.1**

Feedback Form 21: 2nd round Feedback form for updated proposal 5.4-2

1 – Apple France

We support the proposal

2 – Ericsson LM

We think it is premature at this stage to support the feature. At least in RAN1, a WA was made in the last meeting that includes many open issues. Without technical discussions to resolve the issues, it is not clear to us how the feature would end up to be, and eventually what benefits the feature could provide. At least from our point of view, there should be a clear benefit as compared to Rel-17 to support the feature. The benefits rely on how capable the feature would be.

Therefore, we prefer to wait with that decision until more progress has achieved on the design.

3 – Samsung Research America

We are open to this proposal and can support the updated proposal 5.4-2 if majority view of companies.

4 – OPPO

We would prefer to have some agreeable complexity reduction solutions packaged together with an agreement to support this feature. RAN1 already have setup some study directions for complexity reduction, so maybe the better way is to leave the support-or-not decision to RAN1.

5 – New H3C Technologies Co.

we are fine with this proposal

6 – Qualcomm Incorporated

We would object to this proposal. Increasing the number of bands when all the UE is allowed to do is to jump around has diminishing returns. If anything, options with some simultaneous transmission capability should be prioritized, since those offer benefit.

7 – China Telecommunications

We don't agree with the proposal.

8 – HUAWEI TECHNOLOGIES Co. Ltd.

We support the proposal **with removing** the note.

Based on the current agreements, there is no any scenario excluded from Rel-18 UL Tx switching, thus no any note needed to clarify the target scenarios.

9 – Intel Deutschland GmbH

While we understand the intention of the proposal to down-scope the Rel-18 Tx switching and only support the switching UL case, we think dual UL case is an important feature to be supported in Rel-18. We do not support the proposal.

10 – vivo Communication Technology

We do not see the need to preclude dual UL case at least for now, both swiched UL and dual UL cases can be further discussed in RAN1.

11 – ZTE Corporation

We do not support the proposal.

According to the agreement in RAN#96, it has been agreed to focus on both inter-band UL-CA Option 1 (i.e., switched UL) and Option 2 (i.e., dual UL) without SUL band. Also, we had progress on last RAN1 meeting on support of Alt1 of Tx switching signaling for both Option1 and Option2. It's not clear to us why we need to revisit previous agreement here.

In addition, without supporting dual UL for inter-band CA makes the whole objective of Tx switching less attractive. It may require re-evaluation and re-assessment about whether there is still promising benefits the Rel-18 Tx switching feature can provide. In our view, the main controversial discussion in RAN1 is about complexity reduction, for which we observe similar issues for both switched UL and dual UL. In this sense, the proposal would jeopardize the whole work item without proving any help for the progress.

12 – NTT DOCOMO INC.

[as DOCOMO]

We are fine with the updated proposal 5.4-2. In our understanding, it does not intend down-scoping such as deprioritizing dual UL. This proposal is just to make one step forward at least for switched UL. But given companies would like to make such step together with complexity reduction option(s), we are fine to discuss it in WG.

13 – LG Electronics France We are fine with the proposal
14 – China Mobile Com. Corporation We think it is premature to agree on this proposal. We prefer to discuss the other proposals first and draw conclusion later.
15 – Nokia Corporation It would be attractive to limit to single-UL only in order to simplify the remaining work, but we are not convinced there is much use in single-UL only with >2 bands and it could render the whole Rel-18 enhancement somewhat pointless. Hence we are not supportive of the proposal even though would not object to it if there was a strong support to it.
16 – CATT We prefer to continue the discussions in RAN1 without prioritizing switched UL over dual UL.

5.4 Intermediate round summary

Summary of intermediate round feedbacks for the proposal 5.1:

- Fine with the proposal 5.1: Apple, New H3C, China Telecom, Huawei, vivo, CMCC, MediaTek, CATT (8)
- Not fine the proposal 5.1: Samsung, Qualcomm, Intel, ZTE, Nokia, Ericsson (6)
- Fine with the proposal 5.1 if simultaneous transmission between SUL and SUL and between SUL and any NUL are excluded: DOCOMO (1)

Moderator's suggestion: Companies still have different views on whether it is already included or not, and whether/how the support of this scenario will cause additional workload in RAN1/2/4.

Summary of intermediate round feedbacks for the updated proposal 5.2:

- Fine with the updated proposal 5.2: Apple, Samsung, New H3C, Qualcomm, Intel, LG, DOCOMO, CMCC, MediaTek, CATT, Ericsson (11)
- Not fine with the updated proposal 5.2 (prefer original proposal 5.2): China Telecom, Huawei, vivo (3)
- Not fine with the updated proposal 5.2 and also the original proposal 5.2: ZTE, Nokia (2)

Moderator's suggestion: Like the proposal 5.1, companies have different views on whether/how the support of simultaneous transmission between SUL and non-corresponding NUL will cause additional workload in RAN1/2/4.

Summary of intermediate round feedbacks for the updated proposal 5.4-1:

- Not fine with the updated proposal 5.4-1: Ericsson, Apple, Samsung, New H3C, Qualcomm, China Telecom, Huawei, Intel, vivo, DOCOMO, LG, CMCC, MediaTek, CATT (14)
- Fine with the updated proposal 5.4-1: ZTE, Nokia (2)

Moderator's suggestion: It seems better to continue discussion in WG.

Summary of intermediate round feedbacks for the updated proposal 5.4-2:

- Not fine with the updated proposal 5.4-2: Ericsson, OPPO, Qualcomm, China Telecom, Intel, vivo, ZTE, CMCC, Nokia, CATT (10)
- Fine with the updated proposal 5.4-2: Apple, Samsung, New H3C, DOCOMO, LG (5)
- Fine with the updated proposal 5.4-2 with removing note: Huawei (1)

Moderator's suggestion: It seems better to continue discussion in WG.

5.5 Final round discussion

The moderator would like to ask companies to provide feedback if any on above summary and each of following proposals. Based on the RAN chair guidance in Wednesday GTW session, companies are encouraged to provide details on the expected RAN1/2/4 impacts for the proposal.

5.5.1 3rd round Feedback for Proposal 5.1

Proposal 5.1

- **If Rel-18 UL Tx switching is supported, RAN1/2/4 shall work on defining necessary mechanisms and requirements for UL Tx switching across 3 or 4 different bands including the scenarios with {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}.**

Feedback Form 22: 3rd round feedback for proposal 5.1

1 – China Telecommunications

We support Proposal 5.1.

Our understanding of the discussion status is:

- The main concern on Proposal 5.1 is that Dual-SUL without Tx switching is not supported in the current spec.
- Meanwhile, for the R18 Tx switching feature itself, no additional work burden (compared to CA option 2) is observed if dual-SUL scenario is already supported in the spec.

On the first bullet:

To us, it is clear that for inter-band CA with two SUL bands, the CA framework is followed, with one NUL band and one SUL band configured on each serving cell.

We are confused by the argument that "the functional support for integrating SUL and CA in general has not been discussed in general". As we know, RAN4 has already introduced band combination of inter-band CA + SUL with 3 bands configured. If integrating SUL and CA is not supported functionally, does it mean that the existing RAN4 spec on inter-band CA + SUL band combination is incorrect? Here the scenario is just to increase the band number based on the CA with SUL framework.

In RAN #96, we already reached the following agreement. Given that inter-CA with dual-SUL is already supported in the current specification, we don't see the need to preclude it artificially.

- *Mechanisms/requirements should not introduce restrictions on what were already supported in current specifications for UL Tx switching*

2 – Ericsson LM

Our comments remain similar to our input in 5.3.1.

To CMCC:

Thanks for sharing your understanding on the situation. It seems that at least the point we tried to make in 5.3.1 is missing.

The way we see the situation is that the new scenario, {SUL1 band + corresponding NUL1 band} + {SUL2 band + corresponding NUL2 band} we would have at least these cases:

- SUL1 & SUL2
- SUL1 & NUL2
- NUL1 &SUL2

We tried to explain clearly in section 5.3.1 that the existing rules involving SUL and NUL, defines a priority rule to select one of the carriers for transmission.

- We explained that existing rules as it is, can not be reused for the cases above to select of on the carriers. Therefore, to select one, there is a need for additional work.
- If the intention is to transmit simultaneously, that is different from how SUL is handled currently (for example, the priority rule does not apply/needs modifications to distinguish the above cases with SUL1& NUL1 or SUL2&NUL2. That by itself means additional work is needed.

I hope the above make it more clear that from our point of view, to properly address operators need to support this scenario, we need to (1) either acknowledge the additional work that is needed, or (2) exclude the cases above from the scenario.

It is confusing to us, why neither (1) or (2) is not acceptable by proponents.

Hopefully this clarification, provide a (more) accurate picture of the situation.

3 – NTT DOCOMO INC.

[as DOCOMO]

As we commented in previous round, this scenario includes controvirsial cases, such as simultaneous transmission between SUL and SUL, simultaneous transmission between SUL and NUL, as Ericsson also pointed. So, it would not be preferable to discuss this scenario with such cases by consuming limited TU for this WI. At least we should exclude such cases from the scenario at this moment.

