RAN1-105-e-NWM-NR-R17-CovEnh-03 - Version 0.0.5
RAN1

3GPP TSG RAN WG1 Meeting #105-e **R1-2106152**

E-Meeting, May 10th – 27th, 2021

Agenda Item: **8.8.1.3**

Source: **Moderator (China Telecom)**

Title: **[105-e-NR-R17-CovEnh-03] Summary of email discussion on joint channel estimation for PUSCH**

Document for: **Discussion**

1 Introduction

In RAN #90 e-meeting, a new Rel-17 work item on NR coverage enhancements was approved [1] and was revised in [2]. The objective of this work item is to specify enhancements for PUSCH, PUCCH and Msg3 PUSCH for both FR1 and FR2 as well as TDD and FDD.

The detailed objectives are as follows.

Specification of PUSCH enhancements [RAN1, RAN4]

Specify the following mechanisms for enhancements on PUSCH repetition type A [RAN1]

Increasing the maximum number of repetitions up to a number to be determined during the course of the work.

The number of repetitions counted on the basis of available UL slots.

Specify mechanism(s) to support TB processing over multi-slot PUSCH [RAN1]

TBS determined based on multiple slots and transmitted over multiple slots.

Specify mechanism(s) to enable joint channel estimation [RAN1, RAN4]

Mechanism(s) to enable joint channel estimation over multiple PUSCH transmissions, based on the conditions to keep power consistency and phase continuity to be investigated and specified if necessary by RAN4 [RAN1, RAN4]

Potential optimization of DMRS location/granularity in time domain is not precluded

Inter-slot frequency hopping with inter-slot bundling to enable joint channel estimation [RAN1]

Specification of PUCCH enhancements [RAN1, RAN4]

Specify signaling mechanism to support dynamic PUCCH repetition factor indication [RAN1]

Specify mechanism to support DMRS bundling across PUCCH repetitions [RAN1, RAN4]

Specify mechanism(s) to support Type A PUSCH repetitions for Msg3 [RAN1]

This contribution is a summary of the following email discussion:

[105-e-NR-R17-CovEnh-03] Email discussion regarding joint channel estimation for PUSCH – Jianchi (China Telecom)

1st check point: 5/21

2nd check point: 5/25

Final check: 5/27

2 Email discussion (1st round)

2.1 Use cases

FL comments: According to the simulation results provided by Huawei and vivo, considerable gain can be obtained for joint channel estimation across consecutive PUSCH transmissions of different TBs. And as pointed out by some companies as long as power consistency and phase continuity can be maintained, joint channel estimation can be applied to PUSCH transmissions with different TBs. The following proposal is proposed.

Proposal 1:

For back-to-back PUSCH transmissions across consecutive slots, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following cases:

- Over back-to-back PUSCH transmissions with different TBs

Feedback Form 1: Comments on Proposal 1

1 – ZTE Corporation Support the proposal.
2 – InterDigital France R&D We support the proposal.

3 – CATT

Support.

4 – China Mobile Com. Corporation

support the proposal

5 – Nokia Solutions & Networks (I)

Support the FL's proposal.

6 – Intel Deutschland GmbH

We do not support this proposal.

PUSCH transmission with different TBs is not targeted for coverage enhancement, i.e., UE is in good channel conditions. The motivation is not clear to us for joint channel estimation of different TBs.

7 – Qualcomm Incorporated

Do not support this proposal. This is not relevant for a cell-edge UE.

Further, note that this will require a bundling framework that is different from the case for PUSCH repetitions. Unlike PUSCH repetitions, PUSCH transmissions carrying different TBs are triggered at different points in time based on the DCI carrying the UL grant. This then requires the UE to anticipate arrival of new PUSCH grants and react to the requirements to extend the DMRS bundling operation to cover the transmissions triggered by the new grants. UE has to revisit certain decisions it might have made in the past and its not clear if such operations will be feasible. On the whole, given the additional complexity, and the fact that its unlikely to benefit a cell-edge UE, we are not in favor of supporting this use case.

8 – vivo Communication Technology

Joint channel estimation for different TBs can be considered if reusing the same mechanisms developed for the PUSCH repetition. And NW scheduler should guarantee the conditions to maintain power consistency and phase continuity across PUSCH transmission are fulfilled, e.g. NW guarantee the same PRB allocation, modulation order, etc.

9 – SHARP Corporation

We support FL proposal. For different TB, the network should ensure to meet RAN4 requirement (e.g., PRB allocation, Tx power) within the time domain window.

10 – Shenzhen YZF Network Technolog

[OPPO] we don't support the proposal.

1) this is not for coverage enhancement.

2) this would put restrictions on scheduling of multiple TBs: same number of PRBs/same frequency location, same transmission power, same precoder etc..

11 – Ericsson LM

Do not support the proposal. Support for different TBs is for us a redundant functionality that will increase overhead relative to repetition or TBoMS. The different TB case will require extra DCI overhead compared to repetition. Instead of using different same-size TBs, one larger TB could be transmitted using repetition or TBoMS. This can result in equivalent performance but use less DCI overhead than different TBs.

12 – WILUS Inc.

We don't support the proposal. It may cause scheduling restriction to assign the same MCS, RB allocation, and UL transmission power for JCE.

13 – NTT DOCOMO INC.

Support the proposal.

14 – Apple Computer Trading Co. Ltd

We don't support this proposal. Over back-to-back PUSCH transmissions with different TBs is not in the work item scope. In addition, it has limitation for gNB scheduling, e.g., continuous scheduling. it could impact the discussion on time domain window as well.

15 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: We support the FL proposal

16 – Samsung Electronics Co.

We do not support proposal 1.

As discussed in previous meeting, we do not see that the case of back-to-back PUSCH transmissions with different TBS is typical scenario for operation with coverage enhancements. The focus should be on PUSCH transmissions with a same TB.

17 – Panasonic Corporation

We would like to clarify that are different TBs scheduled by multiple DCIs or a single DCI in the proposal 1?

- If a time domain window is composed by the multiple DCIs, depending on one of DCI mis-detection or false-detection, the length of a time domain window varies and gNB cannot assume the same length of a time domain window depending on UE detection status of PDCCH. In such case, the gNB is required to support blind detection of the length of the time domain window, which significantly increase the complexity of gNB. Therefore, we would like to object to support this case.

- If single DCI is used, the discussion is on-going in agenda item 8.2.5 for NR from 52.6GHz to 71 GHz. We think joint channel estimation should wait and/or aligned with the outcome from the discussion of 8.2.5.

18 – LG Electronics Inc.

In our understanding, joint channel estimation of different TBs can be supported with following considerations. The unit of time domain window, which is being discussed, should not be repetition or transmission occasion but slot at least for different TB. And when the UE cannot satisfy condition for joint channel estimation with different TBs due to the misaligned indication, e.g., power control, TA adjustment between TBs, the UE behaviour for such cases should be defined.

19 – HUAWEI TECHNOLOGIES Co. Ltd.

Support the proposal.

Joint channel estimation among different TBs is surely in scope of the WI there are many simulation results of joint channel estimation among different TBs with large gains are provided by companies, which are captured in TR 38.830, e.g. R1-2008626, R1-2007583, R1-2008874, R1-2008026, R1-2008559, etc.. In our understanding, the main deficit for a cell-edge UE with limited coverage is the deficit of UL throughput compared to target UL throughput, which cannot be improved by PUSCH repetition but can be improved by joint channel estimation among consecutive TBs as the TR of CovEnh shows.

Additionally, as all known, the key point for joint channel estimation is phase continuity, which is regardless of same TB or different TBs for back-to-back PUSCH transmissions.

It is agreed in SI phase that 1 Mbps UL data rate is required for eMBB services under Urban scenario without repetition as the simulation baseline, thus it's a very common case of joint channel estimation among different TBs to meet the medium-to-high data rate requirements in uplink coverage enhancement.

In short, we support FL's proposal 1 with necessary design aspects to enable joint channel estimation among different TBs.

20 – Beijing Xiaomi Mobile Software

Open to this proposal when it has realistic use cases, and NW scheduler should guarantee the conditions to maintain power consistency and phase continuity across PUSCH transmission.

21 – Sierra Wireless

Support the proposal. Given the high efficacy of JCE to provide coverage enhancement, all reasonable opportunities to allow and support JCE should be exploited.

22 – TCT Mobile Limited

Support the proposal.

FL comments: In RAN1 #104b-e, joint channel estimation over back-to-back PUSCH transmissions across consecutive slots for repetition type B is supported. Then joint channel estimation over back-to-back PUSCH transmissions within one slot for repetition type B can be supported as well. Regarding PUSCH transmissions with different TBs within one slot, many companies have concerns. The following proposal is proposed.

Proposal 2:

For back-to-back PUSCH transmissions within one slot, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following cases:

-Over back-to-back PUSCH transmissions (of the same TB) for repetition type B scheduled by dynamic grant or configured grant

Joint channel estimation over back-to-back PUSCH transmissions with different TBs within one slot is not supported.

Feedback Form 2: Comments on proposal 2

1 – ZTE Corporation Fine with the first bullet. Regarding the second bullet, we are not clear why it cannot be supported. Similar to use case 3(across consecutive slots), we think both the case for repetition type B and different TBs within one one slot should be supported as the requirements to maintain joint channel estimation is the same.
2 – InterDigital France R&D We support the proposal.
3 – CATT OK.
4 – China Mobile Com. Corporation Fine with the proposal.
5 – Nokia Solutions & Networks (I) We are fine with the proposal in principle. However, we should keep the same formulation as in the agreement made in RAN1#104b-e for PUSCH repetition type B, i.e. adding "if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A." to the sub-bullet of the first bullet.
6 – Intel Deutschland GmbH We are fine with the proposal. But our view is that joint channel estimation for back-to-back PUSCH transmissions within one slot can be deprioritized.
7 – Qualcomm Incorporated If a UE is being provided short allocations of a few symbols, along with multiple repetitions, all contained to a single slot, its most likely that there is a desire to enable precoder/beam cycling or antenna switching to squeeze out some diversity gains. DMRS bundling will preclude use of these diversity schemes. Enabling DMRS bundling in such a setting also suggests that latency isn't that big a concern and the gNB is willing to wait for all the repetitions to come through before beginning the demod and decode steps. In such a case, the gNB is better off scheduling a single longer transmission within that slot. It seems like a completely hypothetical case to enable DMRS bundling under such settings. Do not see any motivation for such an agreement. Lets not keep increasing the list of use cases, especially when they bring no practical gain.
8 – vivo Communication Technology Support this proposal.
9 – SHARP Corporation We are fine with FL proposal.

10 – Shenzhen YZF Network Technolog

[OPPO], OK with the proposal.

share same view with Nokia the same restriction shall be applied

11 – Ericsson LM

Do not support. We think this proposal is premature, and possibly in conflict with the agreement last meeting. The agreement for Type B (copied below) was that it reuses only those enhancements defined for Type A, so we should first design for Type A so that any reusable Type A enhancements can be reused for Type B. Furthermore, the proposal says to support necessary design aspects for Type B, which seems to be not reusing specification enhancements for Type A.

Agreement:

- For back-to-back PUSCH transmissions across consecutive slots, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following cases:
  - Over back-to-back PUSCH transmissions (of the same TB) for repetition type B scheduled by dynamic grant or configured grant, if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A.

12 – WILUS Inc.

We support the FL's proposal.

13 – Apple Computer Trading Co. Ltd

The motivation of this use case is not so strong. It can be deprioritized, it's depending on whether the design from type A can be re-used.

14 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: We support the FL proposal

15 – Samsung Electronics Co.

Fine with FL's proposal.

16 – Panasonic Corporation

We support the proposal 2

17 – LG Electronics Inc.

In our understanding, PUSCH repetition type B is not targeting for coverage enhancement scenarios because it allocates a lot of data to a small number of resources for the purpose of URLLC, resulting in high code rate. Therefore, potential use case 1 and 2 should be deprioritized.

18 – HUAWEI TECHNOLOGIES Co. Ltd. OK
19 – Beijing Xiaomi Mobile Software Fine with it.
20 – Sierra Wireless Agree with Ericsson and Qualcomm. This should be deprioritized.
21 – TCT Mobile Limited This should be deprioritized.

Proposal 3: Confirm the following working assumption

Working assumption:

For back-to-back PUSCH transmissions across consecutive slots, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following case:

- Over back-to-back PUSCH transmissions for one TB processed over multiple slots

– It's subject to UE capability

Feedback Form 3: Commments on proposal 3

1 – ZTE Corporation Support
2 – InterDigital France R&D We support the proposal.
3 – CATT Support.
4 – China Mobile Com. Corporation Support the proposal to confrim the working assumption
5 – Nokia Solutions & Networks (I) According to the current formulation of the WA, the sentence "Over back-to-back PUSCH transmissions for one TB processed over multiple slots" includes Type A PUSCH repetitions, Type B PUSCH repetitions and TBoMS, given that in all these cases a TB is processed over multiple slots. Can anyone think of any other scenario over back-to-back slot that this WA is excluding? If not, this WA is simply "restating the obvious", i.e., the objective of the feature all together, and we do not see its added value.

We suggest prioritizing other discussions before discussing about it or simply dropping the WA.

6 – Intel Deutschland GmbH

We are fine to confirm the working assumption.

7 – Qualcomm Incorporated

@Nokia, with TBoMS a UE may be required to look ahead across multiple slots and plan for a single TB transmission. Its as yet unclear how aspects such as rate matching, UCI multiplexing, etc are to be handled. DMRS bundling also requires UE to look ahead and plan for multiple slots at once. We are concerned that there could be some timeline implications if both these features are enabled at once. It is however hard for us to comment on this until TBoMS is scoped out a little more.

Prefer it leave it as a WA since it doesnt seem to hinder progress on any front.

8 – vivo Communication Technology

Support this proposal.

9 – SHARP Corporation

We support FL proposal.

10 – Shenzhen YZF Network Technolog

[OPPO] Support to confirm the WA.

11 – Ericsson LM

Support (although perhaps not crucial to agree since we will anyway continue to work according to the working assumption).

12 – WILUS Inc.

We support the proposal.

13 – Apple Computer Trading Co. Ltd

We support to confirm the work assumption.

14 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: We support to confirm the working assumption

15 – Samsung Electronics Co.

Fine with the FL's proposal.

16 – Panasonic Corporation

We support to confirm the working assumption in proposal 3

17 – Sony Mobile Communications Ok with the proposal
18 – LG Electronics Inc. Considering current unit of power control for PUSCH is transmission occasion, the transmission occasion of TBoMS, i.e., TOT, is being discussed, which is important aspect for supporting power consistency. Therefore, we can discuss after the TO and power control of TBoMS is agreed.
19 – HUAWEI TECHNOLOGIES Co. Ltd. OK
20 – Beijing Xiaomi Mobile Software support
21 – TCT Mobile Limited We support the proposal.

FL comments: Based on the reply LS, joint channel estimation can be applied to non-back-to-back transmission for non-zero un-scheduled gap case for a gap less than 14 symbols when UE is not required to meet the existing off power requirements. For the case with other UL channels in between repetitions, at least if the other scheduled signals/channels during the non-zero gap have the same settings in antenna port, occupied PRBs and UL power than the repeated transmission signals/channels, it is feasible to maintain the phase continuity and power consistency across the repetitions.

Proposal 4:

For non-back-to-back PUSCH transmissions across consecutive slots, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following cases:

-Over non-back-to-back PUSCH transmissions (of the same TB) for repetition type A scheduled by dynamic grant or configured grant.

-Over non-back-to-back PUSCH transmissions (of the same TB) for repetition type B scheduled by dynamic grant or configured grant, if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A.

– FFS: additional specification enhancements on top of that defined to support repetition Type A

–Only for single layer transmissions

– Subject to UE capability

-FFS: Over non-back-to-back PUSCH transmissions with different TBs

-FFS: Over non-back-to-back PUSCH transmissions for one TB processed over multiple slots

Feedback Form 4: Comments on proposal 4

1 – ZTE Corporation

Do not support the proposal.

Based on the reply LS, for non-zero un-scheduled gap case with a gap less than 14 symbols, the phase continuity can be maintained **only if when UE is not required to meet the existing off power requirements. Whether new or existing off power requirements** for shorter duration than 1 msec as well as the maximum value of X un-scheduled symbols **will be introduced are pending on further RAN4 discussions.** Our understanding is whether and how to support the non-zero un-scheduled gap case is still under investigation in RAN4, and we should wait for further RAN4 reply before making decision in RAN1.

For the case with other UL channels in between repetitions, (Use case 2b/4b/5b), it is very difficult or even impossible to make the other signals (PUCCH, SRS etc.) transmitted in the middle of two PUSCH repetitions has the same antenna port, occupied PRBs and UL power etc. Thus, we don't think RAN1 should support such rather rare case.

2 – CATT

In our understanding, RAN4 just confirms the feasibility of maintaining phase and power condition during X<14 symbols if the UE does not have to off-power, but the exact value of X is still under discussion. We can wait for RAN4 input on the value of X.

3 – China Mobile Com. Corporation

Though RAN4 have replied on the feasibility, the impact of UE power requirement is still not clear. We could wait for further information from RAN4.

4 – Nokia Solutions & Networks (I)

Support the FL's proposal but for the last FFS point (which is redundant as per our previous comments to the "working assumption").

5 – Intel Deutschland GmbH

We are fine with the proposal in principle. But it would be good to list the conditions as mentioned by RAN4 in the proposal, e.g., "have the same settings in antenna port, occupied PRBs and UL power than the repeated transmission signals/channels".

6 – Qualcomm Incorporated

We prefer to narrow the scope of this proposal and limit it to the case of non-back-to-back transmissions with unscheduled/unused gaps in the middle. Our understanding is that RAN4 has said gaps < 14 symbols are okay. Yes, off-power requirement will need to be revisited or amended appropriately, but we don't anticipate this becoming a show stopper.