4 – Qualcomm Incorporated

We don't agree with adding these scenarios, for the same reasons as mentioned before.

5 – Qualcomm Incorporated

We don't agree with adding these scenarios, for the same reasons as mentioned before.

6 – MediaTek Inc.

We are fine with the proposal.

7 – Nokia Corporation

We don't agree that in UL Tx Switcihng context dual-SUL would not add to the concept, or that it is a natural fit. Today there are three differeten branches of UL Tx Switching defined in 38.214

- EN-DC
- CA
- SUL

SUL with CA doesn't exist. A SUL configuration always falls under the SUL branch of UL Tx Switching and a CA configuration falls under the CA branch as per the current specifications, and if the config has both the UE behaviour would be undefined. A new SUL + CA branch would need to integrate the two. This is of course not impossible, nothing is impossible to RAN1 (RAN1's been accused not be bound even by the laws of physics), but this is still a new branch on UL Tx Switching that goes more in the form of SUL enhancements than UL Tx Switching enhancements. Given the 2 quarters left and this debate obviously not being easy, we do not support adding these scenarios.

8 – HUAWEI TECHNOLOGIES Co. Ltd.

Our view is that the above mentioned scenarios are not precluded in Rel-18 multi-carrier enhancement WI, per the agreements made in RAN#96. We are fine with the above proposal 5.1 if companies would like to make it even clearer. At the same time, we will not agree to any proposal that explicit excludes the above mentioned scenarios. Reasons are as given in section 5.3.1.

@Ericsson

Thank you very much for sharing your detailed thinking. Regarding your comment on priority rule, actually, both the agreement from RAN1#92b and the current RAN1 specification show that same CA framework is applied for all scenarios with SUL and without SUL, of course including this particular dual SUL case. Please find the detailed explanations as below:

According to the RAN1 specification, UE will do the power reduction according to the priority order. Basically it can include the following steps:

a) Step 1: determine the one(s) with high priority based on the channel (i.e. PRACH/PUCCH/PUSCH/SRS) priority

i. Note that in this step, only the channel priority matters, regardless whether these channels are transmitted on SUL or NUL, or these channels from same PUCCH group or different PUCCH groups

b) Step 2: if needed, determine the one(s) with high priority based on the cell priority among the outcome from step 1, i.e. PCell has higher priority than SCell (s)

i. Note that no matter whether it is NUL or SUL on a cell, the same cell priority applies

c) Step 3: if needed, determine the one with high priority between to the two UL carriers from the same serving cell, i.e. the last bullet of RAN1#92b agreement

i. Note that this step 3 is only needed for SRS + SRS case where SRS on SUL and SRS on NUL within the same cell are transmitted simultaneously subject to UE capability, since there is no any simultaneous transmission of PUSCH+PUSCH or PUCCH+PUSCH from the two UL carriers from the same serving cell.

Take the case Cell 1 (SUL 1 + NUL1) + Cell 2 (SUL2 + NUL2) as given by you as an example, based on the above priority rule, no matter whether it is SUL1 + SUL2, SUL1 + NUL2, or NUL1 + SUL2, the above priority rule applies, since you could see from the above steps that it doesn't matter whether it is SUL or NUL on the cell.

9 – LG Electronics France

Our position is same as in previous stage. That is, we don't see a clear necessity of this scope, but open to the discussion.

10 – China Mobile Com. Corporation

Firstly, the scenarios proposed in 5.1 is already included in the WI, we are not proposing to add anything new.

Secondly, SUL with intra-band CA and inter-band CA band combinations already supported in 38.101. SUL is a cell with two UL carriers. CA is between multiple cells. It is pretty much clear from RAN1

perspective, if it involves more than one cell aggregated, then it should be CA. So it is clear that the scenario in proposal 5.1 is CA. I do not understand why it is impossible from RAN1 perspective.

For the priority rule, just as Huawei commented, the priority rule does not change for NUL or SUL on the cell.

11 – ZTE Corporation

First of all, we observe that companies not only have different understanding about the expected RAN1/2/4 impacts, but also about the necessity/urgency of the new scenarios, which also needs further discussion.

@ China Telecommunications, Thanks for the clarifications. As we commented before, given that RAN4 specs clearly define SUL band combinations whenever there is any SUL band, our view is that one cannot claim this new scenario belongs to inter-band CA band combination/operation if two SUL bands are introduced. In addition, we don't think RAN4 has already introduced band combination of inter-band **UL** CA + SUL with 3 bands configured.

Regarding the detailed RAN1/2/4 impacts, we have provided many clarification questions in the first two rounds already. We have to reiterate here again.

Reiterating some of our clarification questions in the initial round:

- Inter-band UL CA with one SUL band is not supported yet in RAN4. This should be first discussed before supporting more SUL bands for CA.
- What's the motivation to introduce more than 1 SUL considering that SUL is mainly for coverage enhancement? What's the difference from supporting 3/4 bands CA- Option 1?
- Whether simultaneous transmission between two SUL bands are supported or not? What's the difference from supporting 3/4 bands CA- Option 2?
- A lot of the UE behaviour are defined under the conditions of intra-band/inter-band CA or SUL band combinations in RAN1/RAN2 specs. It is not clear which one the new scenario will fall into.
- It is not clear how to define intra-band and inter-band if NUL and SUL can be overlapped in the same physical band (intra-band?). RAN4 requirements also need to be discussed and defined.

Reiterating some of our clarification questions in the second round:

It cannot be claimed that the current specs are "band-agnostic" in this perspective. If inter-band CA with two SUL bands is supported, it's not clear whether the UE behavior over the two SUL bands should follow SUL band combination or inter-band CA band combination, or how to define intra-band or inter-band especially when the NUL and SUL overlaps in the same frequency band. Given that RAN4 specs clearly define SUL band combinations whenever there is any SUL band, our view is that one cannot claim this new scenario belongs to inter-band CA band combination/operation if two SUL bands are introduced. Also, when we introduce this new type of band combinations, proponents have to clarify whether simultaneous transmission is supported in different combinations including NUL+NUL, NUL+SUL, SUL+SUL and the corresponding specs changes are needed to clarify this. Like the copied spec textsfrom TS 38.214 below, UE behavior should be clarified for the new scenario with two SUL bands.

''For intra-band and inter-band CA operations, a UE can simultaneously transmit more than one SRS resource configured by SRS-PosResource on different CCs, subject to UE's capability

For intra-band and inter-band CA operations, a UE can simultaneously transmit more than one SRS resource configured by SRS-PosResource and SRS-Resource on different CCs, subject to UE's capability.

...

In case of intra-band contiguous carrier aggregation, or in inter-band or intra-band non-contiguous CA band combination if simultaneous SRS and PUCCH/PUSCH transmissions are not supported by UE, the UE is not expected to be indicated with a SRS transmission from a carrier and to be configured or scheduled with a PUSCH/UL DM-RS/UL PT-RS/PUCCH transmission from a different carrier in the same symbol.

In case of intra-band contiguous carrier aggregation, or in inter-band CA band combination if simultaneous SRS and PRACH transmissions are not supported by UE, or in case of intra-band non-contiguous CA band combination if the UE is not configured with higher layer parameter intraBandNC-PRACH-simulTx-r17, the UE shall not transmit simultaneously SRS resource(s) from a carrier and PRACH from a different carrier. "

In fact, we have more clarification questions. Below are some specific examples.

Additional Example #1: In Rel-15, the following FGs is defined for SUL. Then, it needs to clarify whether/how to extend these UE capabilities to the new scenarios. For instance, whether need to define a new FG for support of different numerologies between two SUL carriers? , how to define the UE capabilities for simultaneous transmission of SRS and PUSCH/PUCCH/SRS between SUL+SUL, SUL+non-corresponding NUL, how about the UE capabilities for other simultaneous transmission cases? It expects lots of RAN1/RAN2 impacts here.

- *FG 6-17: Supplemental uplink with different numerologies between SUL and non SUL carriers*
- *FG 6-18: Supplemental uplink with dynamic switch*
- *FG 6-19: simultaneous transmission of SRS on an SUL/non-SUL carrier and PUSCH/PUCCH/SRS on the other UL carrier in the same cell*

Additional Example #2:

In case of two SUL bands, and potential simultaneous transmission between SUL+SUL and SUL+non-corresponding NUL, what's the UE behavior of UCI multiplexing, e.g.,

- Could PUCCH be configured on both SUL bands? If allowed, they belongs to one PUCCH group or PUCCH groups?
- Is it allowed time overlapping between PUCCH and PUSCH from SUL+SUL or SUL+non-corresponding NUL?
- In Rel-17, simultaneous transmission of PUCCH and PUSCH are supported for inter-band CA. Is it allowed to support simultaneous transmission of PUCCH and PUSCH from SUL+SUL or SUL+non-corresponding NUL?
- How to define the UE capabilities for above features?

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12 – HUAWEI TECHNOLOGIES Co. Ltd.

@Nokia

Thank you very much for sharing the detailed thinking! Please find our reply as below:

We don't need to introduce any new branch to support the scenario of {SUL band + corresponding NUL band} + {SUL band + corresponding NUL band}. For all the following cases, it will go to the branch of CA.

- SUL1 + SUL2
- SUL1 + NUL2
- NUL1+ SUL2
- NUL1 + NUL2

Since Rel-15, as long as more than one serving cell is configured, the CA framework will be used, which includes,

- The UE behavior between SUL and paired NUL in the same cell refers to the UE behaviors specified on the context of one serving cell
- The UE behavior across multiple serving cells refers to the same UE behaviors for CA irrespective of whether the UL carrier on SUL band or on TDD/FDD bands

Take section 6.1.6.2 in 38.214 as an example, you could see that the terminology used there is "uplink carrier", which obviously means that this "uplink carrier" can be either SUL or NUL.

13 – Samsung Electronics Co.

Above discussions are very helpful while the company's understandings are still divergent. So we are still reluctant to go with proposal 5.1.

14 – China Unicom

We support proposal 5.1.

And we share the similar view that the mentioned scenario were not precluded in Rel-18 multi-carrier enhancement WI.

15 – Apple France

We are open to accept the proposal considering interest from operators.

5.5.2 3rd round Feedback for Proposal 5.2

Original proposal 5.2

- **If Rel-18 UL Tx switching is supported, RAN1/2/4 shall work on defining necessary mechanisms and requirements for UL Tx switching across 3 or 4 different bands including the scenarios with simultaneous transmission across 2 bands in {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s) (excluding simultaneous transmission between SUL and corresponding NUL).**

Updated proposal 5.2

- **If Rel-18 UL Tx switching is supported, RAN1/2/4 shall work on defining necessary mechanisms and requirements for UL Tx switching across 3 or 4 different bands including the scenarios with simultaneous transmission across 2 NUL bands in {SUL band + corresponding NUL band} + 1 or 2 other NUL band(s) (excluding simultaneous transmission between SUL and any NUL).**

Feedback Form 23: 3rd round feedback for Proposal 5.2

1 – China Telecommunications

Many thanks for moderator's great efforts.

We still prefer the Original proposal 5.2.

As we commented in the intermediate round, for the Updated proposal 5.2, additional restriction of non-simultaneous transmission between 2 serving cells for UL CA (when SUL is used in one cell, and NUL is used in the other cell) is to be introduced, it will require additional specification work, and it is not preferred from workload management perspective.

2 – Qualcomm Incorporated

Our view has not changed. As a compromise we can accept updated proposal 5.2, but we cannot accept the original proposal 5.2.

3 – Intel Deutschland GmbH

We are fine for updated proposal 5.2 as a compromise to move forward.

4 – Apple France

We prefer the updated proposal 5.2

5 – Ericsson LM

Our comment remains similar to 5.3.2 in intermediate round.

Please see additional clarification that we provided in 5.5.1 for Final round (previous question).

6 – NTT DOCOMO INC.

[as DOCOMO]

We are fine with updated proposal 5.2 or excluding this scenario in Rel-18. Given different views among companies on simultaneous transmission between SUL and non-corresponding NUL, it seems not preferable to discuss it by consuming the limited TU for this WI.

7 – Samsung Electronics Co.

We can live with the updated proposal 5.2.

8 – MediaTek Inc.

We are fine with the original proposal 5.2.

9 – Nokia Corporation

SUL+CA simultaneous Tx is a new case to begin with when prioritizing the uplinks for transmission. Excluding the simultaneous transmission fixes the prioritization, but makes the UL CA management in the network cumbersome. Would the UE drop the Carrier 2 NUL if Carrier 1 SUL is scheduler or vice versa? Or is the expectation that these are error cases that are not allowed to happen and the UL schedulers must dynamically coordinate what they do? If PUCCH is on SUL, then HARQ feedback management would need to determine if a PUCCH on SUL is sent or if PUSCH on NUL (with UCI muxed on it) is sent adding to the nice UCI multiplexing rules for UL CA we discussed in the past 1.5 years. That is - preventing simultaneous Tx on SUL of carrier 1 and NUL of carrier 2 may get us around some problems, but it would open up other questions to answer and potentially to specify around.

On top of that we have the new branch for UL Tx Switching with SUL+CA configuration as we explained in 5.5.1 response adding yet another branch to the Tx Switching .

10 – LG Electronics France

We are fine with the updated proposal as well.

11 – China Mobile Com. Corporation

We prefer orignal proposal 5.2

12 – ZTE Corporation

For both proposals, we have similar comments regarding the necessity/urgency of the new scenarios and RAN1/2 impacts as for Proposal 5.1 above. We would not reiterate here.

13 – HUAWEI TECHNOLOGIES Co. Ltd.

We still prefer the original proposal 5.2. We don't support the updated proposal 5.2, which excludes simultaneous transmission of NUL and SUL from different serving cells. Reasons are as given in section 5.3.2.

In addition, as Nokia commented above, excluding simultaneous transmission of NUL and SUL may cause new issues to solve which will cause additional workload, thus it is obvious that supporting simultaneous transmission is even better from workload perspective, since as explained many times common mechanisms can be used for this case and thus no additional workload.

Regarding the comment from Ericsson, please see our reply in section 5.5.1.

14 – ZTE Corporation

Reply to the CMCC's clarification in the intermediate round:

What we meant is to avoid a new Tx switching scenario with supporting 'dual UL' for some band pairs while 'switched UL' for the other band pairs for a band combination. Similar as Rel-16/17, we suggest to focus on configuring 'switched UL' only or 'dual UL' only for a band combination given the limited TU.

15 – China Unicom

Thanks for moderator's hardwork. We still prefer with original proposal 5.2, and do not support updated proposal 5.2.

5.6 Final round summary

Summary of Final round feedbacks for the updated proposal 5.1:

- Fine with proposal 5.1: China telecom, MediaTek, Huawei, CMCC, China Unicom, Apple (6)
- Not fine with proposal 5.1: Ericsson, DOCOMO, Qualcomm, Nokia, LG, ZTE, Samsung (7)
  - Exclude SUL&SUL and SUL&NUL cases: Ericsson, DOCOMO (2)

Summary of Final round feedbacks for the updated proposal 5.2:

- Fine with original proposal 5.2: China telecom, MediaTek, CMCC, Huawei, China Unicom (5)
  - Not fine with original proposal 5.2: Qualcomm, Intel, Ericsson (3)
- Fine with updated proposal 5.2: Qualcomm, Intel, Apple, DOCOMO, Samsung, LG, Ericsson (7)
  - Not fine with updated proposal 5.2: Huawei, China Unicom (2)
- Not fine with both: Nokia, ZTE (2)

Based on above, both proposals are still controversial and for the scenarios in the proposals, companies have different views on necessity/urgency and additional impacts in RAN1/2/4. Since the situation has almost not changed from the beginning even after three rounds of discussions, unfortunately, there seems to be tiny/no chance for these proposals to be converged by the end of this meeting.

No conclusion/agreement could be made on additional scenarios at this meeting.

6 Discussions on new WID for NR CA band combinations with dual SUL bands in Rel-18

As described in section 5, in [9] and [10], new WID on NR Inter-band CA band combinations with dual SUL bands was proposed.

The justification is described as below.

NR CA band combinations with SUL band were introduced from Rel-16. In Rel-16, intra-band CA with SUL band combi

The objective is proposed as below.

Analyse combinations that have self-desensitization due to following reasons:

- TX Harmonic and/or intermodulation overlap of receive band
- TX signal overlap of receiver harmonic frequency
- TX frequency being in close proximity of one of the receive bands
- Any other identified reasons such that insufficient cross band isolation, harmonic mixing

For the combination where self-desensitization exists, specify at least needed

- $\Delta T_{IB, c}$ and $\Delta R_{IB, c}$
- Reference sensitivity exceptions including MSD test cases
- Exceptions to the out-of-band blocking requirement

The following band combinations are proposed.

Table 16:

NR CA configuration	Uplink CA configuration	Pov
CA_SUL_n41A-n95A_SUL_n79A-n98A	SUL_n41A-n95A SUL_n79A-n98A CA_n41A-n79A CA_n95A-n98A	PC
CA_SUL_n41A-n98A_SUL_n79A-n95A	SUL_n41A-n98A SUL_n79A-n95A CA_n41A-n79A CA_n95A-n98A	PC
CA_SUL_n41A-n83A_SUL_n79A-n98A	SUL_n41A-n83A SUL_n79A-n98A CA_n41A-n79A CA_n83A-n98A	PC
CA_SUL_n41A-n83A_SUL_n79A-n95A	SUL_n41A-n83A SUL_n79A-n98A CA_n41A-n79A CA_n83A-n95A	PC
CA_SUL_n78A-n81A_SUL_n78A-n84A	SUL_n78A-n81A SUL_n78A-n84A CA_n78C CA_n84A-n81A	PC
CA_SUL_n78A-n80A_SUL_n78A-n84A	SUL_n78A-n80A SUL_n78A-n84A CA_n78C CA_n80A-n84A	PC
CA_SUL_n78A-n89A_SUL_n78A-n81A	SUL_n78A-n89A SUL_n78A-n81A CA_n78C CA_n81A-n89A	PC

The requested TUs for core part and performance part are as below.