Regarding non-back-to-back transmissions with other uplink transmissions in the middle, unfortunately the RAN4 guidance on this case is too restrictive. We don't think there is any practical value to enabling such a use case under such restrictive conditions.

One clarification that may be necessary is on the modulation order of the intervening uplink transmissions. We think a change in modulation order alone can impact phase continuity, but this needs to be clarified by RAN4.

7 – vivo Communication Technology

Support this proposal.

8 – SHARP Corporation

We support FL proposal.

9 – Shenzhen YZF Network Technolog

[OPPO] We support the proposal as it said under the condition of power consistency and phase continuity.

10 – Ericsson LM

We prefer that non-back-to-back PUSCH transmissions across consecutive slots continues to be considered as a possibility in the design, but not agree to its support at this stage. Furthermore, as commented for proposal 2, explicit agreement support for repetition Type B in the subbullet is premature, and possibly in conflict with last meeting's agreement. Therefore, we can't support the second main subbullet.

In principle, we would like to support non-back-to-back PUSCH transmissions across consecutive slots. However, if the UE does not meet the off power requirements, the interference will be higher at least to some degree, leading to some tradeoff of interference to the gain of joint channel estimation. We would hope that such interference is not significant enough to affect the usefulness of non-back-to-back PUSCH transmissions across consecutive slots, but that is not clear at this stage. Our suggestion would be to continue to investigate what is needed, and to later decide if any mechanisms specifically to support non-back-to-back across consecutive slots.

11 – WILUS Inc.

We support the FL's proposal. However, it is also fine to wait RAN4's additional feedback.

12 – Apple Computer Trading Co. Ltd

We prefer to wait for RAN4 further inputs. The condition of "only if when UE is not required to meet the existing off power requirements" is not clear enough, it could cause the interference of adjacent PRBs without requirement of off power, and it will consume more UE power.

13 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: We are fine with FL proposal

14 – Samsung Electronics Co.

For Type B, the condition of "if it reuses only…." should be mitigated (can be discussed later in detail once joint channel estimation for repetition Type A is defined.).

And the same comment as above - no support of different TBs

15 – Panasonic Corporation

We support the proposal 4

16 – Sony Mobile Communications We are open for further discussions, but think that we shall wait for RAN4 further feedback before we make decisions.
17 – LG Electronics Inc. We can support the proposal with inserting "under condition of TA continuity" for design aspects.
18 – HUAWEI TECHNOLOGIES Co. Ltd. Support. We would like to remind that in TS 38.101-1 as copied below, there is no off-power requirement for the case with less than 14 symbol gap. There is Only requirement for no less than 1ms, which is in line with the RAN4 LS reply. "*The transmit OFF power is defined as the mean power in a duration of* ***at least one sub-frame (1 ms)*** *excluding any transient periods. The transmit OFF power shall not exceed the values specified in Table 6.3.2-1*." The case of non-back-to-back PUSCH with consecutive slots is the case with less than 14 symbol gap. Therefore, we don't see further RAN4 confirmation is needed before agree the FL proposal.
19 – Beijing Xiaomi Mobile Software Fine with the proposal when meet the RAN4 constrains

FL comments: Based on the contributions, it seems not many support of use case 2.

Proposal 5:

Joint channel estimation over non-back-to-back PUSCH transmissions within one slot is not supported.

Feedback Form 5: Comments on proposal 5

1 – ZTE Corporation Fine with the proposal.
2 – CATT OK.
3 – Nokia Solutions & Networks (I) We are fine with the FL's proposal.
4 – Intel Deutschland GmbH We are fine with the proposal.
5 – Qualcomm Incorporated Support.

6 – Shenzhen YZF Network Technolog [OPPO] support
7 – Ericsson LM Support
8 – Apple Computer Trading Co. Ltd Support
9 – Motorola Mobility Germany GmbH [Lenovo, Motorola Mobility]: We are fine with FL proposal
10 – Samsung Electronics Co. Fine with the proposal.
11 – Sony Mobile Communications ok
12 – LG Electronics Inc. Fine with the proposal.
13 – HUAWEI TECHNOLOGIES Co. Ltd. OK
14 – Beijing Xiaomi Mobile Software Fine with it.
15 – Sierra Wireless Support the proposal.

FL comments: Only a few views on use case 5 so far. Companies are encourage to provide views on use case 5.

Use case 5: PUSCH transmissions across non-consecutive slots.

Feedback Form 6: Comments on use case 5

1 – ZTE Corporation Our view is whether to support Use case 5a for PUCCH repetitions depends on RAN4 further discussion, and do not support joint channel estimation for Use case 5b. Similar reasoning as commented for Proposal 4 above. Based on the reply LS, for non-zero un-scheduled gap case with a gap less than 14 symbols, the phase continuity can be maintained **only if when UE is not required to meet the existing off power require-**

ments. Whether new or existing off power requirements for shorter duration than 1 msec as well as the maximum value of X un-scheduled symbols **will be introduced are pending on further RAN4 discussions.** Our understanding is whether and how to support the non-zero un-scheduled gap case is still under investigation in RAN4, and we should wait for further RAN4 reply before making decision in RAN1.

For the case with other UL channels in between repetitions, (Use case 2b/4b/5b), it is very difficult or even impossible to make the other signals (PUCCH, SRS etc.) transmitted in the middle of two PUSCH repetitions has the same antenna port, occupied PRBs and UL power etc. Thus, we don't think RAN1 should support such rather rare case.

2 – CATT

We can wait for RAN4 input of the exact value of X (whether X can be larger than 14 symbols)

3 – Nokia Solutions & Networks (I)

As long as the conditions provided by RAN4 can be guaranteed, this use case can also be supported to extend the benefit of this feature in TDD deployment. We can wait for further inputs from RAN4 for discussion on this use case.

4 – Intel Deutschland GmbH

We can deprioritize this use case for joint channel estimation for PUSCH.

5 – Qualcomm Incorporated

Use case 5a seems to be ruled out by RAN4 since gap has to be less than 14 symbols. For Use case 5b, the restrictions on the intervening transmissions are so strict that we don't think its practically relevant.

6 – Shenzhen YZF Network Technolog

[OPPO] Not sure whether 14 symbols in RAN4 LS referring to 15KHz SCS, if so, it is possible to applied for non-consecutive slots with other larger SCS, such as 30KHz etc.

7 – Ericsson LM

Similar to use case 4, we suggest that non-back-to-back PUSCH transmissions across non-consecutive slots continues to be considered as a possibility in the design, but not agree to its support at this stage. To get the best usefulness for JCE in TDD, similar to PUSCH transmissions across consecutive slots, we would ideally like to see this case supported, but are worried about the off power requirement. Therefore, if this case can be made feasible in terms of interference and channel estimation gain given impairments, we would be supportive. As we have mentioned before, we hope that gNB based estimation of wideband relative phase difference could help the feasibility for such cases.

8 – WILUS Inc.

At least based on the latest version of the RAN4 LS, the value of non-zero gap X is less than 14 (i.e., 1, ..., 13). Therefore, we can deprioritize the Use case 5 for now.

9 – Apple Computer Trading Co. Ltd

Based on current RAN4 incoming LS, the case 5 is not supported. But we can wait for RAN4 further input.

10 – Motorola Mobility Germany GmbH [Lenovo, Motorola Mobility]: We suggest postponing this use case and wait for further reply from RAN4
11 – Sony Mobile Communications We think that we shall wait for RAN4 further input.
12 – LG Electronics Inc. Use case 5 is one of the most frequent scenario supporting PUSCH repetition type A for joint channel estimation considering TDD frame structure. Therefore it should be considered, however the requirement of RAN4 is not decided yet. It would be efficient for us to revisit after the RAN4's conclusion.
13 – Beijing Xiaomi Mobile Software Wait for RAN4 further input.
14 – Sierra Wireless Based on current RAN4 incoming LS, the case 5 is **very likely** not supported. But we can wait for RAN4 further input.

2.2 Time domain window

FL comments: For the unit of the time domain window, two options were agreed to be down selected. No majority view can be observed so far. Companies are encouraged to provide further views on these two options, including pros and cons.

Option 1: The unit of the time domain window is defined separately for the following PUSCH transmissions:

-PUSCH repetition type A

-PUSCH repetition type B

-TBoMS, if agreed

-Different TB, if agreed

Support: CTC, Xiaomi, Spreadtrum, TCL, Samsung, HW, HiSilicon, OPPO, InterDigital, Ericsson, NTT DOCOMO

Option 2: The unit of the time domain window is the same for the following PUSCH transmission:

-PUSCH repetition type A

-PUSCH repetition type B

-TBoMS, if agreed

-Different TB, if agreed

Support: CMCC (by slots and/or symbols), CATT (by slot), Intel (by repetition or slot), Apple (by slot), LG (by slot or transmission occasion), Lenovo, Motorola, Nokia, NSB (by slot), Qualcomm

Feedback Form 7: Comments, including pros and cons for each option

1 – ZTE Corporation

We would like to clarify what the time domain window here refers to? Is it 1) the maximum time domain window UE reports or 2) the time domain window gNB configures or 3) the actual time domain window after solving the collisions with invalid symbols (e.g., DL symbols) or for these cases? For 1) and 2), we think Option 2 with a unit of slot is sufficient. For 3), repetition level or symbol level may be needed.

2 – InterDigital France R&D

We support Option 1. For repetition type A, transmissions are slot-by-slot basis, so it makes sense to define the granularity of time window by slots. For repetition type B, as actual and nominal repetitions coexist, finer granularity compared to repetition type A, i.e., symbols, is suitable for the granularity of the time window. Our understanding is that the time window, during which the UE is expected to maintain phase and continuity, is configured by the gNB. To decide the granularity of the time window for TBoMS, we may need to wait for the details in the TBoMS discussion.

3 – CATT

We prefer Option 2, since 'slot' should be sufficient for all agreed possible cases (repetition type A, repetition type B, TBoMS). Even for repetition type B, 'slot' is still suitable for the case when actural repetitions is less than 14 symbols.

4 – China Mobile Com. Corporation

Need more clarifications on how to use the time domain window. Or it is hard to discuss this issue with each company has different understandings of the using scenario. From our side, the time domain window should be at least a UE capability. Then we cannot define a UE capability with an unclear unit, such as repetitions. The unified unit such as slots or symbols is preferred. Whether slots or symbols are more appropriate depends on RAN4's conclusion and the study of upper bound of the window.

But if the time domain window is used for the scheduling, that will depend on the specific scheduling indications. The unit of time domain window will follow the scheduling indications. And further it does not matter which kind of unit does the time domain window use.

We propose to discuss more about the using scenario of the time domain window. Both options may have their use cases.

5 – Nokia Solutions & Networks (I)

Our understanding on the definition of a time-domain window in the agreement made in RAN1#104b-e, i.e., "a time domain window during which a UE is expected to maintain power consistency and phase continuity among PUSCH transmissions subject to power consistency and phase continuity requirements", is that: a time-domain window is just a "nominal" duration that the UE is "expected" to maintain power consistency and phase continuity, whereas the "actual" durations within this window that the UE can maintain the power consistency and phase continuity depend on the requirements listed by RAN4 and should be specified. The gNB has full flexibility of scheduling such that these requirements can be broken during the time-domain window. In this case, the time-domain window can simply be counted in the unit of slot.

6 – Intel Deutschland GmbH

We support Option 2.

It is not clear why we need to define different units for time domain window for different use cases. This depends on UE capability and for joint channel estimation, it is likely that UE needs to maintain phase continuity and power consistency over a number of slots/repetitions, which can be commonly applied for different use cases.

7 – vivo Communication Technology

Option 2 is preferred.

8 – Qualcomm Incorporated

It seems sufficient to specify the duration in slots. Please note that number of repetitions might not work since this could translate to different durations in absolute time depending on PUSCH allocation and TDD slot pattern and we could potentially end up violating UE capability.

We view time domain window duration as being provided by the base station based on (a) UE cap (b) nature of transmission i.e., is the modulation 64QAM or QPSK, etc (c) gNB implementation on JCE and (d) diversity across reps via methods such as precoder cycling and (e) inter-slot freq hopping. Once this duration is provided to the UE, UE proceeds to appropriately partition the sequence of transmissions, resulting in one or multiple bundled transmissions.

9 – Ericsson LM

We support option 1, with some clarifications.

Since repetition Type B reuses the specification enhancements defined to support Type A, it's not so clear how the agreements apply for Type B. We'd prefer a note for both Option 1 and 2 to be consistent:

Notes:

- The separately defined unit of the time domain window in Option 1 for Type B reuses specification enhancements defined for Type A.

- The same unit of the time domain window in Option 2 for Type B reuses specification enhancements defined for Type A.

In order to be able to use JCE on all slots, the window should be large enough to support all repetitions or slots of a TBoMS. PUSCH repetition type A determines how many slots to occupy according to physical slots in Rel-15, as well as available slots in Rel-17. TBoMS will support at least one of these or will have yet another way to do TDRA. Therefore, the size of the needed window can vary quite a bit between Rel-15 Type A, Rel-17 Type A, and TBoMS. Configuring according to the largest window for these three cases has problems such as that it limits UE flexibility to update transmit chains, and may also create extra interference in case the off power requirements are not met throughout the window. So using the smallest window size that still allows the greatest gain for a given PUSCH configuration should be well supported.

10 – NTT DOCOMO INC.

We prefer the unit of time domain windows for PUSCH is repetition for finer granularity, since UE might transmit PUSCH and SRS/PUCCH/PUSCH containing different TB in the same slot. If the time domain window size is determined by the number of slots, the power and phase continuity needs to be maintained even between PUSCH and SRS/PUCCH where joint channel estimation is not applied. This might deteriorate coverage performance, due to the constraints of power and frequency calibration.

11 – Apple Computer Trading Co. Ltd

Option 2 is preferred.

The unit of time domain by slot is enough. We don't see the motivation to have different unit. For repetition type B, if the window is based on repetition, which repetition is used, nominal repetition, actual repetition? if go this way, the widow is hard to be defined.

12 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: As indicated, we prefer option 2. Benefit of separately defining unit of the time domain window is not clear to us. For option 2, unit could be based on transmission occasion duration

13 – WILUS Inc.

Option 2. At least for the PUSCH repetition type A and B, the number of repetitions is more straightforward as the unit of time domain window, rather than slots or symbols.

14 – Samsung Electronics Co.

We support Option 1.

Option 1 can be useful to take into account the time domain resource allocation of PUSCH transmission. Each cases of PUSCH transmissions (e.g. PUSCH repetition type A/B, TBoMS, etc.) will have a different type of time domain resource allocation. According to each TDRA of PUSCH transmissions, option 1 can be beneficial to determine the proper unit of time domain window.

15 – WILUS Inc.

We support Option 1, not Option 2. Sorry for confusion.

16 – Panasonic Corporation

We don't think it is necessary to agree Option 1 or Option 2 at this moment. RAN1 can directly discuss the length of time domain window for PUSCH repetition type A, PUSCH repetition type B, TBoMS, different TBs, respectively.

17 – LG Electronics Inc.

Since power control of the current PUSCH is performed in units of transmission occasions, a transmission occasion is suitable to support power consistency. Even if different TB and TBoMS are agreed to support, use cases excluding use cases 1 and 2 are based on slots. Therefore, regardless of the option, the unit for time domain window should be slot or transmission occasion.

18 – HUAWEI TECHNOLOGIES Co. Ltd.

Prefer Option 1.

In our understanding, for the case with single TB, like PUSCH repetition type A/B and TBoMS, implicit indication of time window is sufficient, so there is no need to define any unit of time window for them. Only for the case with multiple TBs, explicit indication of time window to a UE is considered because only in this case the UE needs some assistance information from gNB on whether to retain phase contiguity beyond the resources of the first scheduled TB. In this sense, we don't feel Option 2 is necessary.

To remove the ambiguity of implication that the unit of time window is always explicitly define, we propose to add a subbullet to clarify it.

-

In case of that the time domain window is determined/derived implicitly, the unit of time window is not explicitly defined.

19 – Beijing Xiaomi Mobile Software

Prefer Option 1. Option 1 can be beneficial to determine the most proper unit of time domain window for different use cases.

FL comments: Based on companies' contributions, companies (CTC, Xiaomi, vivo, CMCC, ZTE, CATT, Sierra Wireless, Lenovo, Motorola, Nokia, NSB) think the configuration of time domain window depends on UE capability on the maximum duration of maintaining power consistency and phase continuity.

Proposal 6: Send LS to RAN4 asking the following question.

How long is the maximum duration during which UE can maintain power consistency and phase continuity under certain tolerance level?

Feedback Form 8: Comments on proposal 6

1 – ZTE Corporation

We are fine with the proposal. In addition, we may also need to ask RAN4 whether the maximum duration should be the same for different cases for both PUSCH and PUCCH.

But, regardless of the answer from RAN4, RAN1 can make decision that a maximum time domain window is reported by UE and the time domain window configured by gNB should be no larger than the UE reported one.

2 – CATT

We support sending a LS to RAN4 for guidance. Should RAN1 also provide some input in the detailed value of 'certain tolerance level'?

3 – China Mobile Com. Corporation

Besides the proposal, we would also ask for the views about the impact of phase drifting to the performance of joint channel estimation under a large number of consecutive slots. Since if the phase drifting has an impact to the JCE, a maximum slot number should be defined. And it could be the upper bound of the time domain window, as the performance of JCE would degrade due to the impact of phase drifting.

4 – Nokia Solutions & Networks (I)

We think we should first agree on the general principles of the time domain window design before wondering about its length. We are not against sending an LS to RAN4, but maybe we should wait until further elements can be included to avoid fragmented requests to be issued, and ensure higher effectiveness of the communications between the two WGs.

5 – Intel Deutschland GmbH

We are fine to send LS to RAN4 for this.

6 – vivo Communication Technology

Generally support this proposal.

Suggest to revise the proposal as follows.

Proposal 6: Send LS to RAN4 asking the following question.

How long is the ~~maximum~~ duration during which UE can maintain power consistency and phase continuity under certain tolerance level? And whether the duration is dependent on UE capability?

7 – Qualcomm Incorporated

We are fine to send this LS to RAN4.

We would also like to ask RAN4 on the dependence of this duration on the modulation order of transmission. For example, for QPSK transmissions, the maximum duration for bundling can be longer that the bundling duration for 64QAM transmissions — QPSK is far more tolerant to phase inaccuracies in channel estimation and the UE can therefore be provided more relaxed phase tolerance requirements.

8 – SHARP Corporation

We support FL proposal.

9 – Shenzhen YZF Network Technolog

[OPPO] we support to send the LS.

10 – Ericsson LM

Agree to send the question. The length is likely a function of a number of parameters and/or conditions. Can we ask for those explicitly, e.g.:

- How long is the maximum duration during which UE can maintain power consistency and phase continuity under certain tolerance level, and what factors determine this length?

11 – NTT DOCOMO INC.

Support the proposal.

12 – Apple Computer Trading Co. Ltd

We are fine to send the LS to RAN4.

13 – Motorola Mobility Germany GmbH [Lenovo, Motorola Mobility]: We support sending the LS with suggested question by FL to RAN4
14 – Samsung Electronics Co. We would like to further discuss the design aspects for joint channel estimation at RAN1. Rather than sending LS back and forth again, we want to clarify what additional information we are expecting from RAN4.
15 – Panasonic Corporation We support the proposal.
16 – Sony Mobile Communications Ok
17 – LG Electronics Inc. Agree with the spirit of proposal, however modification is needed. LS to RAN4 should include the impact on phase continuity of the UE by TA adjustment.
18 – HUAWEI TECHNOLOGIES Co. Ltd. The proposal seems to assume a necessity of a maximum duration of time window. Suggest to make the question open and provide more room for RAN4 to decide. **Proposal:** For joint channel estimation, is there a maximum duration during which UE can maintain power consistency and phase continuity under certain tolerance level? If any, how long is it?
19 – Beijing Xiaomi Mobile Software We are fine to send the LS to RAN4
20 – Sierra Wireless We are fine to send LS to RAN4. As stated by others, more questions can be asked which should focus on determining what factors affect this length.

FL comments: For the configuration of time domain window, it seems companies tend to share the view that the time domain window can be implicitly derived from the TDD frame structure.

Proposal 7:

For joint channel estimation for PUSCH,

-The time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum.

–FFS: the start and the length of the time domain window.

-FFS: Whether the time domain window can be explicitly configured or implicitly derived for paired spectrum.

–FFS: The time domain window can be implicitly derived from the repetition factors for PUSCH repetition type A or type B.

–FFS: the start and the length of the time domain window.

Feedback Form 9: Comments on proposal 7

1 – ZTE Corporation

After UE reporting the maximum time domain window, a time domain window should be first configured by gNB. Because it should be allowed for gNB to configure one smaller time domain window than the reported one if gNB doesn't want to perform joint channel estimation for a longer duration and this could also avoid UE to keep the phase continuity unnecessarily. Then, the actual time domain window for joint channel estimation could be implicitly determined by TDD configuration or other conditions like SFI etc.

Therefore, we suggest to make the following changes.

Ÿ For joint channel estimation for PUSCH, one time domain window is configured by gNB.

 The actual time domain window can be implicitly derived from at least the DL/UL configuration for unpaired spectrum.

o FFS: the start and the length of the time domain window.

 FFS: Whether the actual time domain window can be ~~explicitly configured or~~ implicitly derived for paired spectrum.

o FFS: The time domain window can be implicitly derived from the repetition factors for PUSCH repetition type A or type B.

o FFS: the start and the length of the time domain window.

 The time domain window configured by gNB is no larger than the time domain window reported by UE.

The actual time domain window determined is no larger than the time domain window configured by gNB.

2 – CATT

For unpaired spectrum, we may need a FFS on the relationship between the implicitly derived window and the reported UE capability.

3 – China Mobile Com. Corporation

The time domain window is related with DL/UL configurations. But it is more related to the indication of scheduling. More discussions are needed.

4 – Nokia Solutions & Networks (I)

This should be discussed after we have further progress on the Use case 5, which still need further inputs from RAN4 according to RAN4 reply LS.

5 – Intel Deutschland GmbH

We do not support this proposal. Our understanding is that a unified solution should be applied for both TDD and FDD systems. Even for TDD case, it may be possible that time domain window is less than the number of consecutive UL slots. In this case, the time domain window can be explicitly configured by the higher layers.

6 – vivo Communication Technology

For both paired and unpaired spectrum, the time domain window can be explicitly configured, while it does not mean UE have to maintain phase continuity and power consistency across the configured duration. An actual duration, which could be shorter than the configured one, may be determined implicitly from other configurations, e.g. UL DL configuration, semi-static DL reception or UL transmissions and etc., since the conditions to maintain phase continuity and power consistency can not be fulfilled due to these factors.

Hence, we suggest the explicit configuration of the time domain window is considered as a baseline for both TDD and FDD. And the time domain window in TDD spectrum can be further determined implicitly from DL/UL configuration, semi-static configured DL reception and UL transmission.

7 – SHARP Corporation

We support FL proposal.

8 – Shenzhen YZF Network Technolog

[OPPO] support the proposal.

9 – Ericsson LM

We prefer to discuss this further before agreeing. This seems to relate to vivo and ZTE's 'actual' windows. The 'actual' window of slots that can be combined can be determined by the TDD pattern, whereas the configured or 'nominal' window can be larger. The proposal seems to assume the window size is equal to the largest 'actual' window size supported by the TDD pattern, and excludes the 'nominal' approach.

10 – Qualcomm Incorporated

The proposal seems to assume a single time domain window. We think multiple time domain windows may be necessary to cover all the repetitions. The UE may indicate a max duration for the window via its capability, but the gNB is free to configure the UE for a smaller duration. The UE then uses this configured value to determine how the PUSCH transmissions are to be partitioned into bundles. For example, UE capability could indicate bundling across 8 slots, while gNB configures UE with time domain window duration of 4 slots. If PUSCH grant indicates 16 repetitions in a FDD band, then the UE partitions these 16 repetitions into 4 sets of 4 transmissions each and defines 4 time domain windows for bundling.

Suggest altering the first line as follows:

Proposal: For joint channel estimation for PUSCH,

-One or more time domain windows are determined for a sequence of PUSCH transmissions. The time domain window(s) can be implicitly derived from the DL/UL configuration for unpaired spectrum.

11 – NTT DOCOMO INC.

We do not support the proposal.

The time domain window should be indicated dynamically according to channel, so that the time domain window covers only PUSCH resources where JCE is applied. If the time domain window is longer than necessary, coverage performance might get worse due to low frequency of power updating and frequency calibration. As the actual duration of JCE on gNB is dependent on channel, the dynamic indication of time domain window size is beneficial.

12 – Apple Computer Trading Co. Ltd

We are general ok with this proposal. it could be update to support two time domain windows in case of dual TDD UL/DL patterns.

13 – WILUS Inc.

We support the FL's proposal in principle. However, same configuration can be considered by take into account common design for TDD and FDD. For this, both explicit and implicit configuration can be applied, e.g., consecutive UL slots are implicitly determined as a window that do not exceed the explicitly configured length.

14 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: We are fine with the proposal

15 – Samsung Electronics Co.

We are generally fine with the FL's proposal.

We think that both the explicit configuration and implicitly derived can be considered to determine the time domain window.

16 – Panasonic Corporation

When DL slots are located between UL slots, the time domain window cannot be same on UL slots before and after DL slots. Therefore, we agree the proposal in principle. On the other hand, the length of time domain window is not determined only the DL/UL configuration. Therefore, we would like to add "at least" as follows

The time domain window can be implicitly derived <u>at least</u> from the DL/UL configuration for unpaired spectrum.

17 – LG Electronics Inc.

Fine with proposal.

18 – HUAWEI TECHNOLOGIES Co. Ltd.

Agree on implicit determination of time window for some cases. But we don't feel its determination is based on DL/UL configuration, but the requirements developed by RAN4 and the scheduled resources.

For example: (Please refer to illustration figures in our tdoc R1-2104241, which cannot be copied into NWM here)

- For FDD mode with back-to-back repetition type A, the time domain widow is determined implicitly

o Starts from the 1st symbol of 1st repetition, ends with last symbol of last repetition or last symbol of the slot with last repetition.

- For FDD mode with non-back-to-back repetition type A, the time domain window is determined implicitly based on whether phase continuity can be ensured (according to RAN4's confirmation).

o If a small number X symbols between non-back-to-back PUSCH repetitions and RAN4 confirms the phase continuity between two adjacent PUSCH repetitions, then 1 large time domain window can be implicitly determined with start and duration length mentioned in above bullet

o If a large number X symbols between non-back-to-back PUSCH repetitions and RAN4 confirms the phase continuity no more retains between adjacent PUSCH repetitions, then each time domain window is determined as one repetition or slot.

o If burst signal (e.g. high priority URLLC, CI, etc) occurs between back-to-back PUSCH repetitions, which leads to non-back-to-back PUSCH transmissions, multiple time domain widows are implicitly determined/segmented from the burst signal.

- For FDD mode with back-to-back repetition type B, the time domain window is determined implicitly, which starts from the 1st symbols of 1st actual repetition and ends with the last symbols of last actual repetition.

- For FDD mode with non-back-to-back repetition type B, such as burst signal occurs between two adjacent PUSCH repetitions, time domain windows are determined/segmented implicitly from the occurred burst signal

- For TDD mode, time domain window can be determined implicitly based on both contiguous UL slots and aforementioned cases in FDD mode (e.g. burst signal occurs, X un-scheduled symbols between two adjacent PUSCH repetitions, etc.)

19 – Beijing Xiaomi Mobile Software

We are generally fine with the FL's proposal.

Support both the explicit and implicit indication can be considered to determine the time domain window.

20 – InterDigital France R&D

(InterDigital) We are ok to discuss further on this subject.

FL comments: Based on companies' contribution, companies (vivo, Samsung, CATT, InterDigital, Intel, LG, Sierra Wireless) think the enabling/disabling of the time domain window should be supported. There can be two alternatives. Companies are encouraged to provide views on the following two alternatives.

Alt 1: For joint channel estimation for PUSCH, the enabling/disabling of the time domain window and the enabling/disabling of joint channel estimation are jointly configured.

Alt 2: For joint channel estimation for PUSCH, the enabling/disabling of the time domain window is separated configured from the enabling/disabling of joint channel estimation.

Feedback Form 10: Comments on enabling/disabling of the time domain window

1 – ZTE Corporation

Alt 1 seems sufficient. In addition, enabling/disabling of the time domain window can be automatically achieved by configuring a time domain window size from gNB.

2 – CATT

We think Alt 1 is sufficient.

3 – China Mobile Com. Corporation

The time domain window is defined or specified for the joint channel estimation. We do not see the

motivation to enable the time domain window but without intention to use JCE or any possibility that JCE could work without maintaining the power consistency or phase continuity, i.e. enabling the time domain window.

More clarifications are needed for the alternative 2. And the proposal seems a little confusing.

4 – Nokia Solutions & Networks (I)

We prefer Alt. 1

5 – Intel Deutschland GmbH

It is not very clear the intention of the proposal. Enabling/disabling of joint channel estimation should mean that time domain window is enabled/disabled.

It would be good to first agree whether enabling/disabling joint channel estimation can be configured by higher layers, which is similar to what was agreed for joint channel estimation for PUCCH.

6 – vivo Communication Technology

In our understanding, joint channel estimation can be configured by RRC signalling, while the enabling or disabling the time domain window can be separately indicated in UE specific/group common DCI or in MAC-CE, which can be used to enabling or disabling full set or subset of the configurations for DMRS bundling window.

7 – SHARP Corporation

We assume that “enabling joint channel estimation” means “maintaining phase continuity and power consistency”. We prefer Alt.1. Motivation of Alt.2 should be clarified if supported.

8 – Shenzhen YZF Network Technolog

[OPPO}

Not sure whether the time domain window needs to be configured.

Based on the reply LS from RAN4, if the conditions can be met as in the LS, the UE can maintain phase continuity, why the the time domain window needs to be configured?

9 – Ericsson LM

While we are open to Alt 2 if a need can be shown; our current preference is Alt 1.

10 – Qualcomm Incorporated

Without time domain window, we dont think bundled transmissions by a UE are even feasible. JCE and time domain window configuration need to go together. Alt 1 seems to be the right choice, but we are not entirely sure of the intent here.

Its not clear if the proposal is aiming to allow a signaling mechanism to enable/disable JCE without having to go through a RRC reconfiguration. Clarifying this would be helpful.

11 – NTT DOCOMO INC.

This discussion point is tightly related to the previous discussion point (The window is implicitly indicated or explicitly indicated.). At least we support explicit indication, and in that case, we think enabling/disabling of the time domain window does not need to be supported. If the time domain window size can be explicitly determined, time domain window size equal to 1 repetition or 1 slot can be the same as disabling the time domain window.

12 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: We support Alt 1 and don't see the need for separate configuration of time domain window and enabling/disabling joint channel estimation. In our view, whenever time domain window size is configured, then it should imply that joint channel estimation is enabled

13 – Apple Computer Trading Co. Ltd

If the joint channel estimation is enabled, then time domain window is applied implicitly. We don't need indicate the time domain window is enabled or not addtionally.

14 – Samsung Electronics Co.

We prefer Alt 1.

The enabling/disabling of the joint channel estimation should be needed to prevent the misunderstanding of between gNB and UE.

We don't see the need for separate configuration.

15 – Panasonic Corporation

Does the term usage of "configured" mean only semi-statical RRC configuration (as used in typical RAN1 discussion) or mean that it includes semi-statical RRC and/or dynamic DCI configuration(s)?

Our position is alt 1 and it is dynamically controlled.

16 – LG Electronics Inc.

It is unclear to us that why the enabling/disabling of time domain window is needed when the configuration of time domain window already exists. The simplest enabling and disabling would be configuring the size of time domain window to be 1 or other number. Further clarification is needed for the case when enabling/disabling of time domain window is necessary.

17 – HUAWEI TECHNOLOGIES Co. Ltd.

Prefer Alt.1. But we doubt that the proposal can be agreed before a consensus is made on which case the time window should be implicitly indicated. Here the proposal seems to assume explicit indication only. In our understanding, explicit indication is only necessary for the case with multiple TBs.

18 – Beijing Xiaomi Mobile Software

alt 1 is enough

2.3 Inter-slot frequency hopping with inter-slot bundling

FL comments: For the bundle size (time domain hopping interval), two options were agreed to be down selected. No majority view can be observed so far. Companies are encouraged to provide further views on these two options, including pros and cons.

Option 1: The bundle size (time domain hopping interval) equals to the time domain window size.

Support: vivo, CMCC, Samsung, HW, HiSilicon, ZTE, Qualcomm, Apple, Panasonic, LG, NTT DOCOMO, Lenovo, Motorola, Sharp (FDD)

Option 2: The bundle size (time domain hopping interval) can be different from the time domain window.

-FFS: Whether the bundle size (time domain hopping interval) is explicitly configured or implicitly determined.

-FFS: Whether/How the bundle size (time domain hopping interval) is defined separately for FDD and TDD.

-FFS: relation between the bundle size (time domain hopping interval) and the time domain window size

Support: CTC, Xiaomi, CMCC, CATT, OPPO, Intel, Panasonic, LG, Nokia, NSB, Ericsson, Sharp (TDD)

Feedback Form 11: Comments, including pros and cons for each option

1 – ZTE Corporation Option 1 is preferred. But we suggest to first discuss the determination of time domain window for joint channel estimation. After a clearer definition on the time domain window, we can further determine whether it can be applied for the bundle size.
2 – CATT Slightly prefer Option 2. In addition we think the bundle size should be smaller than or equal to the time domain window. But we are OK to discuss the determination of time domain window first. For example, if RAN4's feedback is that a UE can only maintain the time domain window=2 slots, then seems no need to discuss this issue.
3 – China Mobile Com. Corporation If the time domain window is defined as a UE capability, the bundle size should not be larger than the time domain window. This contains both option 1 and parts of option 2 (smaller than the time domain window). If the duration of the window is smaller than the bundle size, partial repetitions cannot use the JCE, which is obvious not the intentions of the study.
4 – Nokia Solutions & Networks (I) We prefer Option 2, which provides full scheduling flexibility for the gNB. In case the gNB needs to schedule something that could break the phase continuity within a time-domain window, the bundling size can be considered as the "actual" time-domain window which could be less than the time-domain window.

5 – Intel Deutschland GmbH

We prefer Option 2.

In our view, the time domain window can be larger than bundle size. For example, UE may maintain the power consistency and phase continuity over 4 consecutive slots. When 4 slots are allocated for PUSCH repetitions, the bundle size can be 2 slots, where gNB may perform joint channel estimation in two bundled slots.

6 – SHARP Corporation

Our preference is Option 1 for FDD and TDD. For TDD, since the number of consecutive UL slots are limited (e.g., at most 2 or 3 slots), we don't see benefit configuring those two separately. For FDD, we think that time domain window size and bundle size can be configured by single parameter.