- 0.5 TU/meeting for RAN4 RF from Q4 2022 to Q4 2023 for core part
- 0.1 TU/meeting for RAN4 RF from Q4 2022 to Q4 2023 for performance part

6.1 Initial round discussion

The moderator would like to ask companies to provide feedback if any on each of the proposed WID contents.

6.1.1 1st round Feedback for Proposal 6.1

Proposal 6.1

Companies are encouraged to provide feedback on the justification in [9] if any.

Feedback Form 24: 1st round Feedback form for Proposal 6.1

1 – Ericsson LM If the intention is to support the scenario in [9] and then apply UL TX switching for 4 bands in MCE WI if supported, the expected impact on RAN4 needs clarification. For example, the assumption on co-location, or the assumption on simultaneous transmissions. At least the latter could consequently constrain DL and could impact the duplex filtering. All these aspects need clarifications if UL Tx switching is intended to be applied for the scenario in the new WID.
2 – Apple (UK) Limited For the proposed dual-SUL CA combinations, please clarify if only 2-band UL would be configured at a time, or all 4 UL bands need to be configured. Using CA_SUL_n41A-n95A_SUL_n79A-n98A as an example, if only two UL bands are configured at a time, we do not think CA_n95A-n98A is a valid UL configuration as there is no PCell in the UL. On the other hand, if only UL CA_n41A-n79A is configured, it is no different from 2-band combination CA_n41A-n79A for both DL and UL.
3 – Qualcomm Technologies Int For the justification, it would be good to understand more why operator would demand to use only half of the spectrum, meaning only the UL part of the FDD band and how does it boos the wide band experience. And a note, the justification for the WID is to enable dual SUL as it is written, to our understanding RAN1 design does not support two simultaneously configured SUL bands.
4 – ZTE Corporation We respect operators' demands, however we disagree the justification. In the NR CA band combinations with SUL in Rel-16/17, carrier aggregation is applied among downlink carriers, or intra-band non-SUL uplink carriers. Support of aggregating an SUL carrier with another NR normal uplink carrier or another SUL carrier is a new feature and requires specifying RF core requirements and RAN1/RAN2 core specs impacts. Before completing the new feature, a basket WID shall not be approved. The proper procedure should be ensured.
5 – ZTE Corporation We respect operators' demands, however we disagree the justification. In the NR CA band combinations with SUL in Rel-16/17, carrier aggregation is applied among downlink carriers, or intra-band non-SUL uplink carriers. Support of aggregating an SUL carrier with another NR normal uplink carrier or another SUL carrier is a new feature and requires specifying RF core requirements and RAN1/RAN2 core specs impacts. Before completing the new feature, a basket WID shall not be approved. The proper procedure should be ensured.
6 – E-surfing Digital China Telecom:

As co-sourcing company of RP-222130, we support the new basket WID. Creating new basket WID with increasing numbers of bands is a usual business based on operators' request.

Response to E///'s comment (Comment #1):

The basket WI is to specify band combination specific requirements and can be release independent from Rel-15, and thus it should be discussed separately with any further enhancement in Rel-18.

Response to Apple's comment (Comment #2):

In our understanding, only 2-band UL would be configured. When CA_n95A-n98A is configured for UL, the DL CA configuration is still CA_SUL_n41A-n95A_SUL_n79A-n98A, so the PCell DL can be on either band n41A or n79A.

Response to QC's comment (Comment #3):

On the justification, for the DL spectrum, there are legacy RATs which cannot be re-farmed for NR deployment in some scenarios. For example, in 800 and 900MHz spectrum, there are 2G/3G/4G deployed and DL traffic is heavy for the legacy RATs.

On the RAN1 design, under the framework of UL CA with 2 cells, and one NUL band and one SUL band in each cell, dual-SUL configuration is supported in RAN1/2 from Rel-15.

Response to ZTE's comment (Comment #4):

We agree new RF band combination specific requirements are needed to support UL CA with dual SUL, and that's the reason to bring this basket WID. But we don't think RAN1/2 will be impacted.

This basket WI is same with other CA/DC or EN-DC basket WIs to increase the number of bands in RAN4 based on Rel-15 RAN1/2 spec.

7 – Ericsson LM

Thanks China Telecom for the feedback.

Our comment did not question the basket WI. That is well understood. It is not clear to us, if this scenario is intended to use with UL-Tx switching, what are the related assumptions for this scenario that would impact UL Tx switching.

8 – Huawei Technologies France

The justification part reflects the deployment scenario by operators. We support requests on band combinations based on the deployment scenario.

In addition, we think that this band combination WI proposal is not related to the Rel-18 multicarrier enhancements WI. As usual, the band combination requested by operators is a RAN4 only and spectrum related topic, which shall be release independent. Thus, we think the topic is more proper to be discussed under [97e-08-R18-RAN4-OtherSpectrumRelated]. Even though the band combination proposal is treated under this thread, we do believe it is not dependent on the Rel-18 multicarrier enhancements WI.

To Ericsson's comments, we think this WI is just RAN4 band combination work, no Tx switching described in the WID.

To Apple's comments, we share similar view with China Telecom.

To ZTE's comments, band combination specific requirements would be specified, which is similar to other band combination basket WIs. RAN4 spectrum work (e.g. band combination) is usually done per the request from operators in release independent way. We also don't think there are RAN1/2 impact for just band combination work in RAN4.

9 – Nokia Corporation

We tend to agree with ZTE and Ericsson that the described scenario is not just a matter of band combination, but there are functional aspects that would seem to need investigation and potentially new specification work.

10 – MediaTek Inc.

It is clear this WI is beyond the scope of R18 UL Tx switching. Hence, this should be discussed part of [97e-08-R18-RAN4-OtherSpectrumRelated] email discussion.

11 – China Mobile Com. Corporation

To Ericsson: As commented by CTC and Huawei, this WI proposal is not related to Rel-18 multicarrier enhancement WI. This should be treated as a RAN4 only spectrum topic. No Tx switching is assumed.

12 – China Mobile Com. Corporation

To Apple: The DL PCell will be either n41 or n79 when CA_n95A-n98A is configured for UL.

To Qualcomm: As commented by CTC, some DL spectrum of FDD bands cannot be refarmed due to the heavy DL traffic. Also, there are also some TDD bands, when refarming to NR, SUL only requires receiver at the BS side, which will reduce the equipment cost significantly.

In our view, following CA framework, dual-SUL configuration in CA framework is supported in RAN1/2.

13 – Ericsson LM

To CMCC:

Thanks for the feedback. The point that is not clear to us and we try to understand is that:

For 6.1 discussions, we understand that the proponents view that this should be viewed as only a new band combination, impacting only RAN4. However, it appears that the proponents have the view that the same scenario is used as a motivation for proposal 5.1 for example. This is confusing and therefore, we would like to have a realistic assessments regarding applying UL Tx switching for this scenario.

14 – China Unicom

We support for this WI, and this WI is not related to Rel-18 MCE WI.

For spectrum utilization for FDD band, we share the same view with CT and CMCC. It is very hard to have the balance load in both DL and UL at most of the time. This WI is spectrum related RAN4 topic and it should be treated in R18.

6.1.2 1st round Feedback for Proposal 6.2

Proposal 6.2

Companies are encouraged to provide feedback on the objective including target band combinations in [9] if any.

Feedback Form 25: 1st round Feedback form for Proposal 6.2

1 – Ericsson LM See our comment to Proposal 6.1.
2 – Qualcomm Technologies Int For every CA configuration in the list, there is dual SUL uplink configuration: CA_n81A-n89A, CA_n80A-n84A, CA_n84A-n81A, CA_n83A-n95A, CA_n83A-n98A, CA_n95A-n98A. It is not clear what is the expected UE behavior for this uplink configuration. Is simultaneous transmission expected? And if this uplink configuration would be removed, then it is unclear what is the expected UE behavior for a CA configuration with two SUL bands? Is it according to proposal 5.1 or proposal 5.2? And what about simultaneous transmission with the SUL and non corresponding NUL band? In case simultaneous transmission, more items are needed in the general part such as Pcmax handling for dual SUL and SUL with non corresponding NUL, which then make this WI not spectrum related but a general feature which should be discussed under rel-19 package. In the absence of clear understanding it is difficult to agree this proposal.
3 – ZTE Corporation As stated, it is not the proper procedure to approve a basket WID requiring a new feature with core specs impacts.
4 – E-surfing Digital China Telecom: Response to QC's comment: The CA + SUL band combination is under the framework of CA. So for the Pcmax, we just follow the definition for UL CA.
5 – Huawei Technologies France We support the objectives and proposed band combinations. The possible RF requirements for the band combinations are captured clearly in the objectives which also follow the usual way adopted by other band combination basket WIs. To Qualcomm's comments: The band combinations in the WI follow the CA framework. Since dual SUL bands belong to two different cells, inter-band UL CA requirements are applicable to the dual SUL bands or SUL with non corresponding NUL.