7 – Shenzhen YZF Network Technolog

[OPPO] our preference is option 2. The bundle size in itself is determined with the purpose trying to maximize PUSCH transmission performance considering balance of the frequency hopping gain and joint channel estimation. When gNB sets the bundle size, the total number of repetition number, the channel condition, the slot structure tec. shall be taken into account.

8 – Ericsson LM

We prefer to defer this discussion until the definition of the time domain window is more clear.

However, for us, what is more critical to agree is how the hopping pattern is adjusted. The phase continuity & power consistency constraints can then determine which DMRSs in which hops can be combined. Tradeoffs on channel estimation gain vs. frequency hopping gain should be quantified to allow the right frequency hopping patterns to be defined.

9 – Qualcomm Incorporated

Proponents of Option 1 and Option 2 dont seem to have a common understanding of what the time domain window duration is supposed to signify. To be clear, this time domain window duration is not the same as UE capability; it will need to be explicitly provided to the UE by the gNB (this takes care of what ever flexibility the gNB may desire). Using this parameter, UE may determine one or more time domain windows and their exact placement. The new hopping framework will then need to be defined around this framework.

With this interpretation, Option 1 seems like a reasonable choice.

10 – WILUS Inc.

We prefer Option 2. The bundle size is smaller than or equal to the time domain window size. However, it seems better to discuss after the clarification of the time domain window.

11 – NTT DOCOMO INC.

The bundling size should be treated after the discussion of signaling mechanisms of time domain window sizes. As each company has different assumption about the time domain window indications, it is difficult to down select the two options.

For example, if the time domain window is dynamically determined by an explicit indication. There is no strong motivation to differentiate the bundling size from the time domain window size. On the other hand,

if the time domain window size is implicitly determined, the bundling window size should be configured separately.

12 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: As indicated, our preference is option 1. We see following benefit of option 1:

- No additional signalling required for indicating both bundle size as well as the time domain window, only indicating one of the is sufficient
- Not clear benefit of having difference size

13 – Apple Computer Trading Co. Ltd

Option 1 is preferred.

The only purpose of defining the bundle size is for joint channel estimation, i.e., to align the size of time domain window. Option1 provide this baseline function.

14 – Samsung Electronics Co.

Support Option 1.

From our understanding, the gNB can adjust the actual time domain window size to perform the joint CE by implementation, even if the bundle size equals to the time domain window.

15 – Panasonic Corporation

The relation with inter-slot precoder cycling should be taken into account in addition to frequency hopping. If the discussion is for UE not to support precoder cycling, our view is option 1. If the discussion is for UE supporting precoder cycling, we would like to discuss it further between option 1 and option 2.

16 – LG Electronics Inc.

For option 1, the advantage of it comes from the simplicity. Option 1 would be better if every UEs have same size of time domain window, however the size of it could be UE-specific due to the channel condition of UEs, which will be less flexible for gNB in terms of resource management, especially for multi-user multiplexing.

For option 2, it can provide gNB more flexibility in resource management. At the same time, the gain of joint channel estimation can be guaranteed with condition that time domain hopping interval is equal to or larger than time domain window. Therefore, we support option 2 with the condition.

17 – HUAWEI TECHNOLOGIES Co. Ltd.

Optino1 is preferred

18 – Beijing Xiaomi Mobile Software

We prefer Option 2. the time domain window can be larger or equal than bundle size. For example, if a fixed time window size is explicit configured by gNB, such as time window size is 4 consecutive slots but there is greater X un-schedule happened suddenly in the third slot because of SFI, CI or higher priority.

Then the phase continuity & power consistency constraints is broken. One effective method is to reduce the actual DMRS bundle size for channel estimation, such as reduce the bundle size to 2 on the first two available slots.

2.4 Optimization of DMRS location/granularity in time domain

FL comments: For optimization of DMRS granularity in time domain with joint channel estimation, for the case of no DMRS for some PUSCH transmissions, based on the simulation results, only one company show performance gain while two companies show performance degradation.

Proposal 8:

Optimization of DMRS granularity in time domain for PUSCH is not considered for joint channel estimation in Rel-17.

Feedback Form 12: Comments on proposal 8

1 – ZTE Corporation Based on the simulation results from companies, optimization of DMRS granularity has performance gain in some cases while not all cases. This is a common situation for most of the enhancements. Given gNB can enable or disable the optimization for different cases, performance gain can still be obtained, and the performance degradation could be avoided. Thus, we prefer to support optimization of DMRS granularity for PUSCH.
2 – CATT Suggest to take more simulation results from different companies into consideration before having a decision. No need to hurry to such conclusion.
3 – Nokia Solutions & Networks (I) Support the FL's proposal.
4 – Intel Deutschland GmbH We are fine with the proposal.
5 – Qualcomm Incorporated Support.
6 – SHARP Corporation We support FL proposal.
7 – Ericsson LM Ok with the proposal.

8 – Motorola Mobility Germany GmbH [Lenovo, Motorola Mobility]: We are fine the FL proposal
9 – Apple Computer Trading Co. Ltd We support this proposal.
10 – Panasonic Corporation We support the proposal 8
11 – LG Electronics Inc. We support FL's proposal.

FL comments: Following simulation results are observed for DMRS located in special slots.

One company (HW) shows JCE w/ 1/2 DMRS located in special slot can improve the performance of PUSCH transmissions by 0.75/1.3dB at 10% BLER in typical TDD mode 'DDDSUDDSUU' compared to the baseline of UL slot with 1 DMRS w/o JCE. Additionally, JCE w/ 1/2 DMRS located in special slot can improve the performance of PUSCH transmissions by 0.45/0.65dB at 10% BLER in typical TDD mode 'DDDSUDDSUU' compared to the baseline of UL slot with 2 DMRS w/o JCE.

One company (InterDigital) shows JCE w/ 1 DMRS located in special slot can provide 0.5 and 0.8dB gain at 10% BLER in TDD configuration 'DDDSU', with 2 DMRS in the UL slot with the baseline and optimized DM-RS placement in the uplink slot, respectively, compare to the baseline DM-RS placement in the uplink slot in TDD configuration 'DDDDU'.

One company (vivo) shows JCE w/ 1 DMRS located in special slot can provide 0.7dB gain at 10% BLER with 2 repetitions, TDD configuration 'DDSUU' and 1 DMRS symbol per UL slot. Moreover, the performance gain is not sensitivity to the DMRS pattern.

One company (Intel) shows JCE w/ 1 DMRS located in special slot can provide 0.5 dB gain at 10% BLER with 2 and 4 repetitions, TDD and 2 DMRS symbol per UL slot.

One company (Ericsson) observes jointly estimated DMRS in special slot can theoretically improve channel estimation performance slightly, but in a fair comparison, where the total amount of system resources used by the UE is kept unchanged and 14% of the UL is needed for A/N or SRS, no net gains from having DMRS in special slot are observed in the simulations.

Proposal 9:

For joint channel estimation for PUSCH, DMRS located in special slots is supported in the following cases,

-Additional DMRS is located in special slots for repetition type A

-FFS: optimization of DMRS location in special slots for repetition type A

-FFS: Transmission of different TBs

Feedback Form 13: Comments on proposal 9

1 – CATT

OK. We are open to taking the chance of utilizing UL resource in special slots to improve coverage.

2 – China Mobile Com. Corporation

If my understanding is right, the intention of 'additional DMRS' in the 1st sub bullet is to use the DMRS in the special slot as the additional DMRS for the latter uplink slots, not additional DMRS in the current specification. Then we proposal update the 1st sub bullet as below.

~~Additional DMRS is located in special slots for repetition type A~~

The DMRS located in special slots could be used for repetition type A in the special slot and the following uplink slots.

In the special slot, we have the 6:4:4 configuration, in which the last 4 symbols could carry both data and DMRS.

3 – InterDigital France R&D

We support the proposal.

4 – Nokia Solutions & Networks (I)

We do not support the proposal. We share similar observation with Ericsson that the practical benefit of using DMRS located in special slot for joint CE is not evident. In addition, this should be considered as advanced design aspect and can be considered after the basic framework of joint CE has been finalized.

5 – Intel Deutschland GmbH

Although we showed the performance gain for additional DMRS symbols in the special slots, it would be good to also list all the potential spec impact before we can agree on this feature. If the spec impact is large, we do not think it can be fit into the WI

6 – vivo Communication Technology

Support this proposal.

7 – Shenzhen YZF Network Technolog

[OPPO] this feature shall be deprioritized.

8 – Ericsson LM

Do not support. Gains are at most about 0.5 dB for a more reasonable baseline of 2 DMRS/slot, and assume that SRS or PUCCH is not transmitted, since the special slot is always used. If the number of repetitions is adjusted to allow some resource availability for SRS and/or PUCCH, the gains vanish as we show in our contribution R1-2105654.

9 – Qualcomm Incorporated

The gains are not surprising — this is similar to saying that a 14 symbol PUSCH outperforms a 13 symbol symbol. Using additional resources ought to bring performance improvement. We should however note that S slots accommodate PUCCH/SRS, and its not right to assume them to be readily available.

We anticipate significant spec impact to support such an enhancement and would therefore prefer to deprioritize this.

10 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: We are fine the FL proposal

11 – Apple Computer Trading Co. Ltd

The potential gain of additional DMRS in special slot is coming from the less opportunity of SRS transmission, which means more users would be impacted. SRS serves serval important roles in NR system, we have concerns to introduce DMRS in special slot.

12 – Panasonic Corporation

We support the proposal 9.

13 – LG Electronics Inc.

Many thanks to the simulation results. However, it requires quite a lot of effort compared to the performance gain. For example, DMRS in special slot is likely to limit the transmission of SRS and PUCCH, and the spec work may be increased depending on whether considering additional DMRS in special slot as a PUSCH including the DMRS, or transmission of only the DMRS rather than the PUSCH. Therefore we cannot support the proposal.

14 – HUAWEI TECHNOLOGIES Co. Ltd.

Support FL's proposal.

By fully utilize the UL symbols in special slot, more number of DMRS symbols without increasing the pilot overhead can enable a better channel estimation and improve uplink coverage performance obviously.

15 – Beijing Xiaomi Mobile Software

Fine with the proposal.

2.5 Others

FL comments: Companies are encouraged to provide a list of items (e,g., SFI, UL CI, channel prioritization, PT-RS, TPC command, TA command, Phase correction at gNB, CA operation, DC operation) that may have impact on joint channel estimation for PUSCH, label each item with a priority for discussion, i.e., high priority, medium priority or low priority, and provide views on each item.

Feedback Form 14: Comments

1 – ZTE Corporation

We'd like to highlight that joint channel estimation should be support for CA in our view. The main reason include 1) UL CA is beneficial for UL coverage enhancement and we observe that using two carriers with Tx switching for PUSCH transmission can provide about 3 dB performance gain compared to single carrier case. 2) Based on the requirements defined by RAN4, the phase continuity can be kept for CA at least when PUSCH is only transmitted in one carrier at a given time.

2 – InterDigital France R&D

We consider the PT-RS item to be high-priority. PT-RS may be needed to correct disruption in phase continuity after switching from DL to UL slot or during transmissions of repetitions that may cross the slot boundary. Thus, the UE may need to send PTRS along within the DM-RS bundle so that the gNB can perform phase correction.

3 – Intel Deutschland GmbH

This can be discussed at later stage after basic framework for joint channel estimation is defined.

4 – Ericsson LM

We think high priority items are phase correction at gNB (or other mechanisms to improve non-consecutive JCE), frequency hopping patterns optimized for JCE, TPC operation, and TA operation. CA and DC can be medium priority.

5 – Qualcomm Incorporated

Interaction between DMRS bundling and the following needs be specified/clarified: SFI, UL CI, channel prioritization, TPC command, TA command. This can be considered medium priority. CA and DC operation can be low priority for now.

6 – Samsung Electronics Co.

TPC command:

A UE updates the closed-loop power control(CLPC) adjustment state per time domain window.

Within time domain window, the UE skips application of TPC commands and does not update the CLPC adjustment state to maintain the power consistency and the phase continuity. The UE can accumulate TPC commands, update the CLPC adjustment state and apply a latest updated value to determine a power for repetitions of the PUSCH transmission when the time domain window changes.

CA operation and DC operation:

We don't support the CA operation/DC operation for CovEnh.

It is highly unlikely that a UE with poor coverage will be configured with CA/DC. No need to consider unrealistic cases.

7 – LG Electronics Inc.

TPC command, TA command : high priority

Both of TPC command and TA will impact directly to the consistency of UE's transmission since it adjusts power or derive linear phase which cannot be known to gNB. Especially the impact of TA adjustment is shown in simulation of our contribution. Therefore, it is correct to be high priority.

CA operation, DC operation : high priority

Coverage enhancement is required not only for cell-edge UEs but also for UEs under coverage mismatch, i.e., sufficient downlink coverage and shortage in uplink coverage at the same time. A gNB can configure CA or DC to such UEs judging by sufficient downlink coverage and it could impact power and phase consistency. In that sense, it should be high priority.

PT-RS, Phase correction at gNB : low priority

Considering PT-RS is narrowband signal, the performance of wide band phase correction is questionable to us and furthermore it could be replaced by additional DMRS. And phase correction at gNB is rather gNB implementation issue than described in specification. Therefore both of them can be low priority.

3 Email discussion (2nd round)

3.1 Use cases

FL comments: Companies having concerns on proposal 1 please check the following comments.

There are many simulation results of joint channel estimation among different TBs with large gains are provided by companies, which are captured in TR 38.830, e.g. R1-2008626, R1-2007583, R1-2008874, R1-2008026, R1-2008559, etc.

As long as the condition of power consistency and phase continuity can be maintained, joint channel estimation can be applied.

1 Mbps UL data rate is required for eMBB services under Urban scenario without repetition as the simulation baseline, thus it's a very common case of joint channel estimation among different TBs to meet the medium-to-high data rate requirements in uplink coverage enhancement.

Observations captured in TR 38.830.

Eleven sources (R1-2008874, R1-2007743, R1-2008626, R1-2008399, R1-2008378, R1-2008026, R1-2007680, R1-2008419, R1-2009792, R1-2008479, R1-2007583) show 0.2 2.1 dB SNR gain for joint channel estimation over multiple slots for eMBB at 10% iBLER depending on the number of slots for FR1, compared to Rel-16 PUSCH transmission without joint channel estimation.

If companies still have concerns, please answer the following questions.

For the 1 Mbps target UL data rate, whether different TBs or single TB with repetition should be considered?

Is it beneficial if joint channel estimation is applied for PUSCH transmissions with different TBs?

Proposal 1:

For back-to-back PUSCH transmissions across consecutive slots, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following cases:

Over back-to-back PUSCH transmissions with different TBs

Support: Huawei, HiSilicon, CATT, LG, InterDigital, CMCC, China Telecom, Sony, ZTE, Sharp, Nokia, NSB, Lenovo, Motorola Mobility, Sierra Wireless, vivo, Sharp, DOCOMO

Not support: Qualcomm, Panasonic, Apple, WILUS, OPPO, Ericsson, Intel, Samsung

Feedback Form 15: Comments on proposal 1

1 – TCT Mobile Limited

Support the proposal.

2 – Beijing Xiaomi Mobile Software

support the proposal.

3 – vivo Communication Technology

support this proposal

4 – Qualcomm Incorporated

Dont support; reiterating some points below along with answers to questions posed by FL.

For the 1 Mbps target UL data rate, whether different TBs or single TB with repetition should be considered?

We assumed 1 Mbps data rates for TDD systems with DDDSU slot pattern with 30 kHz SCS. May be a more important question for us to address is whether DMRS bundling is even feasible here. If not, this whole discussion is moot. Please do note that as things currently stand, RAN4 guidance suggest that bundling will not be feasible here (gap is too long between 2 U slots.)

On the question of repetitions: the gNB can set up the UE with a sequence of PUSCH transmissions with no repetitions and carrying 2500 bits each or set up the UE with a sequence of PUSCH transmissions with repetitions carrying a larger payload, 10000 bits say. Both options are valid.

Is it beneficial if joint channel estimation is applied for PUSCH transmissions with different TBs?

If we need to support JCE across different TBs, the trigger for JCE must be received prior to the start of the first TB's transmission. UE needs to know this ahead of time, else it cannot plan. A UE cannot be asked to extend DMRS bundling on the fly. A UE handles multiple processes in parallel (freq tracking, time tracking, RF calibration, power control, ant switching, etc) and its not trivial to maintain phase coherence unless given clear advance notice. The trigger must make it very clear when DMRS begins and when it ends.

Under the above prerequisite, the question then emerges on why the gNB needs to schedule multiple TBs. If gNB knows ahead of time, it can allocate a single grant with a larger TB size and enable repetitions. Every conceivable scenario for JCE across multiple TBs can be reduced to a single TB case with repetitions. Overall system reliability might actually improve considering the reduced DCI overhead.

FL: if you'll be asking us to comment once again on this topic, please provide some clarity on what the trigger mechanism is if multiple TBs are involved. Further, please let us know whether under current RAN4 guidelines, bundling is even feasible for a TDD system with DDDSU slot pattern.

5 – Intel Deutschland GmbH

We do not support the proposal. Same comments as before and we do not see the need of coverage enhancement for different TBs. This also poses restriction on the scheduling on the PUSCH, which indicates that multiple PUSCHs need to have same TBS, FDRA, MCS, etc.

6 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: Support the FL proposal

7 – Ericsson LM

To respond to the comments and why we do not support:

- **There are many simulation results of joint channel estimation among different TBs with large gains are provided by companies, which are captured in TR 38.830, e.g. R1-2008626, R1-2007583, R1-2008874, R1-2008026, R1-2008559, etc.**

It is intuitive that reducing DMRS overhead through JCE will have some gains. However, we think the amount of gain should be more carefully quantified against a best performing baseline. The focus seems to be on the case where the greatest gains are found, which is where insufficient DMRS are used, e.g. with 1 DMRS as the baseline. Gains are naturally less with 2 DMRS. We also note that 4 DMRS often provides the best performance in coverage conditions (although this depends on the data rate), but unfortunately there do not seem to be results with this case as a baseline.

Furthermore, the results we are aware of assume that UEs are scheduled in the exact same PRBs, which implies some loss from the absence of frequency domain scheduling, which is not accounted for.

- **As long as the condition of power consistency and phase continuity can be maintained, joint channel estimation can be applied.**

This is true, but the question is if it can be maintained sufficiently often in the different TB case without undue scheduling constraints in practical operation. How will network algorithms such as outer loop link adaptation work? Does the network have to delay control signaling in order to force the TB sizes to be the same? Does the network need to limit the number of radio bearers to force the total traffic in each slot to be the same? Etc.

Then if one were to force the TB size to be identical for a fixed number of slots, why not then use TBoMS, where the scheduling overhead is reduced?

- **1 Mbps UL data rate is required for eMBB services under Urban scenario without repetition as the simulation baseline, thus it's a very common case of joint channel estimation among different TBs to meet the medium-to-high data rate requirements in uplink coverage enhancement.**

We agree that it is important to improve PUSCH coverage for such data rates. However, it is not clear to us which 1 Mbps services will have fixed TB sizes.

8 – China Telecommunications

Although from operator point of view, we expect joint channel estimation can be widely used. From FL perspective, I'm fine to support joint channel estimation over PUSCH transmissions with different TBs or not support it, as long as we can make progress. J

So far, what we can see is that there are a large number of supporting companies and there are many simulation results of joint channel estimation among different TBs with large gains captured in TR 38.830. To make progress, it's fair to ask companies having concerns to provide the detailed reasons why joint channel estimation cannot be applied to PUSCH transmission with different TBs.

In my understanding, for DDDSU, DMRS bundling can be adopted for the special slot (UL symbols) and the subsequent U slot. Besides DDDSU, there are other two TDD frame structures evaluated in SI phase, and many results based on DDDSUDDSUU are captured into the TR. For these two TDD frame structures, DMRS bundling can be adopted for the special slot (UL symbols) and the subsequent two U slots.

As for RAN4 guidance, although in the reply LS, RAN4 confirms the feasibility of phase continuity and power consistency for non-zero un-scheduled gap case for a gap less than 14 symbols, the off power requirements are defined for no less than 1 ms. To keep consistent with 1 ms, RAN4 is currently discussing the gap can be up to 14, 28, 56, and 112 symbols for SCS of 15, 30, 60 and 120 kHz respectively.

Agree that PUSCH transmission with different TBs for a single TB with repetition are both valid. However, I was wondering which one has better performance for cell edge UE with the target UL datarate of 1Mbps. And I was also wondering which one is adopted in the real network.

Regarding the trigger mechanism, in my understanding, this certainly needs to be addressed similar as PUSCH repetition type A, but it seems it cannot justify objecting to PUSCH transmission with different TBs.

Considering current situation, maybe the best way is we try to find some middle ground to make progress, e.g., make some restrictions to support joint channel estimation over PUSCH transmissions with different TBs or reuse the mechanism for PUSCH repetition type A as much as possible just as we did for repetition type B.

9 – Ericsson LM

We think Type B should be at least deprioritized, in order to focus on the Type A design, noting that Type B should anyway reuse the designs for Type A.

The second bullet to not support different TBs within one slot is OK.

10 – CATT

Generally, we would like to see widely application of JCE to improve the coverage performance in different scenarios as much as possible. But based on the valuable input from different companies so far, we agree that RAN4's condition on phase/power are Necessary Condition, but not Sufficient Condition.

For Ericssion's comments, we think that even if the specification may support JCE between different TBs, the gNB can still disable it if they would like to. For example, a gNB can just schedule the 2nd TB with different BW/freq location with the 1st one, and thus the JCE cannot be applied naturally. In this regard, our understanding is that supporting JCE by specification should not force the gNB to 'always apply JCE'. Otherwise we will also reconsider our position.

For Qualcomm's comments, it seems the concerns from UE's perspective are not widely considered nor addressed by other companies. We may need some time to think about it.

11 – MediaTek Inc.

Not preferred.

It may impose more restrictions on UE side and gNB side including gNB scheduling. Moreover, the overall system performance and scheduling fairness are be impacted, which may require the system level evaluation. The spec impact may also be large to address some error cases or corner cases later on whether/how to use it.

For the most coverage limited scenario, the UL resources are limited and distributed. so the JCE across the different TBs for one UE may not help much in terms of the system performance gain.

12 – China Mobile Com. Corporation

Support the proposal.

Firstly, to fulfil the requirement of cell edge data rate, different TBs should be transmitted. The repetition could enhancement the coverage with the cost of available uplink resources. Secondly, the UE which located at cell edge, there is no need to use diverse MCS level and different allocated PRB numbers. Then it is feasible to maintain the power consistency and phase continuity for single UE but with different TBs.

13 – InterDigital France R&D

Support

14 – Panasonic Corporation

Based on our interpretation to FL comment, it seems that the FL proposal 1 is to target to the case when multiple TBs scheduled by multiple DCIs. As mentioned earlier in the 1st round, our concern is how to handle the case one of DCI is mis-/false-detected, i.e., the length of a time domain window varies and gNB cannot assume the same length of a time domain window depending on UE detection status of PDCCH. In such case, the gNB is required to support blind detection of the length of the time domain window, which significantly increase the complexity of gNB. In addition, the concerns mentioned by QC and E// are also valid. Therefore, we do not support this case.

15 – WILUS Inc.

We do not support this proposal. In addition to scheduling restriction, the gain/motivation of such a case is unclear instead of single TB with more symbol allocation (e.g., 14-symbol PUSCH) for coverage enhancement.

16 – Samsung Electronics Co.

We would like to suggest to deprioritize the discussion for the case of back-to-back PUSCH transmissions with different TBs.

In our view, the framework for same TB can be applicable for the case of different TBs. What additional design aspects are needed for different TBs for joint channel estimation?

For the sake of progress, we should at least reformulate above proposal in a similar way of joint channel estimation for Type B repetition (as in proposal 2, add “if it reuses only those joint channel estimation specification enhancements defined to support same TB”).

17 – ZTE Corporation

Support the proposal

18 – Apple Computer Trading Co. Ltd

The use case is not straight forward for coverage limited UEs. For UE in cell edge, the repetition would be applied first, then the joint channel estimation could be applied on top of that. Regarding the target data rate in the evaluation, the target can be achieved without repetition, but it leaves the at least 6dB coverage gap for PUSCH, so typeA repetition enhancement is the target of this WI.

19 – LG Electronics Inc.

Even for different TBs, we think it is possible for joint channel estimation if scheduling of each TBs satisfies the requirements of RAN4, however there are many companies that oppose this, so at least we can revisit after the operation of the UE for the same TB is determined.

20 – HUAWEI TECHNOLOGIES Co. Ltd.

We would like to share our views as responses to some companies' questions and comments

Regarding Qualcomm's question below, we feel that the competitive solution of more repetition plus larger TB size per slot is much inferior to joint channel estimation with different TBs. Because there are only two ways to have larger TB size in one slot for a cell-edge UE, either allocating more PRBs or allocating higher MCS (higher coding rate/higher SE). Taking Qualcomm's example for discussion, the first method with more PRBs means lower PSD due to limited UE transmission power, so 4 times number of PRBs plus 4 repetition mean 1/4 PSD and does not provide any gain. The second method is limited by the MCS table where the ratio between the highest SE and the lowest SE for QPSK is less than 6 (Table 6.1.4.1-1, TS 38.214). Additionally, the typical optimized MCS for no repetition and 1Mbps target throughput was MCS#3 or MCS#5 according to the TR of Rel-17 CovEnh which results in that the ratio is less than 4. Therefore, higher MCS cannot provide better performance in the example provided by Qualcomm, no mention the case with 8 or 16 repetition which is totally beyond the MCS adjustment.

"*On the question of repetitions: the gNB can set up the UE with a sequence of PUSCH transmissions with no repetitions and carrying 2500 bits each or set up the UE with a sequence of PUSCH transmissions with repetitions carrying a larger payload, 10000 bits say. Both options are valid.*"

Regarding Qualcomm's comment on triggering, we feel time domain window has been agreed to provide a solution for such triggering. To be specific, the gNB scheduling is subject to fulfill the RAN4 requirements for phase contiguity, and signals the UE a time domain window for the next potential TB scheduling. The time domain window can be signaled in the DCI of current TB scheduling, so the UE is informed in advance. If the next TB is scheduled within the time domain window, then phase contiguity is fulfilled, otherwise phase contiguity is not guaranteed by the UE.

Regarding Qualcomm's comment on gNB scheduling, "*If gNB knows ahead of time, it can allocate a single grant with a larger TB size and enable repetitions.*", we hope our reply on MCS and number of PRBs could answer the question. Besides, the UL traffic demand from L2 arrives at different slots, the gNB will not schedule a TB size larger than the UL buffer that the UE is going to transmit at current slot.

Regarding Ericsson's comment, "*the results we are aware of assume that UEs are scheduled in the exact same PRBs, which implies some loss from the absence of frequency domain scheduling, which is not accounted for.* ", we don't feel the scheduling restriction of exact same PRBs is a reason not to support JCE with different TBs, because PUSCH repetition Type A has the same restriction and JCE support for it has been agreed. More importantly, whether there is potential gain is a task of SI, since obvious gains have been captured in the TR, we don't have to reopen the discussion unless any company can provide simulation results with new founds.

Regarding Ericsson's comment, "*How will network algorithms such as outer loop link adaptation work? Does the network have to delay control signaling in order to force the TB sizes to be the same? Does the network need to limit the number of radio bearers to force the total traffic in each slot to be the same? Etc.*", we feel the questions are about gNB implementation. It is up to gNB algorithm to decide when and how to exploit the potential gain from JCE. Since it has no spec impact, we may not have to discuss it here.

Regarding Ericsson's comment on fixed TB size, "*if one were to force the TB size to be identical for a fixed number of slots*," and "*it is not clear to us which 1 Mbps services will have fixed TB sizes*.", according to RAN LS replies, there is no such restriction of fixed TB size for phase contiguity. If any fixed TB size were scheduled by gNB for multiple slots, it is much more probably because the MCS and the number of PRB is limited by the UE Tx power of the cell-edge UE.

Regarding Panasonic's comment, "*how to handle the case one of DCI is mis-/false-detected*," taking two TBs in two slots as an example, in our understanding, the phase contiguity for the Tx duration of the first TB must be maintained as required by RAN4 spec because it is just a Rel-15/16 UE behavior. There is no need to explicitly indicate a time window for the first TB. Similarly, so does for the Tx duration of the second TB. But for the interval between the slot of the first TB and the slot of the second TB, a time window is needed to be indicated so that the UE can be aware of whether phase contiguity should be maintained additionally. It can be carried by the DCI of the first TB. If the second TB is scheduled to be started no later than the indicated time window expires, then the second TB has the phase contiguity as the first TB, otherwise it has not. So both UE and gNB have the same understanding. This is just an example to answer your question, we don't see an issue of mis-detection.

FL comments: Proposal 2 is updated based on comments with adding the red part.

Proposal 2:

For back-to-back PUSCH transmissions within one slot, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following cases:

- Over back-to-back PUSCH transmissions (of the same TB) for repetition type B scheduled by dynamic grant or configured grant, if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A.

* FFS: additional specification enhancements on top of that defined to support repetition Type A

* Only for single layer transmissions

* Subject to UE capability

- Joint channel estimation over back-to-back PUSCH transmissions with different TBs within one slot is not supported.

Support: InterDigital, CATT, CMCC, Nokia, NSB, Intel, vivo, Sharp, OPPO, WILUS, Lenovo, Motorola Mobility, Samsung, Panasonic, Huawei, HiSilicon, Xiaomi

Not support: Qualcomm

Not support: Qualcomm

Deprioritize: Apple, LG, Sierra Wireless

Feedback Form 16: Comments on proposal 2

1 – NTT DOCOMO INC. Support the proposal.
2 – Beijing Xiaomi Mobile Software Support the proposal
3 – vivo Communication Technology support this proposal
4 – Nokia Solutions & Networks (I) Support the FL's proposal. With the same formulation as in the sub-bullet (of the first main bullet), we don't see why one would support it for the case "across consecutive slots" but not "within a slot". This would make the support of joint-CE for repetition type B incomplete and inconsistent.
5 – Qualcomm Incorporated We do see Nokia's point about not fragmenting support for Type B repetitions. After further consideration, we drop our objection.
6 – Intel Deutschland GmbH We are not sure the red part "if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A.". Repetition type A does not have back to back transmission in a slot. Suggest to remove it.
7 – Motorola Mobility Germany GmbH [Lenovo, Motorola Mobility]: Support the FL proposal
8 – Ericsson LM (apologies for the duplicate response that was inadvertently added to proposal 1 responses above) We think Type B should be at least deprioritized, in order to focus on the Type A design, noting that Type B should anyway reuse the designs for Type A. The second bullet to not support different TBs within one slot is OK.
9 – CATT Support.
10 – MediaTek Inc. "Over back-to-back PUSCH transmissions (of the same TB) for repetition type B" means the consecutive resources within a transmission based on repetition type B w/o gap. Right?

11 – InterDigital France R&D Support
12 – Panasonic Corporation Support the proposal.
13 – WILUS Inc. We support the FL's proposal.
14 – Samsung Electronics Co. Support the FL's proposal.
15 – Samsung Electronics Co. We would like to clarify whether or not the sub-bullet "Only for single layer transmissions" can be generalized to other scenarios, e.g., repetition type A?
16 – ZTE Corporation For the last bullet, it's still not clear to us why we cannot support back-to-back PUSCH transmissions with different TBs within one slot if Proposal 1 (across slot case) is supported. Note that, for repetition type B, we are proposing to support in both across slot case and within slot case.
17 – LG Electronics Inc. As Nokia pointed out, it is correct to support repetition type B under the condition of "if it reuses only those joint channel estimation specification enhancements defined to support repetition type A" for use case 3 in the agreement of previous meeting. However, as Intel pointed out, since repetition type A does not support repetition within one slot, it is questionable for us how it can be applied. Therefore, we still do not support the first bullet. For the second bullet, we are supportive.

FL comments: It seems companies have different understandings on off-power requirement in RAN4 LS. As pointed out by Huawei, in TS 38.101-1, there is no off-power requirement for the case with less than 1ms gap. There is only requirement for no less than 1ms, which is in line with the RAN4 LS reply. Even if new off-power requirement is defined in RAN4, it seems it will not preclude the case of non-back-to-back PUSCH transmissions as mentioned by Qualcomm.

Proposal 4:

Joint channel estimation over non-back-to-back PUSCH transmissions with no uplink transmission in the middle of two PUSCH transmissions across consecutive slot is supported.

- Under the condition of power consistency and phase continuity

- FFS: other uplink transmissions in the middle of two PUSCH transmissions

For non-back-to-back PUSCH transmissions across consecutive slots, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following

cases:

- Over non-back-to-back PUSCH transmissions (of the same TB) for repetition type A scheduled by dynamic grant or configured grant.

- Over non-back-to-back PUSCH transmissions (of the same TB) for repetition type B scheduled by dynamic grant or configured grant, if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A.

* FFS: additional specification enhancements on top of that defined to support repetition Type A

* Only for single layer transmissions

* Subject to UE capability

- FFS: Over non-back-to-back PUSCH transmissions with different TBs

- FFS: Over non-back-to-back PUSCH transmissions for TBoMS

Feedback Form 17: Comments on proposal 4

1 – vivo Communication Technology The first bullet, text in red, says "non-back-to-back …with no uplink transmission in the middle if two PUSCH…" then the second bullet says "over non-back-to-back ….". Is second bullet intended for "with uplink transmission in the middle …." If no, then the added bullet in red doesn't provide any additional information.
2 – Nokia Solutions & Networks (I) We think it is too early to include the second FFS. We do not even know how the structure of a single TBoMS will look like, and which constraints may exist in this sense. It is hard to speculate on the relevance of this use case as of today. We suggest removing it. Either way, the solution should be based on maintaining certain channel features and parameters constant over a period of time, not on how the TB is transmitted over multiple slots.
3 – Qualcomm Incorporated Dont see any text in red that vivo is pointing to... Proposal seems okay to us. Not too sure if RAN4 will define new requirements for such gaps even when the gap is < 1 ms.
4 – Intel Deutschland GmbH We are fine with the proposal.
5 – Motorola Mobility Germany GmbH [Lenovo, Motorola Mobility]: Fine with the FL proposal

6 – Ericsson LM

Do not support the proposal. While we'd like to see non-back-to-back supported, we think this proposal is premature. We think RAN1 can continue to design for non-back-to-back as a possibility, however.

We think agreeing to support non-back-to-back is premature given the ongoing discussion of off power requirement and the potential for interference. RAN4 pointed out the off power requirement issue so we can consider it in our work, and I think we should do so.

Furthermore, off power is measured in 1ms, but that does not mean that the UE does not need to turn off the PA until 1ms has passed. The UE must turn off the PA within e.g. 10us, as in section 6.3.3.2 of 38.101-1 below. Please note Figure 6.3.3.2-1 identifies the 10us transient period, although the figure can't be included here due to NWM tool limitations.

6.3.3.2 General ON/OFF time mask

The general ON/OFF time mask defines the observation period between transmit OFF and ON power and between transmit ON and OFF power for each SCS. ON/OFF scenarios include: contiguous, and non-contiguous transmission, etc

The OFF power measurement period is defined in a duration of at least one slot excluding any transient periods. The ON power is defined as the mean power over one slot excluding any transient period.