To ZTE's comments, every new band combination proposed in RAN4 would have BC specific RF requirements. But it is not called a new feature.

6 – Nokia Corporation

Tend to agree with Qualcomm and ZTE comments.

7 – China Mobile Com. Corporation

To Qualcomm: For the listed UL CA configurations, UE is expected to transmit simultaneously. The UL CA can be configured with RRC. For simultaneous transmission with SUL and NUL, we do not propose this type of UL simultaneous transmission in this WI.

For Pcmax, since this is exactly follow CA framework, definition of UL CA Pcmax is followed.

6.1.3 1st round Feedback for Proposal 6.3

Proposal 6.3

Companies are encouraged to provide feedback on the TU requests in [9] if any.

Feedback Form 26: 1st round Feedback form for Proposal 6.3

1 – Ericsson LM

See our comment to Proposal 6.1.

2 – Qualcomm Technologies Int

With the current understand and open items in the UE behavior, ran1 TUs would be needed for this WI.

3 – ZTE Corporation

It requires TU for both RAN1, RAN2 and RAN4. While Proposal 6.1 and Proposal 6.2 should be discussed first before allocating any TU for the proposed WI.

4 – ZTE Corporation

It requires TU for both RAN1, RAN2 and RAN4. While Proposal 6.1 and Proposal 6.2 should be discussed first before allocating any TU for the proposed WI.

5 – E-surfing Digital

China Telecom:

RAN1/2 work is not needed.

6 – Huawei Technologies France

We are fine with the proposed TU. It is noted that spectrum related WI could be handled with running CR according to the RAN4 normal basket procedure and TUs for all spectrum WI/basket WI are considered as a package.

There are no RAN1/2 impact for the RAN4 band combination work.

7 – Nokia Corporation

There is obviously no RAN1/RAN2 impact on band combination work itself, but this band combination is something that didn't exist before and it opens up functional questions that need to be answered/specified before the proposed band combinations are meaningful.

8 – China Mobile Com. Corporation

As explained above, no RAN1/2 impact is required for this WI proposal. The justifications are provided and operator has clear request.

6.1.4 1st round Feedback for Proposal 6.4

Proposal 6.4

Companies are encouraged to provide feedback on any other part in [9] if any.

Feedback Form 27: 1st round Feedback form for Proposal 6.4

6.2 Initial round summary

Based on the initial round discussion, companies' views could be summarized as below.

- For Proposal 6.1
  - Support the justification: China Telecom, Huawei, CMCC, China Unicom
  - Clarification is necessary: Ericsson, Apple, Qualcomm
  - Not support the justification: ZTE, Nokia
    - It would not be just band combination matter, but there would be some functional aspects with RAN1/2 impacts
  - This should be discussed in [97e-08-R18-RAN4-OtherSpectrumRelated]: China Telecom, Huawei, MediaTek, CMCC, China Unicom
    - This WID does not assume UL Tx switching

Based on above, it is clarified by proponents that the proposal in [9] is not related to Rel-18 UL Tx switching discussed in NR_MC_enh WI at all. However, even in such case, some companies would think the proposed band combinations would have some functional aspects with RAN1/2 impacts. It is up to RAN chair whether

it should be discussed here or separately, but anyway more discussion seems necessary. It is also encouraged for the proponents to provide updated justification text if any to address the comments from companies.

- For Proposal 6.2
  - Support the objectives: China Telecom, Huawei, CMCC
    - Band combinations in this WI follow the CA framework
    - Simultaneous transmission with SUL and NUL is not proposed
  - Clarification is necessary: Ericsson, Qualcomm, Nokia
    - What is the expected UE behavior for dual SUL uplink configuration
  - Not support the objectives: ZTE, Nokia
    - This requires a new feature with core spec impacts

Same as the proposal 6.1, it is up to RAN chair whether it should be discussed here or separately, but anyway more discussion seems necessary. It is also encouraged for the proponents to provide updated objective text if any to address the comments from companies.

- For Proposal 6.3
  - Support the TU request: China Telecom, Huawei, CMCC
    - RAN1/2 work is not needed
  - Clarification is necessary: Ericsson
  - RAN1 TU is also necessary: Qualcomm, ZTE, Nokia
  - RAN2 TU is also necessary: ZTE, Nokia

Same as the proposal 6.1/6.2, it is up to RAN chair whether it should be discussed here or separately. As suggested by some companies, it seems necessary to discuss the justification and objective parts first before discussing TU request. So, the TU requests can be discussed after further discussion on proposal 6.1/6.2.

For Proposal 6.4, there is no input and hence it can be closed.

6.3 Intermediate round discussion (if the discussion on the new WID continues in this email discussion)

The moderator would like to ask proponents to provide provide updates on justification/objectives if any to address comments in initial round discussion. The moderator would also like to ask companies to provide further feedbacks based on the initial round discussion and summary.

6.3.1 2nd round Feedback for Proposal 6.1

Proposal 6.1

Companies are encouraged to provide further feedback on the justification in [9] if any. Proponent companies are also encouraged to provide any update on the justification to address comments from companies.

Feedback Form 28: 2nd round Feedback for Proposal 6.1

1 – China Telecommunications

We, together with other operators, have explained the scenario and impacted WG of this basket WI on defining band combination specific requirements.

For companies commenting that RAN1/2 TU is needed, could someone clarify what work RAN1/2 is assumed to do?

2 – Qualcomm Technologies Int

On the justification, was it so that UE was not allowed to declare on which band it supports PCell since in DL CA case, network wants to distribute the UL PCell to the DL bands evenly to balance the loads. If the deployment is such that the UL is un used for the bands whose DL is configured for CA on other bands, can we then bring back the PCell indication? And for this case the is the rel-15 ULSUP can be used. So it is mildly difficult to relate to the justification based on what is commented.

For the RAN1 TU, as discussed in previous meetings in RAN1, PHR report is not supported with SUL whenever more than two UL bands are configured. This will need some checking and or work ensure PHR indeed works in this scenario.

However, more important aspect is the late introduction of such large WI bypassing the Rel-18 package.

3 – Apple (UK) Limited

For our question on whether CA_n95-n98 is a valid UL configuration in CA_SUL_n41A-n95A_SUL_n79A-n98A, the comment from the proponent company was still unclear to us. Our concern is on what is the PCell for UL, but not for DL. Our reasoning is that in the existing single SUL band combination, SUL always needs to pair with a NUL. SUL alone cannot be the UL configuration in a band combination.

In our view, if only 2-band UL would be configured at a time for the proposed dual-SUL CA combination, such as for CA_SUL_n41A-n95A_SUL_n79A-n98A where either SUL_n41A-n95A, SUL_n79A-n98A, CA_n41A-n79A, or CA_n95A-n98A would be configured, CA_n95A-n98A would not be a valid UL configuration as there would be no PCell in the UL. CA_n41A-n79A as UL would be no different from non-SUL CA combination. With SUL_n41A-n95A as UL, the combination would be no different from CA_n79A_SUL_n41A-n95A. With SUL_n79A-n98A as UL, the combination would be no different from CA_n41A_SUL_n79A-n98A.

If more than 2-band UL would be configured, such as CA_n41_SUL_n79-n98A as UL, in our view this would be a new feature which may require general requirements development first. Overall, we think further clarifications on the dual-SUL CA operation are still needed.

4 – ZTE Corporation

Firstly we would like to reiterate that in the current RAN4 specs on inter-band CA combination with SUL the carrier aggregation only happens on the downlink direction, or among non-SUL carriers. The justification texts are incorrect at this regard.

Secondly, we are talking about the core requirement impacts from combining UL inter-band CA and SUL bands, not band-specific requirements. More specifically, for example, if (NUL#1 + SUL#1) is aggregated with an inter-band (NUL#2 + SUL#2) at the uplink direction, what would be the configured transmit power requirement in this case? Actually, likewise combining UL CA and UL MIMO results in separate sections with a suffix -H for all Tx core requirements, which is treated as a new feature. The story is similar for combining UL inter-band CA and SUL, and all of Tx core requirements have to be reviewed/specified accordingly.

In addition, as we commented for proposal 5.1, it could also cause large RAN1/2 impacts. One example is that a lot of the UE behaviour defined in RAN1/RAN2 specs depends on different types of band combination , e.g., under the conditions of intra-band/inter-band CA or SUL band combinations. Therefore, it cannot be claimed that the current specs are "band-agnostic" in this perspective. If inter-band CA with two SUL bands is supported, it's not clear whether the UE behavior over the two SUL bands should follow SUL band combination or inter-band CA band combination, or how to define intra-band or inter-band especially when the NUL and SUL overlaps in the same frequency band. Further details can be also found in our comments for Proposal 5.1.