7 – CATT

We think RAN4's input on maximum value of X is needed. As far as we know, whether X can be a non-zero value is still under discussion.

In addition, for the 1st bullet, we are not sure the scenario from channel's view. If the 2 PUSCH are for different TBs, it is overlapped with the former proposal.

8 – vivo Communication Technology

@QC, the red text was posted in email which is the first bullet and subsequent sub-bullets

9 – MediaTek Inc.

We would like to wait for more feedback from RAN4. as we know, RAN4 is discussing the Power OFF requirement issue. It is too early to conclude it.

Besides, how many gap symbols are expected in between? from UE perspective, the large amount of gap symbols will cause the large power consumption. So some restriction on the max number of gap symbols should be added if such feature is to be supported.

10 – Panasonic Corporation

We are fine with the proposal.

11 – Samsung Electronics Co.

We support the non-back-to-back PUSCH transmissions across consecutive slot.

In the above proposal, we think the 1st bullet "with no uplink…" seems to overlap with the 2nd bullets "(under the condition of power consistency and phase continuity)". So, we think the 1st bullet is redundant.

12 – China Mobile Com. Corporation We share the similar views that we should wait for RAN4's feedback. And the further confirmation of the X value is preferred. The off-power requirement may impact other uplink or downlink transmissions, which RAN1 do not know if that is acceptable or not. If the performance degradation happens and reach a certain level, there is no need to further discuss this case.
13 – ZTE Corporation Can line with the proposal, while we prefer to postpone the decision with similar reason as commented by companies.
14 – Apple Computer Trading Co. Ltd For this proposal, more RAN4 inputs are needed, postponing the discussion is preferred.
15 – TCT Mobile Limited Fine with the proposal.
16 – LG Electronics Inc. We support FL's proposal.

FL comments: Proposal 5 is stable. Please refrain from any further comments.

Proposal 5:

Joint channel estimation over non-back-to-back PUSCH transmissions within one slot is not supported.

3.2 Time domain window

For the time domain window, companies have different understandings. From FL understanding, there are two kinds of time durations, one is defined in RAN4 while the other is specified in RAN1. Before discussing other aspects of the time domain window, we need to align the understandings. Thus, proposal 10 is proposed.

Proposal 10:

Definition of **the time domain window**: a time duration during which **UE is expected to** maintain power consistency and phase continuity among PUSCH transmissions subject to power consistency and phase continuity requirements.

Note 1: The time domain window is specified in RAN1.

Note 2: The time domain window may be explicitly configured by gNB or implicitly derived.

Definition of **the maximum duration**: a time duration during which **UE is able to** maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.

Note 1: The maximum duration is defined in RAN4.

Note 2: The maximum duration may be reported by UE.

Feedback Form 18: Comments on proposal 10

1 – SHARP Corporation

We support FL proposal 10.

2 – vivo Communication Technology

Looks fine

3 – Nokia Solutions & Networks (I)

We would like to ask the following question for clarification: Concerning "the maximum duration may be reported by UE", does it mean that multiple maximum durations will be defined in RAN4 as the maximum durations gNB can assume UE may support, and the UE will report its actual set of maximum durations?

4 – Qualcomm Incorporated

@Nokia: our current thinking is that UE reports the maximum duration it can support, potentially per band. Max duration may need to be reported for each modulation order. RAN4 may provide a range for this value.

Beyond this, its up to gNB to configure the UE with an appropriate window size.

UE then takes this size and partitions the PUSCH repetitions appropriately.

5 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: Support the FL proposal

6 – China Telecommunications

@Nokia, @Qualcomm, in my understanding, the maximum duration will be defined in RAN4, but it may or may not be reported by UE. If RAN4 only defines one value for the maximum duration, it seems not necessary for UE to report the value, while if RAN4 defines multiple values for the maximum duration, UE can report one of the values. For either case, gNB can configure the time domain window with an appropriate window size or the window size may be implicit derived, which is not necessary to be always equal to the maximum duration UE can support.

7 – Ericsson LM

The definition of the maximum duration seems OK to us.

We see a few drawbacks to this definition of the time domain window, and instead suggest that the UE maintains phase continuity and power consistency over at least a subset of the transmissions in the window. Note that in the following, our understanding is that the UE first is informed of at least on window location/duration, and then evaluates continuity/consistency as a second step. The definition does not make sense otherwise, since the duration is subject to the continuity/consistency constraints.

-

Assuming that the UE receives during downlink slots, the window should not contain downlink slots, because the UE is expected to maintain phase continuity among all transmissions in the window. If the UE repeats across downlink slots, then there can be multiple windows over which it can maintain

phase. The location of these windows needs to be defined. One way is to define a periodically recuring window. However, if the window exactly matches the TDD pattern, there may be no benefit from defining the window, since continuity will solely be determined by the TDD pattern itself and equivalently the requirement that the UE does not receive in a downlink slot.

- If the window contains a subset of repetitions, then it is not clear that the UE should maintain continuity/consistency across all the repetitions. We could specify that the UE maintains phase for each window, but that may be extra specification effort compared to saying that the UE should combine at most all repetitions, and then rely on the continuity/consistency constraints to determine where the UE actually does maintain continuity/consistency.

- The definition precludes where a UE may or may not maintain continuity/consistency over a set of slots (since it is expected to maintain continuity/consistency). Consider the example in the figure in our email response in [105-e-NR-R17-CovEnh-03] (not in the NWM tool due to its limitations), where there are 4 repetitions and the UE either transmits PUCCH or is DTX between repetitions. Our understanding of the FL proposal is that there would be two windows in this case; this is shown as 'Alt 1'. If the Alt 1 windows are semi-statically configured, R0/R1 and R2/R3 can't be in time domain windows, since they may or may meet the requirements. On the other hand, if the Alt 1 windows are dynamically determined according to continuity/consistency requirements, there is again no need.

Our proposal (shown as Alt 2 in the figure) is therefore that the time domain window cover all transmissions of a TB, and that subsets of transmissions where continuity/consistency are maintained are at least identified by the continuity/consistency requirements.

UE capability or other aspects may further restrict when UE should maintain continuity/consistency, and it is not our intention to limit those here. The FFS is to clarify that these are not the main point of the proposal, and that they should be discussed further.

Therefore, we suggest the following update to the proposal:

Proposal:

- Definition of **the time domain window**: a time duration during which **UE is expected to** maintain power consistency and phase continuity among at least a subset of PUSCH transmissions subject to power consistency and phase continuity requirements.
  - The subset is determined by at least the power consistency and phase continuity requirements
  - FFS: additional factors to determine the subset

8 – CATT

We support the proposal for clear distinguishing.

9 – Beijing Xiaomi Mobile Software

support the proposal.

10 – vivo Communication Technology

@Ericsson, in our view discussion here is about maximum length of the time domain window. Separate discussion for window location/start position is needed, no explicit indication is needed in our view.

11 – MediaTek Inc.

From our understanding, RAN4 would only define the minimum requirement on the time window whereas BS may configure and use the time window based on UE capability (or UE report) in terms of RAN1 procedure. So we need to discuss:

1. ask RAN4 the minimum requirement and the possible capabilities.
2. RAN1 will define the procedure to configure/use the time window based on the report of UE capabilities defined in RAN4.

12 – InterDigital France R&D

As long as ”time domain window” in the proposal indicates start & end time for the UE to maintain power/phase continuity, we are ok with the proposal.

13 – Panasonic Corporation

We support the proposal.

14 – Samsung Electronics Co.

Generally fine with the proposal.

We would like to be clear on the purpose of discriminating the time domain window and the maximum duration. What is the reason for creating such terminologies?

15 – China Telecommunications

@Ericsson, The definition of the time domain window is exactly the same as the following agreements we have made in RAN1 #104b-e.

Agreements:

- For joint channel estimation, specify a time domain window during which a UE is expected to maintain power consistency and phase continuity among PUSCH transmissions subject to power consistency and phase continuity requirements.

16 – ZTE Corporation

Fine with the proposal.

17 – China Mobile Com. Corporation

Fine with the proposal. This could make the following discussion more clear. And the maximum duration, we think it is more like a UE capability to be reported.

18 – Apple Computer Trading Co. Ltd

As most of companies agree to send the LS to RAN4 on how long the maximum duration could be in Proposal 6. Before we get clear answer from RAN4, maybe the definition of the maximum duration can be hold. Whether RAN4 define the maximum duration is the RAN4's choice.

19 – TCT Mobile Limited

Support the proposal.

20 – Shenzhen YZF Network Technolog

[OPPO] Share similar view with apple that Before we get clear answer from RAN4, maybe the definition of the maximum duration can be hold. Whether RAN4 define the maximum duration is the RAN4's choice.

21 – LG Electronics Inc.

For the definition of the time domain window, it looks fine to us. However, it may not be selected as configured by the gNB only or determined by the UE only. For example, although the gNB has configured it, the UE may not maintain the phase/power requirement for example, due to TA adjustment, and it may be considered that the UE reports it, which can be interpreted to gNB that smaller window determined by UE. Therefore, for now, it is desirable to modify Note 2 as follows:

Note 2: The time domain window may be explicitly configured by gNB **and**/or implicitly derived.

For definition of the maximum duration for joint channel estimation, we are quite questionable whether there is a maximum duration during which UE is able to maintain power consistency, phase continuity and uplink transmission timing consistency under certain tolerance level or not.

FL comments: Since the design of the time domain window is highly related to the maximum duration, we need to send LS to RAN4 as early as possible.

Proposal 6: Send LS to RAN4 asking the following questions

For joint channel estimation, is there a maximum duration during which UE is able to maintain power consistency and phase continuity under certain tolerance level? If any, how long is it?

- What factors determine the maximum duration?

- Whether the maximum duration should be the same for different cases for both PUSCH and PUCCH?

- Whether the maximum duration is dependent on the modulation order of transmission, e.g., QPSK, 16QAM, 64QAM?

- Whether the maximum duration is dependent on UE capability?

Feedback Form 19: Comments on proposal 6

1 – NTT DOCOMO INC.

Support the proposal.

In our views, knowing the length of maximum duration helps us decide if the time domain window should

be configured or not. If the maximum duration is quite short (such as a few slots) due to UE capability, the time domain window should be determined by UE capability rather than parameters indicated by the gNB. On the other hand, if the maximum duration is determined by channel qualities, the gNB should indicate time domain window sizes based on the channel conditions on top of UE capability. Likewise, this information can facilitate the discussion about time domain windows.

2 – SHARP Corporation

We support FL proposal.

3 – vivo Communication Technology

Ok

4 – Nokia Solutions & Networks (I)

This maximum duration is related to the Proposal 10. If Proposal 10 is supported, then an LS to RAN4 is needed as well. If Proposal 10 is not supported, then LS may not be necessary.

5 – Qualcomm Incorporated

I think its good to send this LS out. Content looks good. Can we also ask them if this value will be band specific? (I am assuming so, but will be good to confirm).

6 – Intel Deutschland GmbH

We are fine with the proposal.

7 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: Support the FL proposal regarding sending LS to RAN4

8 – CATT

Support to send the LS.

9 – Beijing Xiaomi Mobile Software

Support the proposal

10 – InterDigital France R&D

Support the proposal and agree with Qualcomm to clarify whether the maximum duration is band specific.

11 – Panasonic Corporation

We support the proposal 6.

12 – Samsung Electronics Co.

Fine with the proposal in principle.

13 – ZTE Corporation

Support the proposal

14 – China Mobile Com. Corporation Generally fine with the proposal. We should have the knowledge of the maximum duration in which the UE could maintain power consistency and phase continuity. Besides that, as commented in the last round, we would link to know the impact of the phase drifting. Once the gNB cannot distinguish the phase drifting from UE side and that from the channel itself, the different phases would be considered at different instance for the JCE, which could degrade the performance of JCE and even there is no performance gain.
15 – Apple Computer Trading Co. Ltd Fine with this proposal.
16 – TCT Mobile Limited OK
17 – Sony Mobile Communications ok
18 – Shenzhen YZF Network Technolog support
19 – Shenzhen YZF Network Technolog Resend with company name. [OPPO] support
20 – LG Electronics Inc. For better understanding of RAN1, it seems appropriate to send the contents of the proposal to LS. However, as shown by simulation results in our contribution, the influence of TA adjustment on phase continuity is very large. We have to ask about this together, and if so, support proposal.

FL comments: For the enabling and disabling of the time domain window, companies ask for clarification of Alt 2. The motivation of discussion on Alt 1 and Alt 2 is to handle the FFS in the agreements in RAN1#104b-e. Some companies think the time domain window can be separately enabled or disabled. Seen from the discussion, the majority think the time domain window is not explicitly enabled or disabled. Proposal 11 is proposed.

Proposal 11:

For joint channel estimation for PUSCH, the time domain window is not explicitly enabled or disabled.

- FFS: If the joint channel estimation for PUSCH is enabled or disabled, the time domain window is enabled or disabled implicitly.

- FFS: how the time domain window is determined (e.g., via explicit configuration and/or implicitly derived)

Feedback Form 20: Comemnts on proposal 11

1 – vivo Communication Technology

Joint channel estimation is done at gNB, the time domain window is intended for UE, hence the wording seems confusing.

We are fine to enabling/disabling DMRS bundling window together with the signalling enabling UE to maintain phase continuity and power consistency as indicated by NW. But we suggest to consider enabling/disabling this feature at UE, through signalling other than RRC signalling.

Maintaining power consistency and phase continuity is intended for poor coverage UEs, and there is price to support this feature. First, NW should properly configure/schedule DL/UL transmission for UE, e.g. avoid DL receptions and UL transmission in between the multiple transmissions in a window, or UE have to skip some transmissions to maintaining phase continuity, which may lead to restrictions for NW and UE. Otherwise the coverage for PUSCH can not be improved. While for UEs with good coverage, the benefit of DMRS bundling is marginal, and it is not necessary for these UEs to maintaining phase continuity, and put such restrictions at NW and UEs. Hence, NW can provide the configurations for DMRS bundling, e.g. parameters for DMRS bundling window, through RRC signalling, and enabling or disabling this feature at UE based on link quality through other signalling, e.g. PDCCH, MAC-CE.

Since we do not have clear picture on this feature. We are also fine to postpone this discussion and look back this issue when the framework is clear.

2 – SHARP Corporation

We are not sure if we understand the intention of the proposal. Does it mean ”Rel-17 doesn’t support explicit indication of enabling/disabling the time domain window when the UE is configured to determine the time domain window”? If so, we suggest to revise the main-bullet of the proposal as follows.

For joint channel estimation for PUSCH, ~~the time domain window is not explicitly enabled or disabled~~Rel-17 doesn’t support explicit indication of enabling/disabling the time domain window when the UE is configured to determine the time domain window.

3 – Nokia Solutions & Networks (I)

Support the FL’s proposal.

4 – Qualcomm Incorporated

A little hesitant to support/not support this. Can we wait a bit more for the discussion on TDW to progress. A UE will always want to get out of DMRS bundling (its a lot easier to operate without this constraint), and its not yet clear how sticky/static our DMRS bundling configurations will be.

5 – Intel Deutschland GmbH

It is not very clear to us the proposal. In our early comment, we suggest to first agree that joint channel estimation can be enabled/disabled by higher layers, similar to what was agreed for joint channel estimation for PUCCH. We can further discuss this issue.

6 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: Support the FL proposal

7 – China Telecommunications

Thanks Intel's suggestion! To keep consistent with PUCCH, Proposal 11 is reformulated as follows. The enabling/disabling of the time domain window need further discussion.

Proposal 11:

Joint channel estimation for PUSCH transmissions is enabled or disabled via RRC configuration.

 FFS: whether additional dynamic signaling is needed to enable/disable joint channel estimation for PUSCH transmissions.

 FFS: If the joint channel estimation for PUSCH transmissions is enabled or disabled, the time domain window is enabled or disabled implicitly.

o FFS: how the time domain window is determined (e.g., via explicit configuration and/or implicitly derived)

8 – Ericsson LM

If we understand correctly, the intention is that the time domain window is not configured separately from joint channel estimation. However, since to our knowledge there is not an explicit agreement that JCE is configured yet, then an alternative would be to configure the window but not JCE. We can support a clarified proposal:

- For joint channel estimation for PUSCH, the time domain window is not explicitly enabled or disabled separately from joint channel estimation.
  - FFS: If the joint channel estimation for PUSCH is enabled or disabled, the time domain window is enabled or disabled implicitly.
  - FFS: how the time domain window is determined (e.g., via explicit configuration and/or implicitly derived)

9 – vivo Communication Technology

it is about how enable/disable this function, in our view if gNB doesn't intend to perform joint channel estimation then it should disable time domain window configuration for the UE(s), then the UE can relax its operation without concerning all those constraints

10 – CATT

We are OK with the revised FL's proposal.

For Ericsson's proposal, it may be fine too. We donot see strong motivation to dynamically enable/disable JCE. A UE configured with JCE in poor coverage is unlikely to have fast varying channel condition. Note that fast varying channel condition will largely reduce the efficiency of JCE.

11 – MediaTek Inc.

We prefer more details on options of "explicit" or "implicit" solutions for down-selection and decision. Now it is unclear on the implication of such agreement.

12 – Beijing Xiaomi Mobile Software

Support the main bullet, that is joint channel estimation can be enabled/disabled by higher layers. But for when and how to determine the time domain window, we think it depends on UE capability.

13 – InterDigital France R&D

We can wait for the discussion to clarify the details of the time domain window.

14 – Panasonic Corporation

We think that the enabling/disabling of the time domain window and the enabling/disabling of joint channel estimation are jointly indicated by an enhanced TDRA table, i.e., no need explicit field in DCI. RRC is used for configuring the enhanced TDRA table. In short, we support the updated FL proposal 11 in the following

The updated FL proposal 11:

Joint channel estimation for PUSCH transmissions is enabled or disabled via RRC configuration.

- FFS: whether additional dynamic signaling is needed to enable/disable joint channel estimation for PUSCH transmissions.
- FFS: If the joint channel estimation for PUSCH transmissions is enabled or disabled, the time domain window is enabled or disabled implicitly.
  - FFS: how the time domain window is determined (e.g., via explicit configuration and/or implicitly derived)

15 – Samsung Electronics Co.

We are fine with the proposal.

16 – ZTE Corporation

Fine with the proposal.

17 – China Mobile Com. Corporation

We are fine with the updated proposal 11.

In our thinking, the JCE and the TDW is bundled together. When the TDW is configured to the UE, the UE should maintain the power consistency and phase continuity for the PUSCH transmissions. Meanwhile the maintenance would not come without price. When the coverage of UE have been improved, such as moving more close the gNB, the JCE could be shut down. And in some cases, such as non- consecutive PUSCH transmissions, the gain and cost is not well balanced, the JCE could be disabled. Then, we think the dynamic indication of JCE should be considered for the further discussion.

For the 2nd FFS, as we commented above, we think the JCE and TDW should be bundled for enabling and disabling. And we would rather to reform the FFS as,

FFS: If **the time domain window is enabled or disabled** ~~the joint channel estimation for PUSCH transmissions is enabled or disabled~~, ~~the time domain window is enabled or disabled~~ **the joint channel estimation for PUSCH transmissions is enabled or disabled** implicitly.

18 – Apple Computer Trading Co. Ltd We are fine with the proposal.
19 – NTT DOCOMO INC. The proposal is unclear to us. Since whether to apply should be up to gNB, enabling/disabling JCE is transparent to UE. As far as I understand, this proposal just confines the explicit indication signaling for enabling/disabling time domain window. Since implicit indication of time domain window size is not out of scope in Rel.17, we prefer Sharp's update.
20 – LG Electronics Inc. It is understood that FL's intention is to allow enabling/disabling of the time domain window implicitly, for example, by configuring its size to one or another value, and if this understanding is correct, we support proposal.
21 – HUAWEI TECHNOLOGIES Co. Ltd. The subbullet "□ FFS: If the time domain window is enabled or disabled, joint channel estimation for PUSCH transmissions is enabled or disabled implicitly." can be removed, because it is not in line with the main bullet where it is enabled or disabled via RRC. Regarding "the time domain window is not explicitly enabled or disabled separately from joint channel estimation.", a clarification is needed. Does it mean a time domain window cannot be explicitly indicated for all cases? In our view, explicit indication of time domain window may be necessary for JCE (joint channel estimation) with different TBs.

3.3 Optimization of DMRS location/granularity in time domain

FL comments: The majority support proposal 8.

Proposal 8:

Optimization of DMRS granularity in time domain for PUSCH is not considered for joint channel estimation in Rel-17.

Feedback Form 21: Comments on proposal 8

1 – vivo Communication Technology support this proposal
2 – Nokia Solutions & Networks (I) Support the FL's proposal.
3 – Qualcomm Incorporated Support

4 – Intel Deutschland GmbH

We support the proposal

5 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: Fine with the FL proposal

6 – Ericsson LM

Support

7 – CATT

OK.

8 – MediaTek Inc.

Support

9 – Beijing Xiaomi Mobile Software

Support the proposal.

10 – Panasonic Corporation

Support the proposal 8.

11 – ZTE Corporation

Can live with the proposal if majority companies support

12 – Apple Computer Trading Co. Ltd

We support this proposal.

13 – China Mobile Com. Corporation

Thanks for the further clarification from FL.

The situation could be more tricky, if only DMRS could be transmitted in the special slot. SRS would be more important for the TDD system, not only the uplink transmission but also downlink transmission. And for the current wording in red, special slots which cannot be used for the PUSCH seems hard to be described in the specification.

We would propose a softer proposal for the sub-bullet, saying,

 The DMRS located in the special slot could also be used for the transmissions in the following uplink slots, such as repetition type A

¡ **Reuse the current design of DMRS as much as possible**

 FFS: optimization of DMRS location in special slots for repetition type A

 FFS: Transmission of different TBs

We support to use the DMRS in special slot to facilitate the JCE in the following uplink slots. For the challenge of specification effort, we propose to limit the scenarios to reduce the workload.

14 – China Mobile Com. Corporation Sorry for filling under a wrong propoal. please ignore the replies in the row #13
15 – Shenzhen YZF Network Technolog □OPPO□Can live with the proposal if majority companies support
16 – LG Electronics Inc. We support FL's proposal.

FL comments: From FL perspective, a number of companies provided simulation results and most of the results show considerable gain. The proponents are encourage to provide the spec impact as requested by Intel. Companies having concerns please also provide the spec impact and provide simulation results, not just saying large impact, no gain.

@CMCC, If I understand correctly, the main motivation is to add additional DMRS in special slots for repetition type A, in case that special slots cannot used for PUSCH transmission. In case special slots can be used for PUSCH transmission, e.g., if the number of symbols indicated in TDRA is small, both DMRS and data can possibly be transmitted.

Proposal 9:

For joint channel estimation for PUSCH, DMRS located in special slots is supported in the following cases,

- Additional DMRS is located in special slots for repetition type A, in case special slots cannot used for PUSCH transmission.

- FFS: optimization of DMRS location in special slots for repetition type A

- FFS: Transmission of different TBs

Feedback Form 22: Comments on proposal 9

1 – vivo Communication Technology support this proposal
2 – Nokia Solutions & Networks (I) We do not support the proposal. Again, as pointed out by many companies, even if in case the special cannot be used for the UL transmission the UL symbols are still needed for other channels such as SRS, etc. It's rather obvious that there are significative specification impacts, just to list some:
- First, we need to define where to place the DMRS and how to do that because allocating DMRS without data is not compatible with the current DMRS allocation procedure.
- Second, we need to agree on how many DMRS symbols can be allocated if there is more than one available UL symbol in the S slot.

- Third, we need to agree on a concept of enabling and disabling the allocation of DMRS on the S slots, which should be a separate discussion from the enabling/disabling of the Joint-CE feature.
- Fourth, impacts on the processing timeline for PUSCH should also be resolved.
- Fifth, impacts on the definition/indication of the time-domain window, which also needs to include at least the DMRS symbols in the special slots.
- Sixth, how to handle the collision of the DMRS symbols in the S slot with any other UL channels?
- etc.

The above workload could be equivalent to efforts that are needed to specify an independent feature. On the other hand, the joint CE feature should work without the above advanced optimizations. Given that we did not even agree on the basic framework of joint CE, we are not sure that we can finalize everything at the end of the WI, if this advanced optimization is also considered.

3 – Qualcomm Incorporated

As Nokia points out above, this is a pretty intricate feature, and it wont get done easily. Timeline impact is our biggest concern. Would ideally prefer to consider this with lower priority.

4 – Intel Deutschland GmbH

Thanks to Nokia for providing very comprehensive list of open issues if additional DMRS in special slots is supported. Given the potential large spec impact and limited remaining time for completion of CovEnh WI, we are a little bit hesitant to further study the additional DMRS in special slots.

5 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: Fine with the FL proposal

6 – Ericsson LM

Do not support the proposal.

As discussed in the first round, to our knowledge, all simulation results except those in R1-2105654 assume that the special slot is always used, which is not reflective of realistic operation. As shown in R1-2105654, the gains can vanish (or actually turn to a small loss) if resources are reserved for PUCCH and/or SRS.

Regarding specification impact: we encourage proponents to list what is needed. However, possible impacts from the use of special slot in JCE include modified TDRA, different collision rules, requirements to support TBoMS, modified rate matching, support for a new DMRS pattern, impacts on frequency hopping, etc.

7 – CATT

In principle, we support the features which can provide performance gain and within-scope. But we do feel a little hesitated whether it is a suitable trade-off between the benefit, workload and specification impact.

8 – MediaTek Inc.

We share the similar view as Nokia. this is more for optimization but with potential large spec impact. We can firstly sort out those details before the agreement.

9 – Beijing Xiaomi Mobile Software

Support the proposal.

10 – InterDigital France R&D

Thank you very much for the discussion. We support the FL's proposal and we provide our views for Nokia's questions.

- *First, we need to define where to place the DMRS and how to do that because allocating DMRS without data is not compatible with the current DMRS allocation procedure.*

[IDC] We agree that the location of DMRS symbols in the special slot has specification impacts as identified during the SI.

- *Second, we need to agree on how many DMRS symbols can be allocated if there is more than one available UL symbol in the S slot.*

[IDC] Judging from companies results, 1 or 2 symbols can be candidate values. If there are available uplink symbols in the special slot, 1 or 2 symbols can be placed in the special slot.

- *Third, we need to agree on a concept of enabling and disabling the allocation of DMRS on the S slots, which should be a separate discussion from the enabling/disabling of the Joint-CE feature.*

[IDC] DMRS is jointly bundled with DMRSs in the PUSCH in the uplink. Following the principle of joint channel estimation, separate enabling/disabling of DMSR in the S slot (or DMRS symbols in any slots in the bundled slots) is not envisioned from our perspective.

- *Fourth, impacts on the processing timeline for PUSCH should also be resolved.*

[IDC] Could opponents elaborate how the timeline may be complex in this scenario?

- *Fifth, impacts on the definition/indication of the time-domain window, which also needs to include at least the DMRS symbols in the special slots.*

[IDC] Since details related to time domain window is ongoing, this is a topic that can be discussed jointly with the mechanism discussed in the ongoing topic.

-

Sixth, how to handle the collision of the DMRS symbols in the S slot with any other UL channels?

[IDC] Priority handling between bundled DMRS and other channels can be discussed in the later stage of the WI, along with other scenarios/use cases. The agreed collision rules should be applied to collision cases between DMRS in the S slot and other UL channels.

11 – Panasonic Corporation

We fine with the FL proposal in general.

12 – Samsung Electronics Co.

Share similar view as Nokia and Ericsson. We think it will be premature to make agreements.

13 – TCT Mobile Limited

Fine with the FL proposal

14 – Apple Computer Trading Co. Ltd

We share the view with Nokia and other companies, the additional DMRS is not considered in special slot.

15 – China Mobile Com. Corporation

Thanks for the further clarification from FL.

The situation could be more tricky, if only DMRS could be transmitted in the special slot. SRS would be more important for the TDD system, not only the uplink transmission but also downlink transmission. And for the current wording in red, special slots which cannot be used for the PUSCH seems hard to be described in the specification.

We would propose a softer proposal for the sub-bullet, saying,

 The DMRS located in the special slot could also be used for the transmissions in the following uplink slots, such as repetition type A

¡ Reuse the current design of DMRS as much as possible

 FFS: optimization of DMRS location in special slots for repetition type A

 FFS: Transmission of different TBs

We support to use the DMRS in special slot to facilitate the JCE in the following uplink slots. For the challenge of specification effort, we propose to limit the scenarios to reduce the workload.

16 – Shenzhen YZF Network Technolog

OPPOShare similar view as Nokia and Ericsson. it is more of optimization, but involves significant specification impact

17 – LG Electronics Inc.

We share similar view with Nokia and other companies. Specification impact of DMRS in special slot will be significant and it could limit other transmission.

4 Email discussion (3rd round)

4.1 Use cases

FL comments: Suggest to continue the discussion to find some middle ground to make progress.

Proposal 1:

For back-to-back PUSCH transmissions across consecutive slots, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following cases:

-Over back-to-back PUSCH transmissions with different TBs, if it reuses only those joint channel estimation specification enhancements defined to support same TB

– FFS: additional specification enhancements on top of that defined to support same TB

– Only for single layer transmissions

– Subject to UE capability

Feedback Form 23: Commnets on proposal 1

1 – Shenzhen YZF Network Technolog [OPPO] Based on the current discussion, we propose to lower the priority for the case of different TBs .
2 – Nokia Solutions & Networks (I) We are fine with the proposal.
3 – Intel Deutschland GmbH Same comments as before and we do not see the need of coverage enhancement for different TBs. This also poses restriction on the scheduling on the PUSCH, which indicates that multiple PUSCHs need to have same TBS, FDRA, MCS, etc.
4 – Motorola Mobility Germany GmbH [Lenovo, Motorola Mobility]: We are fine with the proposal
5 – Qualcomm Incorporated We continue to believe this use case requires us to consider a design that is different from what we would pursue for PUCCH/PUSCH repetitions. We anticipate a major fork in the design directions and it essentially doubles the work we need to do to complete this feature. Restrictions in the form of gNB scheduling are more than likely to be required. TDW considerations could be quite different. Trigger mechanisms and/or activation/deactivation also require separate considerations. For the above reasons and the availability of alternatives such as TBoMS and scheduling larger TBs with repetition, we don't see a compelling need to support this use case.

6 – Ericsson LM

To respond to some of Huawei's answers to our comments in the second round:

- Huawei pointed out that repetition Type A requires that UEs are scheduled in the same PRBs, and it therefore does not benefit from the frequency domain scheduling that is possible in the different TB case when joint channel estimation is not used. This is true, however my point was that the benefit of frequency domain scheduling is available in the different TB case, which means that joint channel estimation that requires the same PRBs is less beneficial for the different TB case.

- Regarding outer loop link adaptation, control signaling delays, and radio bearer constraints, these are functions that networks have to handle, and so in that sense are gNB implementation. However, the TB size variability they may cause affects the use case for different TBs, and so they should not be neglected when considering the pros and cons of supporting different TBs with JCE.

- For fixed TB size, we may not have been clear. If the TB size varies, the number of PRBs and/or modulation state may also vary, which then changes the transmitted power, and therefore precludes JCE.

The revised proposal for this round does help address concerns about spec impact by requiring reuse of the enhancements for the same TB case. However, is this really possible? Repetition and TBoMS will use one grant, and so needs no constraints for closed loop power control, MCS, resource allocation, etc. The different TB case seems like it will need such constraints.

A drawback with this proposal is that we will continue to discuss spec enhancements on top of the same TB given the FFS. If we want to focus the work, then the FFS should be dropped or discussion of the additional specification enhancements should be deferred until a later meeting.

Therefore, we don't support this proposal at this time. In our view, it could be revisited after the enhancements needed for same TB are more clear.

7 – InterDigital France R&D

We support the FL's proposal.

8 – Apple Computer Trading Co. Ltd

At this stage we prefer to focus on the coverage issue first. The optimization feature can be reprioritized .

9 – Samsung Electronics Co.

Fine with the proposal with the added 'if' condition. For clarification, what kind of additional specification enhancements are expected with respect to same TB case?

10 – CATT

While we are not against the scenario, it is true that the motivation of supporting JCE for different TB across slots is weakened, due to the support of repetition and TBoMS case. Note that JCE can be applied to these cases, as have been agreed (or made as a WA).

Similar to Samsung, we are also wondering will there be any specification enhancements on top of same-TB case. Anyway, considering that the specification impact is still unknown even for the same-TB case, the group may focus on the already agreed scenario first.

11 – vivo Communication Technology

we are fine with this proposal

12 – Panasonic Corporation

As commented in earlier rounds, we still have a concern if multiple TBs are scheduled by multiple DCIs. We propose to limit the discussion to the case that one DCI schedules multiple TBs. Our reply to comment of Huawei is in the following

Huawei's comment: "Regarding Panasonic's comment, "*how to handle the case one of DCI is mis-/false-detected*,"taking two TBs in two slots as an example, in our understanding, the phase contiguity for the Tx duration of the first TB must be maintained as required by RAN4 spec because it is just a Rel-15/16 UE behavior. There is no need to explicitly indicate a time window for the first TB. Similarly, so does for the Tx duration of the second TB. But for the interval between the slot of the first TB and the slot of the second TB, a time window is needed to be indicated so that the UE can be aware of whether phase contiguity should be maintained additionally. It can be carried by the DCI of the first TB. If the second TB is scheduled to be started no later than the indicated time window expires, then the second TB has the phase contiguity as the first TB, otherwise it has not. So both UE and gNB have the same understanding. This is just an example to answer your question, we don't see an issue of mis-detection."

Our reply: In example of Huawei, let's assume that the first DCI schedules the first TB and the 2nd DCI schedules the 2nd TB, respectively. There could be the following cases

- Case 1: When a UE correctly receives both the first DCI and 2nd DCI, it should not be the issue as Huawei described.

- Case 2: When a UE receives the first DCI correctly, but it does not receive 2nd DCI correctly. The UE sends only the 1st TB and the 2nd TB is not able to be sent. For the reception of the 1st TB, gNB could not use DMRS in the 2nd TB. For joint channel estimation, DTX detection of the 2nd TB is necessary before performing joint channel estimation with using DMRS in the 2nd TB. In poor SINR condition, DTX detection can be more demanding than a reception.

- Case 3: When a UE receive the 2nd DCI correctly, but it does not receive the 1st DCI. The UE sends only the 2nd TB and the 1st TB is not able to be sent. For the reception of the 1st TB, gNB is required to have DTX detection only from DMRS of the 1st TB. Hence, joint channel estimation using DMRS of both the 1st TB and 2nd TB is not possible.

- Case 4: When UE does not receive both the 1st and 2nd DCI, the situation is similar to the case that one DCI schedules both the 1st and 2nd TBs.

Therefore, when one DCI schedules both the 1st and 2nd TBs, there is no case 2 and case 3. gNB can always use DMRS of the 1st and 2nd TBs jointly. Hope it can clarify our concern.