5 – Nokia Corporation

As commented on the 1st round, the functional support for the proposed band combination does not exist. introducing a band combination that the functional specs do not support is meaningless. If e.g. in the UL Tx Switching related proposal leads 3GPP to agree to define support for such, then the band combination can of course be introduced too.

6 – China Unicom

We support this new basket WI, and the WI is defining band combination specific requirements. There is no need for RAN1/2 work for spectrum related RAN4 topic.

7 – China Mobile Com. Corporation

We have to emphasis that the band combinations proposed in this spectrum WI are requested by operators based on deployment demand. Following the legacy procedure, the band combinations are spectrum related and specified based on operator request, this should not be treated the same as other WIs. We fail to understand why companies object this spectrum WI and question the demand from operators.

To Qualcomm:

We don't quite get the comments about PCell indication, how this relates to the proposed band combinations.

For the PHR report, it is reported per serving cell. We do not see there is any issue with PHR report for inter-band CA with SUL.

To Apple:

PCell is a cell, there is no concept of UL PCell or DL PCell. PCell can be configured regardless whether there is SUL in this cell, this has no difference compared with R15.

To ZTE:

We do not think this is a new feature and a new suffix in RAN4 spec is not needed. What Tx core requirements do you refer to? For output power, both PC3 and PC2 are requested by operators. For configured transmit power, CA requirements should be followed.

We do not agree that there is large RAN1/2 impacts. We clarified multiple times that inter-band CA with two SUL bands follow inter-band CA procedure and UE behavior. Please provide detailed comments on what are the impacts on RAN/2 specification.

To Nokia:

The proposed band combinations are not related to Rel-18 Tx switching as multiple companies commented in 1st round. Tx switching is introduced from Rel-16. However, in Rel-15 switching between UL carriers can already be supported by RRC reconfiguration. Without dynamic Tx switching, the proposed band combinations can still work.

8 – Huawei Technologies France

We support the band combination basket WI, which is a RAN4 only WI with no RAN1/2 impact. And the WI proposal follows the normal spectrum related WI procedure based on deployment demand from operators.

To QC's comments:

PHR is reported per cell as specified in Rel-15 no matter whether the cell is configured with SUL or not. For the band combination with dual-SUL, each SUL still belongs to one certain cell and therefore nothing is broken. The current mechanism can be reused.

Regarding PCell indication, there is no relation to dual-SUL here, if it is meant FG 22-6, it is already very clear in the FG 22-6 note as copied below:

NOTE: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission

To Apple's comments:

All the combinations mentioned above, can already be supported by RAN1 and RAN2 signaling. Please refer to the agreements made in RAN1#96 meeting where the allowed configurations are all listed in R1-1903209, e.g. PUCCH can be configured on SUL only.

R1-1903209 Clarification on UL/SUL indicator field and SRS request field in DCIs

The proposal is the common understanding. Further discussion needed on whether a CR is needed or a conclusion in the chairman's notes is enough.

R1-1903708 Clarification on UL_SUL indicator field and SRS request field

Final CR agreed in R1-1903799 (TS38.212, CR0013, Rel-15) without the changes to the last two bullets in Section

To ZTE's comments:

We cannot fully understand the similarity of the CA band combinations with UL CA with UL MIMO. Only band combination specific requirements need to be defined, and dual SUL combination is not a new feature which does not need new RAN1/2 mechanism to support the configuration.

To Nokia's comments:

As explained above, the proposed band combinations in the spectrum WI just follow the existing mechanism. It is not a new feature hence no functional support issue.

9 – Ericsson LM

It seems to us that CA framework cannot be directly reused. As explained in section 5.3.1, TU should be allocated to RAN1/RAN2 to address simultaneous transmission between 2 SULs or SUL and any NUL.

6.3.2 2nd round Feedback for Proposal 6.2

Companies are encouraged to provide further feedback on the objectives in [9] if any. Proponent companies are also encouraged to provide any update on the objectives to address comments from companies.

Feedback Form 29: 2nd round Feedback for Proposal 6.2

1 – Qualcomm Technologies Int

From RAN4 point of view and to the discussion if this is basket or general WI, it is very easy to check section 5 and see that there are no configurations with two SULs thus this objective has general scope. Basket is meant only to handle new band combinations of type that is already in the specification.

To the questions on details, the following issue need to be updated to cover the dual SUL in Ran4 specifications:

- Section 4.3 Speciation suffix information
    - Change needed to clarify the behavior when there are two SUL carriers in two serving cells.
- Section 5.2C
    - Current tables exist:
        - Table 5.2C-1: Operating band combination for SUL in FR1
        - Table 5.2C-2: Operating SUL band combination with intra-band non-contiguous CA in FR1

        - Table 5.2C-3: Operating SUL band combination with intra-band contiguous CA in FR1
        - Table 5.2C-4: Operating SUL band combination with inter-band CA in FR1
    - New tables needed for dual SUL with inter band CA
    - Possibly also tables for intra band with dual SUL, depending on the exact configurations.
    - Note in table says: "*NOTE 1: If a UE is configured with both NR UL and NR SUL carriers in a cell, the switching time between NR UL carrier and NR SUL carrier is 0 us. "*
        - Question to be handled in the general WI, maybe also objective should include target to define requirements what is the switching time between two SULs or none since simultaneous transmissions?
        - Also "*NOTE 2: For UE supporting SUL band combination simultaneous Rx/Tx capability is mandatory*."
        - Objective to clarify is simultaneous tx/rx mandatory between SUL and NUL in a different cell (also clarification needed for earlier releases)

- Section 5.5C: new tables needed similarly to section 5.2C
- New tables for these new types of band combinations are needed in section 6 for delta TI,B and section 7 for delta RI,B
- 6.2C.1 Configured transmitted power for SUL has a text: "*When a UE is configured with both NR UL and NR SUL carriers in a serving cell with active transmission either on the UL carrier(s) or SUL carrier, the configured transmit power requirements specified in clause 6.2.4 and 6.2A.4 are applicable for the UL carrier(s) and the SUL carrier, respectively. "*
    - In case UE is configured with two serving cells with SULs in both of them, how is the Pcmax configured between the two SULs?
    - If companies are saying this follows CA framework, why there is this section 6.2C.1 then at all? Then the objective should be to remove suffix C.
- 7.3C.2 Reference sensitivity power level for SUL
    - When it is cleared, if two SUL transmit simultaneously with each other or with NR UL band in different cell, corresponding MSD requirements are needed and new specification clauses and tables are needed under this section. Since this simultaneous transmission was not clarified despite the question, in Initial round and it is not defined in ran1 specifications, we interpret that the two SUL can transmit at the same time thus MSD work is needed. This is already in the objective but it is not within the scope of the basket WI but a general WI.
- Alternatively, if dual SUL should be treated as CA as some companies feel, then this section 7.3C should be removed since it is same as CA.
- 7.6C.3 Out-of-band blocking for SUL
    - Something similar as in *7.6A.3.3: the requirements for all downlinks shall be met with the single uplink carrier active in each band capable of UL operation*. Would be needed

- Or if ran4 is to re-use the CA sections, then removing 7.6C should be considered

Regarding the RAN1/2 work, if the general WI will be ran4 lead, ran4 should send LS to ran1 and ask what the UE behavior in dual SUL configuration is. Alternatively, a TU for RAN1 can be added but this depends on discussions and ran1 needs to be involved regardless.

2 – ZTE Corporation

We would like to reiterate that the basket approach does not apply for this WI given its impacts on RAN4 core requirements. It has also impact on RAN1/RAN2 specs to make it clear what kind of simultaneous transmission is allowed, as also mentioned in our comments for proposal 5.1.

3 – Nokia Corporation

Agree with Qualcomm and ZTE.

4 – China Mobile Com. Corporation

Thanks Qualcomm for provide the detailed comments. Existing SUL band combination with inter-band and intra-band CA was introduced in the basket WI from Rel-16. New tables are introduced to section 5 also. We should keep the consistency to treat different WI proposals. Even though it may need some updates on the general sections, it does not impact the fact that this is a spectrum WI. We are fine with either categorize it as basket WI or spectrum WI with some example band combinations. RAN4 had many WIs treated in this approach. For example, the HPUE WIs that specify requirements with some example bands. This should not be the reason to object the requested band combinations by operators.

As for the detailed comments, it should belong to RAN4 discussion. We provide some initial thoughts as follows:

Section 4.3: We do not see the necessity to clarify in suffix information. This can be easily updated depending on RAN4 discussion.

Section 5 related: New table can be added depending on RAN4 discussion. Adding new band combination tables and corresponding requirements tables are business as usual, as we commented the previous SUL band combination with CA was introduced in basket WI.

Switching time was not defined in Rel-15 for SUL. We do not propose to define additional switching requirements in this WI.

Section 6 related: the requested band combinations are inter-band CA with dual SUL. It belongs to CA. Section 6.2C.1 is for SUL band combination. We do not understand why this section is relevant.

Section 7 related: Defining MSD requirements for UL CA is business as usual.

We do not see any impact on RAN1/2. Could companies elaborate more on what are the RAN1/2 impacts?

5 – MediaTek Inc.

To address some of the concerns, a conditional support for these band combinations should be considered, such as: 1) co-location single-TAG, 2) not to mandate simultaneous Rx/Tx for the UE supporting these NR CA band combinations with dual SUL bands.

6 – Huawei Technologies France

Thanks QC for the detailed comments. For the questions, our response are as follows. In our view, all the questions can be addressed by the band specific requirements for a spectrum related WI.

 Section 4.3 Speciation suffix information

Dual SUL follow the CA framework as two SUL CCs are in two different cells. New suffix is not necessary as it is not a new feature or UE type like MIMO or RedCap.

 Section 5.2C

Since dual SUL follow the CA framework, either include the combinations in inter-band CA tables or new tables under SUL clauses are workable. For RRC configured dual SUL band configuration, no switching time is needed, which is the same case for UL inter-band CA. For simultaneous Rx/Tx, since SUL and NUL are in different bands, we see no reason simultaneous Rx/Tx operation cannot be supported. Clarification of simultaneous Rx/Tx is not the objective of CA/DC basket WI, but it can be further clarified during the RAN4 discussion.

 Section 5.5C

We think existing table 5.5C-4: Supported channel bandwidths per SUL band combination with inter-band CA is enough to capture the new SUL configurations.

 section 6 for delta TI,B and section 7 for delta RI,B

Delta Tib, Rib is the normal work for new band combinations. The values reflect physical insertion loss for combining operating bands, has nothing to do with SUL, CA, DC or V2X con-current operating in the NR bands.

 6.2C.1 Configured transmitted power

6.2C.1 is for single cell SUL and NUL, which follows the RAN1 procedure with only one Tx transmission at a time. Since it is different from inter-band CA, which has two serving cells, a separate clause is needed in the spec. However, for two-cell dual SUL bands, it is just a normal UL inter-band CA configuration, the current Pcmax configured for CA is also applicable for dual SUL inter-band CA.

 7.3C.2 Reference sensitivity power level for SUL

MSD is considered as band combination specific requirements from Rel-12. It has never been considered as general requirement. Otherwise all the objectives of Rel-18 band combination baskets are not valid.

 7.6C.3 Out-of-band blocking for SUL

For inter-band CA with dual SUL bands, the main band combination specific requirements are for UL, we don't think existing requirements for SUL should be affected, which considers the scenario where SUL and NUL in the same cell.

 Regarding the RAN1/2 work

What kind of UL CA UE behavior is foreseen? The combinations proposed in this WI just need to follow existing RAN1/2 mechanism.

In summary, we think the questions raised by QC are normal RAN4 work for spectrum related WI, which have no RAN1/2 spec impact.

To MKT, simultaneous Rx/Tx capability can be discussed separated, which is the similar case for other CA/DC basket WIs.

7 – Ericsson LM

It seems to us that CA framework cannot be directly reused. As explained in section 5.3.1, TU should be allocated to RAN1/RAN2 to address simultaneous transmission between 2 SULs or SUL and any NUL.

6.4 Intermediate round summary

Summary of intermediate round feedbacks for the justification part:

- Fine with the justification: China Telecom, China Unicom, CMCC, Huawei
- Not fine with the justification (concern on late introduction of such large WI, it requires functional support in addition to the band combinations): Qualcomm, Apple, ZTE, Nokia, Ericsson

Moderator's suggestion: Companies still have different views on whether/how the support of the band combinations with dual SUL bands will cause the work in RAN1/2/4.

Summary of intermediate round feedbacks for the objectives part:

- Fine with the objectives: CMCC, Huawei
    - With some conditions such as co-location single TAG, not to mandate simultaneous Rx/Tx for the UE supporting these CA band combinations with dual SUL bands: MediaTek
- Not fine with the objectives (more work necessary in RAN4, and RAN1/2 work may also be necessary): Qualcomm, ZTE, Nokia, Ericsson

Moderator's suggestion: Companies still have different views on whether/how the support of the band combinations with dual SUL bands will cause the work in RAN1/2/4.

6.5 Final round discussion

The moderator would like to ask companies to provide feedback if any on above summary and the proposed new WID in RP-222130. Based on the RAN chair guidance in Wednesday GTW session, companies are encouraged to provide details on the necessary RAN1/2/4 works for the proposed WID especially if the company has a concern on the current proposed WID. Proponent companies are also encouraged to provide any update on the proposed WID to address comments from companies.

6.5.1 3rd round Feedback for Proposal 6.1 & 6.2

Proposal 6.1 & 6.2

Companies are encouraged to provide further feedback on the justification and the objectives in [9] if any.

Feedback Form 30: 3rd round feedback for proposal 6.1 & 6.2

1 – China Telecommunications

We support the WID.

The comments from companies are in general on two aspects:

1) RAN1/2 has not supported the dual-SUL scenario

2) New RAN4 RF requirements are required.

For the aspect 1), as we commented on Proposal 5.1, it is already supported in RAN1/2 since Rel-15. For companies commenting that "lot of clarifications needed" or "not clear", could you please elaborate which part requires clarification and which part is not clear?

For the aspect 2), thanks QC for the detailed technical comments, we agree with CMCC that although some new tables/requirements are needed, they are still band combination specific requirements but not generic requirements. So, the WI still belongs to a spectrum WI.

Regarding the new tables, in my understanding, for pure CA, when the number of DL configured bands is increased, e.g., from 3 to 4, new tables and requirements are also needed, which was handled in the basket WI. The situation here is similar in our view.

2 – China Mobile Com. Corporation

Firstly, we would like to repeat comments of intermediate round. This WI is a spectrum WI proposal with example band combinations, similar as the spectrum WI with adding new band, adding new bandwidth or HPUE. Having some impacts on general sections in the spec is not the reason to object operator request. We should keep the consistency to treat operator proposed spectrum WIs.

For the RAN1/2 impacts, we already provide feedback in the initial and intermediate round. Companies please check and explicit comments on the actual impact are appreciated.

To address companies' comments, we propose to add a subbullet as below. Since according to the comments, there is no consensus on the necessity of other changes. So just following the existing WI approach, we do not exclude any other changes if identified.

The objectives of the core part are as follows:

 Specify the PC3, PC2 band-combination specific RF requirements for the listed CA configurations with dual SUL bands including at least

§ Applicable frequencies if necessary

§ Applicable bandwidths and bandwidth sets if necessary

§ **Other requirements or specification changes are not excluded if identified**

 Analyse combinations that have self-desensitization due to following reasons:

§ TX Harmonic and/or intermodulation overlap of receive band

§ TX signal overlap of receiver harmonic frequency

§ TX frequency being in close proximity of one of the receive bands

§ Any other identified reasons such that insufficient cross band isolation, harmonic mixing

 For the combination where self-desensitization exists, specify at least needed

§ ΔTIB, c and ΔRIB, c

§ Reference sensitivity exceptions including MSD test cases

§ Exceptions to the out-of-band blocking requirement

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3 – Qualcomm Technologies Int

For the RAN1 part, maybe also ran2: the specification [38.213] refers to SUL at multiple places as "UE is configured with two UL carriers for a serving cell". These paragraphs obviously don't apply to the CMCC proposed dual-SUL scenarios because there is no two UL carriers configured for any serving cell in the CMCC proposed cases with dual-SUL. A single UL carrier is configured for each serving cell. Therefore the relevant UE behavior is the one where a serving cell consists of a DL and an UL carrier at different frequencies. This exact scenario has been proposed by Huawei in RP-182794 and subsequently by Vodafone in RP-191363; however they were not agreed because a serving cell that consists of a carrier for DL and another carrier for UL, at different frequencies were agreed to be treated as variable duplex FDD, as documented in RP-191567. The relevant agreements made that resulted in these should not be overturned.

Therefore our proposed way forward is the following: Similar to RP-191567, the WID should introduce two variable duplex FDD bands, and then a band combination that aggregates those two bands.

On the spectrum related Wi vs general WI, my understand is that extending 3 to 4 band DL was a general WI. However, this functionality was done before basket WI era in Rel-13 for LTE and since CA design is very similar for NR, the work for included 4 DL CA in NR was easy and I don't recall how exactly it was done, but still it was and is not purely spectrum related. If we start to go to the road that we try to find something similar from the past that was spectrum related and use that as basis to be spectrum related, then everything is spectrum related after few releases. Spectrum related was give a free pass originally only when a regulator enables some spectrum that came to a possession of a company who wanted to utilize it using existing 3GPP technologies and because regulators don't follow 3GPP release schedules, a free pass, or an exception from regular release content planning timelines was given for this kind of work items. The real concern we have here is the work load management of RAN4 where very complicated new items are added mid release.

For the WID objectives, these are necessary amendments:

Create new tables to accommodate two variable duplex bands for cases where needed

For aggregation of two variable duplex band operation specify

- Specification handling to cover this case, new suffix is necessary
- Configured maximum power for simultaneous transmissions of two variable duplex uplinks

- Receiver degradation originating from interaction of two transmissions of two variable duplex bands and interaction of SUL and NR UL when not in same UL cell. Note: MSDs from intermodulation distortion product from two uplinks landing on receive bands should be specified according to work case IMD for the DL band, not the corresponding DL frequency on a band

So in conclusion, we can not support this WID is this form.

4 – Apple (UK) Limited

Thanks to China Telecom, CMCC, and Huawei's clarifications on the UL configurations during the first and intermediate round discussions. It is clear to us on the proposed UL configurations and no further clarification is needed.

5 – Ericsson LM

Our view remains as previous round. Please see also our comments for 5.5.1.

To avoid repetition, we support the analysis and suggestions by Qualcomm.

6 – China Mobile Com. Corporation

To Qualcomm:

In our requested band combinations, SUL is still two UL carrier configured in one serving cell. CA is two UL carriers from different cells transmitted at the same time. There is no restriction in the specs whether the aggregated UL carrier is UL only band or FDD or TDD. Hence, there is no impact on RAN1/RAN2 specs. Existing specs work well. Please elaborate more what need to be changed in RAN1/2 specs.

Also there is nothing to do with variable duplex FDD, since we use the legacy SUL function and CA function.

On the spectrum related WI, we have different views. We should hold the same principle on approving spectrum WIs. If the similar WIs from the past was spectrum WI, of course this should be use as basis to approve the spectrum WI. I do not see the reason to change the principles. This spectrum WI is requested by operators with clear deployment scenarios described.

7 – Huawei Technologies France

We support this spectrum WI.

As we commented in previous rounds, we have the following understanding of the WI proposal:

1. This is a RAN4 only spectrum WI proposed under agenda 9.1.5, which has no relationship to the RAN1 ongoing discussion for multicarrier enhancements from basket WI perspective

2. It is a basket WI follows normal RAN4 WI procedure with enough supporting companies and the band combinations are based on clear demand for the deployment scenarios with the operator's spectrum

3. The band combination specific requirements as well as the combination configurations have no RAN1/RAN2 spec impact, which just follow the existing RAN1/2 mechanism

To QC's comments:

The band combinations proposed in the WID are aggregation with two already supported SUL combinations. The functionality is the same as existing SUL and CA mechanism in the specifications, nothing to do with variable duplex.

We are fine with the updated objectives by CMCC to accommodate companies' comments during the discussion.

8 – MediaTek Inc.

As we mentioned in the previous round of discussion, a conditional support for these band combinations should be considered, such as: 1) co-location single-TAG, 2) not to mandate simultaneous Rx/Tx for the UE supporting these NR CA band combinations with dual SUL bands.

9 – Nokia Corporation

As pointed out by Qualcomm, the recorded justification for SUL (38.300 Annex B.1) is improving the coverage when the NUL UL has worse coverage than SUL UL. Adding UL CA to this mix seems to be counterproductive to the SUL's reason of existence. Add to that the second SUL cell in a band combo and it goes one step further. There are calls to limit which ULs can transmit simultaneously that point to functional restrictions and different UE capabilities.

Round 2 CMCC comment to Nokia:

The proposed band combinations are not related to Rel-18 Tx switching as multiple companies commented in 1st round. Tx switching is introduced from Rel-16. However, in Rel-15 switching between UL carriers can already be supported by RRC reconfiguration. Without dynamic Tx switching, the proposed band combinations can still work.

Re: CMCC: Definitely the UE can be switched from one SUL+NUL config to another by RRC in Rel-15, but that is an inter-frequency handover from one cell to another, where the source and target cells both have also a SUL carrier (could, and likely typically is the same SUL carrier). This in no way directly extends to the two cells, both with SUL tagged to them.

Round 2 Huawei comment to Nokia

As explained above, the proposed band combinations in the spectrum WI just follow the existing mechanism. It is not a new feature hence no functional support issue.

Re Huawei: To our understanding existing specifications were not written with SUL+CA combination in mind and when introducing a thing like that as a UE band combination/capability is something Huawei has opposed in the past (not investigated by RAN1, hence RAN1 cannot say it is feasible/supported by the spec". Existing specifications haven't considered the Tx on SUL at the same time with a Tx on NUL. If that is however, ruled out in a CA combination we are in Tx switching setup.

10 – Nokia Corporation

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11 – Nokia Corporation

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12 – ZTE Corporation

It seems the proponents are also proposing dual SUL without NUL, e.g., CA_n95A-n98A for uplink CA configuration. If it is the case, does it mean for each of the two aggregated cells, there is only SUL while no NUL? In current RAN1/2 specs, there are lots of places specifying the selection between NUL and SUL within one cell, does it mean the SUL band is always selected and used for transmission? We also have the same understanding with Qualcomm that in some places in the specs, the description ”UE is configured with two UL carriers for a serving cell” is not ambiguous in 2 SULs configuration.

For the case where UL carrier aggregation is performed between cells with SUL configured, the configured transmit power for inter-band CA cannot be directly applied, and the corresponding equation needs to be revised for this case.

In addition, as we commented for proposal 5.1 (many of these comments are applicable to here), it could also cause large RAN1/2 impacts. Also, in the stage-2 functional spec, “**SUL differs from the aggregated uplink** in that the UE may be scheduled to transmit either on the supplementary uplink or on the uplink of the carrier being supplemented, but not on both at the same time.” Like many companies said, this is clearly a new feature which requires new functional support.

13 – China Unicom

We support the justification and objectives of the WID.

The band combinations in the WID are proposed based on commercial deployment demands. Such types of works belong to RAN4 spectrum related topics which evaluate band-combination specific requirements. And the work does not have impact to other WGs, we support to approve the WID in this meeting.

14 – NTT DOCOMO INC.

[ZTE (late comment)]

We appreciate the good discussions and clarifications in the past three rounds, which makes us understand each other better. As we commented before, we respect the demands from operators as long as the raised clarifications could be well addressed. To avoid confusion, we’d like to clarify that we are ok to further discuss those clarifications, and would be ok to consider if it concludes with no or minor RAN1/2 spec impacts.

6.6 Final round summary

Summary of Final round feedbacks for the proposal 6.1&6.2:

- Fine with proposed WID in RP-222310: China Telecom, CMCC, Apple, Huawei, China Unicom (5)
  - OK to add “Other requirements or specification changes are not excluded if identified”: CMCC, Huawei (2)
- OK if it concludes no or minor RAN1/2 spec impacts after further clarification: ZTE (1)
- Not fine with proposed WID in RP222310: Qualcomm, Ericsson, Nokia (3)

Based on above, still companies have different views on necessity/urgency and required work in RAN1/2/4 for the proposed WID even though there are operators' requests with specific examples. Since the situation has almost not changed from the beginning even after three rounds of discussions, unfortunately, there seems to be tiny/no chance for the proposed WID to be converged by the end of this meeting.

No conclusion/agreement could be made on the proposed WID at this meeting.

7 Conclusion

Following proposals were agreed in Wednesday GTW.

Updated proposal 3.1:

- **Clarify that the number of TAGs is limited to up to 2 for both 2 bands switching and more than 2 bands switching cases**
- **Apply the proposed WID update in [5]**
- **Capture following conclusion in the meeting report of RAN#97-e.**
  - **Conclusion: for the work on UL Tx switching with 2 TAGs, RAN1/2 discussion can be triggered by RAN4 LS. No RAN1 spec impact is expected.**

Updated proposal 4.1:

- **Deprioritize any optimization for unlicensed spectrum operation for designing the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

Updated proposal 4.2:

- **Enhanced Type-2 HARQ-ACK codebook is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**
- **Type-1 HARQ-ACK codebook is supported only for the case where co-scheduled cells by a DCI format 1_X have same SCS/carrier type/duplex mode in Rel-18.**
  - **Additional restriction(s) can be discussed in RAN1**

Updated proposal 4.3:

- **Configuring more than one scheduling cell for DCI format 0_X/1_X for each scheduled cell is not supported for the multi-cell PUSCH/PDSCH scheduling in Rel-18.**

Updated proposal 4.5:

- **Followings are excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.**
  - **SCell schedules multiple cells including P(S)Cell**
  - **Different SCS among co-scheduled cells**
  - **Different carrier type (licensed or unlicensed, FR1 or FR2-1 or FR2-2) among co-scheduled cells**
  - **Configuration of both multi-cell PDSCH/PUSCH scheduling and multi-TRP for a scheduled cell**
  - **Support for any sidelink scheduling**

Following conclusion was made after the final round.

Conclusion:

- **Following is excluded from multi-cell PDSCH/PUSCH scheduling in Rel-18.**
  - **PCell schedules multiple cells by DCI format 0_X/1_X when a sSCell is configured to schedule PCell**