13 – LG Electronics Inc. Fine with proposal.
14 – MediaTek Inc. Do not support at the moment with the following consideration: 1. Different TBs vs. TBoMS: different TBs may be more beneficial for the non-cell-edge UEs with support of large TBS per slot whereas TBoMS is more suitable for the cell-edge UEs with the large TBS via multiple slot. when the TBS is not so large, the segmented transmission over different TB will cause the additional CRC overhead compared to TBoMS. So it is not a must for the cell edge performance enhancement but may be for the higher performance. that is, it is more like a nice-to-have but not must-to-have feature for coverage enhancement. 2. As commented early, most of evaluation in the TR is based on the link level rather than the system level. And the baseline is not TBoMS yet. Different TB transmission may impose the restriction on the scheduling and eventually there may be no system gain. 3. Spec impact may also be large considering the handling of DCI for association of one or multiple TBs and the mis-/failed detection of any one DCI. Considering the work load, we prefer not support it in this release.
15 – China Mobile Com. Corporation Support the proposal. First for the cell edge UE, if the data rate are required to be improved to fulfil the requirement, the different TB should be used instead of repetitions. And for the cell edge UE, the allocated PRB would be changed, since the power is limited and maximum number of PRB should be used. And for the scheduled UE, the MCS will not change in a such short time duration, e.g. a few consecutive slots. This is the same situation if the repetition is used.
16 – Beijing Xiaomi Mobile Software Fine with the proposal.
17 – ZTE Corporation Fine with the proposal
18 – WILUS Inc. We share the similar view with Ericsson. Suggest to prioritize same TB case.

FL comments: It seems the majority are fine with proposal 2. If companies still have concerns, please provide constructive comments on how to refine the proposal.

Proposal 2:

For back-to-back PUSCH transmissions within one slot, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following cases:

- Over back-to-back PUSCH transmissions (of the same TB) for repetition type B scheduled by dynamic grant or configured grant, if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A.

– FFS: additional specification enhancements on top of that defined to support repetition Type A

– Only for single layer transmissions

– Subject to UE capability

Joint channel estimation over back-to-back PUSCH transmissions with different TBs within one slot is not supported.

Feedback Form 24: Comments on proposal 2

1 – Shenzhen YZF Network Technolog [OPPO] support
2 – Intel Deutschland GmbH We are still not sure the red part "if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A.". Repetition type A does not have back to back transmission in a slot. Suggest to remove it.
3 – Motorola Mobility Germany GmbH [Lenovo, Motorola Mobility]: We support the proposal
4 – Ericsson LM We can support the proposal. Nokia and other companies had the fair point that not supporting Type B reusing Type A within one slot but doing so across slots (as previously agreed) is inconsistent. Given this, we agree with the proposal.
5 – InterDigital France R&D We support the FL's proposal.
6 – Apple Computer Trading Co. Ltd We are ok with this proposal.
7 – TCT Mobile Limited We are fine with the proposal.
8 – Samsung Electronics Co. Support the FL's proposal. As already commented, we would like to clarify whether or not the sub-bullet "Only for single layer transmissions" can be generalized to other scenarios, e.g., repetition type A?
9 – CATT Support.

10 – vivo Communication Technology

we are fine this proposal

11 – Panasonic Corporation

We support the proposal 2.

12 – LG Electronics Inc.

In the previous meeting, it was agreed to support PUSCH repetition type B for use case 3. In our understanding, it can be agreed since it matches to coverage enhancement since it may not have high coding rate considering it is repeated over consecutive slots. However in this proposal, we are discussing about PUSCH repetition within one slot. As pointed out before, it will have short SLIV since it should be repeated within one slot, which leads high coding rate. A UE who needs coverage enhancement will be under low SNR environment, therefore high coding rate should not be applied for that UE. We don't see the reason why such UE should transmit PUSCH repetition type B within one slot. From our understanding, it conflicts with the target of coverage enhancement. Please provide clear reason why PUSCH repetition type B within one slot should be supported for a UE who needs uplink coverage enhancement.

13 – MediaTek Inc.

Share the similar view as LG.

besides, regarding to "if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A", is there any further enhancement for Type A repetition within a slot?

14 – SHARP Corporation

We support FL proposal.

15 – Beijing Xiaomi Mobile Software

Fine with the proposal.

16 – ZTE Corporation

Looking into the discussions in Proposal 1, we are fine with not supporting joint channel estimation for different TBs within a slot. So, we are fine with the proposal.

17 – WILUS Inc.

We support the proposal.

FL comments: To avoid mis-understanding, proposal 4 is separated into proposal 4a and 4b. Proposal 4a is for different type of PUSCH transmissions while proposal 4b discusses no uplink transmission or other uplink transmissions in the middle of two PUSCH transmissions. It seems the majority support non-back-to-back PUSCH transmissions across consecutive slots. The concerns are off-power requirements and the value of the gap between PUSCH transmissions. From FL understanding, according to RAN4 LS, the value of the gap X is larger than zero and RAN4 is discussing the maximum value, e.g., 13, 14 or different value for different SCS respectively. Considering RAN4 is discussing off-power requirements, FL suggests to make proposal 4a and 4b as working assumptions. Regard the last sub-bullet commented by Nokia, since it's under FFS, we can discuss whether to support joint channel estimation for TBoMS later anyway.

Proposal 4a:

Working assumption:

For non-back-to-back PUSCH transmissions across consecutive slots, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following cases:

- Over non-back-to-back PUSCH transmissions (of the same TB) for repetition type A scheduled by dynamic grant or configured grant.

- Over non-back-to-back PUSCH transmissions (of the same TB) for repetition type B scheduled by dynamic grant or configured grant, if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A.

– FFS: additional specification enhancements on top of that defined to support repetition Type A

– Only for single layer transmissions

– Subject to UE capability

- FFS: Over non-back-to-back PUSCH transmissions with different TBs

- FFS: Over non-back-to-back PUSCH transmissions for TBoMS

Feedback Form 25: Comments on proposal 4a

1 – Shenzhen YZF Network Technolog [OPPO] Support
2 – Nokia Solutions & Networks (I) We are fine to make it as a working assumption for the sake of progress. We do not wish to create issues to the FL, however we do think it is important to establish some consequentiality between discussions in 8.8.1.2 and 8.8.1.3 for discussing support JCE in case of TBoMS. Design aspects of TBoMS should be derived independently. In 8.8.1.2 Subsequently, if applicable and possible, JCE aspects can be discussed in 8.8.1.2. For this reason, would it be possible modify the last FFS bullet as follows? - FFS: Over non-back-to-back PUSCH transmissions for TBoMS (to be discussed after core aspects of TBoMS are agreed)
3 – Intel Deutschland GmbH We are fine with the proposal.
4 – Motorola Mobility Germany GmbH [Lenovo, Motorola Mobility]: We are fine with the proposal

5 – Qualcomm Incorporated

If the assumption here is that there are intervening uplink transmissions, it will be good to mention this explicitly. Consider the following:

”For non-back-to-back PUSCH transmissions across consecutive slots **with intervening uplink transmissions**, support necessary design aspects (under the condition of ...”

As things currently stand, the RAN4 requirements on intervening uplink transmissions are rather onerous, and make it almost impossible to satisfy.

Unless RAN4 revises their guidance, we don’t think this is a useful use case to support.

6 – Ericsson LM

While we continue to be concerned with the off power requirement, the extra flexibility of non-back-to-back is appealing, and we can support this as a working assumption.

7 – InterDigital France R&D

We support the FL’s proposal.

8 – Apple Computer Trading Co. Ltd

We agree with Qualcomm comments. It’s better to make it clear in this proposal that other physical signals/channels are transmitting in-between PUSCH repetitions

The following words (of the same TB) in the sub-bullet are not redundant, there is no confusion that the repetition is only for the same TB.

9 – NTT DOCOMO INC.

We are fine with the Qualcomm’s update.

10 – TCT Mobile Limited

We are fine with the proposal.

11 – Samsung Electronics Co.

Fine with the proposal.

12 – CATT

According to FL’s summary, **Proposal 4a is for different type of PUSCH transmissions while proposal 4b discusses no uplink transmission or other uplink transmissions in the middle of two PUSCH transmissions.** But it is hard to tell whether current wording of Proposal 4a means there will be some other UL signal (e.g. SRS) between the 2 PUSCHs.

If so, we agree that Qualcomm’s verson seems more clear.

13 – Panasonic Corporation

We support the proposal 4a.

14 – vivo Communication Technology

similar to comments from other companies, whether proposal 4a is for the case of ”other UL transmission” in the middle.

15 – LG Electronics Inc.

Fine with the proposal.

16 – China Telecommunications

The intention of separating the original proposal 4 into proposal 4a and 4b is to avoid mis-understandings. Proposal 4a is for different type of PUSCH transmissions while proposal 4b discusses no uplink transmission or other uplink transmissions in the middle of two PUSCH transmissions. Now it seems the separation causes another confusion. Proposal 4a and proposal 4b are combined to formulate Proposal 4 – v2. Hopefully it is clear now.

Proposal 4 – v2:

Working assumption:

For non-back-to-back PUSCH transmissions with no uplink transmission in the middle of two PUSCH transmissions across consecutive slots, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following cases:

- Over non-back-to-back PUSCH transmissions (of the same TB) for repetition type A scheduled by dynamic grant or configured grant.
- Over non-back-to-back PUSCH transmissions (of the same TB) for repetition type B scheduled by dynamic grant or configured grant, if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A.
  - o FFS: additional specification enhancements on top of that defined to support repetition Type A
  - o Only for single layer transmissions
  - o Subject to UE capability
- FFS: Over non-back-to-back PUSCH transmissions with different TBs
- FFS: Over non-back-to-back PUSCH transmissions for TBoMS (to be discussed after core aspects of TBoMS are agreed)

FFS: Joint channel estimation over non-back-to-back PUSCH transmissions with other uplink transmissions in the middle of two PUSCH transmissions across consecutive slot.

17 – SHARP Corporation

We support Proposal 4 - v2.

18 – MediaTek Inc.

For proposal 4-v2, we would like to add one FFS considering the impact on UE power consumption.

FFS: the max number of gap symbols considering UE power consumption.

19 – Beijing Xiaomi Mobile Software

Fine with the proposal.

20 – ZTE Corporation Fine with the proposal as a working assumption.
21 – WILUS Inc. We are fine with the proposed WA.

Proposal 4b:

Working assumption:

Joint channel estimation over non-back-to-back PUSCH transmissions with no uplink transmission in the middle of two PUSCH transmissions across consecutive slot under the condition of power consistency and phase continuity is supported.

FFS: Joint channel estimation over non-back-to-back PUSCH transmissions with other uplink transmissions in the middle of two PUSCH transmissions across consecutive slot under the condition of power consistency and phase continuity is supported.

Feedback Form 26: Comments on proposal 4b

1 – Nokia Solutions & Networks (I) We are fine with the working assumption.
2 – Intel Deutschland GmbH We are fine with the proposal.
3 – Qualcomm Incorporated A little confused. Isn't Proposal 4a trying to address the FFS listed here?
4 – Ericsson LM While we continue to be concerned with the off power requirement, the extra flexibility of non-back-to-back is appealing, and we can support this as a working assumption.
5 – InterDigital France R&D We support the FL's proposal.
6 – Apple Computer Trading Co. Ltd To avoid the confusion, the two PUSCH transmission can be replaced with PUSCH repetitions. The case of two PUSCH transmission with different TB is still on discussing.
7 – NTT DOCOMO INC. Support.

8 – TCT Mobile Limited We are fine with the proposal.
9 – Samsung Electronics Co. As we commented in previous discussion, proposal 4a (specifically, with the statement of "(under the condition of power consistency and phase continuity)") already includes proposal 4b. No need for proposal 4b.
10 – CATT We support the WA in general. But to avoid misunderstanding, it should be clarified that this proposal is for 'the same TB'. The different TBs case is still under discussion in previous proposals.
11 – Panasonic Corporation We support the proposal 4b.
12 – vivo Communication Technology we are fine with this proposal
13 – LG Electronics Inc. Support the proposal.
14 – Beijing Xiaomi Mobile Software Fine with the proposal.

4.2 Time domain window

FL comments: It seems the majority have the same understanding that joint channel estimation for PUSCH and the time domain window are jointly enabled or disabled. Proposal 11 is reformulated based on the comments. The first bullet is aligned with the agreements for PUCCH while the second bullet is to exclude separate enabling/disabling between joint channel estimation for PUSCH and the time domain window. If companies think the wording "enabling/disabling of joint channel estimation for PUSCH transmissions" is not appropriate, we can change the wording "joint channel estimation" to "DMRS bundling"

Proposal 11:

~~Joint channel estimation~~ DMRS bundling for PUSCH transmissions is enabled or disabled via RRC configuration.

- FFS: whether additional dynamic signaling is needed to enable/disable ~~joint channel estimation~~ DMRS bundling for PUSCH transmissions.

For ~~joint channel estimation~~ DMRS bundling for PUSCH, the time domain window is not explicitly enabled or disabled separately from ~~joint channel estimation~~ DMRS bundling.

~~- FFS: If the joint channel estimation for PUSCH transmissions is enabled or disabled, the time domain window is enabled or disabled implicitly.~~

- FFS: If the time domain window is enabled or disabled, ~~joint channel estimation~~ DMRS bundling for PUSCH transmissions is enabled or disabled implicitly.

– FFS: how the time domain window is determined (e.g., via explicit configuration and/or implicitly derived)

Feedback Form 27: Comments on proposal 11

1 – vivo Communication Technology it's too early to discuss RRC signaling design, what is needed is the functionality for now. if desired to agree on RRC functionality, similar wording as for PUCCH can be used "support enabling PUCCH repetitions with DMRS bundling via RRC configuration", then how/which signal is used to enable/disable is for further discussion. Time domain window will be configured, then it is straight forward to use this signal to enble/disable DMRS bundling.
2 – Nokia Solutions & Networks (I) We are fine with the proposal in principle. However, we have been using the wording joint channel estimation so far in our agreements, is there any reason why we should change it? (our apologies if this is in response to some comments companies made in the last round…keeping track using NWM is not always very convenient) Can we also move the last FFS "one level above"? In our view, it should be like this: - FFS: If the time domain window is enabled or disabled, ~~joint channel estimation~~ DMRS bundling for PUSCH transmissions is enabled or disabled implicitly. - FFS: how the time domain window is determined (e.g., via explicit configuration and/or implicitly derived)
3 – Intel Deutschland GmbH We do not see the need to change joint channel estimation to DMRS bundling. It has same meaning based on our understanding. Suggest to remove the last FFS as it was already agreed (FFS) before.
4 – Motorola Mobility Germany GmbH [Lenovo, Motorola Mobility]: We are fine with the proposal. We are also okay to keep the previous wording "joint channel estimation"
5 – Ericsson LM Support the proposal with 'DMRS bundling', as this terminology seems more technically correct.
6 – InterDigital France R&D We are also supportive of using "DMRS bundling" instead of "joint channel estimation" to be consistent with the terminology used in PUCCH. We support the FL's proposal.

7 – Apple Computer Trading Co. Ltd

Either DMRS bundling or joint channel estimation is fine for us. Agree with Intel, the last FFS was agreed in the last meeting already.

8 – TCT Mobile Limited

Agree with Intel's comment. No need to change joint channel estimation to DMRS bundling. They have the same meaning.

9 – NTT DOCOMO INC.

In our understanding, the reason behind replacing JCE with DMRS bundling comes from the difference that DMRS bundling and JCE are performed on UE and gNB, respectively. If so, it is better to clarify the definition of DMRS bundling since we don't have the definition of the DMRS bundling in common. For example, adding "DMRS bundling means maintaining the phase and power consistency over multiple slots by UEs. "

10 – Samsung Electronics Co.

The wording 'joint channel estimation' is from the WID, and has been used so far. It should not be changed.

We are fine with the proposal with the original wording.

11 – CATT

We have the same understanding with DOCOMO, JCE and DMRS bundling are the two coinsides of the same feature, depending on views of gNB or UE.

So technically, we are fine with both wording. A note may help if companies have concerns.

12 – Panasonic Corporation

Wording "joint channel estimation" has been used in agreements so far. We are not sure the motivation to change it to "DMRS bundling" because they have the same meaning. For a sake of progress, we are fine with the proposal 11 in general.

13 – LG Electronics Inc.

From our understanding, the reason why we used term "time domain window" instead of "DMRS bundling" was for defining UE behavior to maintain power and phase consistency. In that perspective, for now we do not have any specific UE behavior under DMRS bundling to ensure power and phase consistency, it can be misunderstood by replacing joint channel estimation to DMRS bundling. To be accurate, it is desirable to replace "DMRS bundling" to "time domain window for power and phase consistency".

14 – MediaTek Inc.

fine with proposal.

15 – SHARP Corporation

We agree with docomo and CATT. Putting a note that DMRS bundling means maintaining the phase and power consistency over multiple slots by UE works for us.

16 – China Mobile Com. Corporation It could be confusing to use another terminology in the middle of WI and even replacing a terminology that had been captured in the WID. If the update is necessary, we should also update the WID.
17 – Beijing Xiaomi Mobile Software Either DMRS bundling or joint channel estimation is fine for us.
18 – ZTE Corporation Prefer to keep using joint channel estimation. If necessary, a note can be added to clarify this.

FL comments: As we have clarified the definition of the time domain window and the maximum duration. We can resume the discussion on the unit of the time domain window. The following two options seem to have equal support. As commented by some companies, we may not have to make down selection on these two options as some of the cases haven't been agreed yet. We can discuss the unit for each case. Based on the discussion, it seems the majority are fine with slot as the unit of the time domain window for repetition type A. For other cases, we can discuss further.

Option 1: The unit of the time domain window is defined separately for the following PUSCH transmissions:

Option 2: The unit of the time domain window is the same for the following PUSCH transmission:

Proposal 12:

For joint channel estimation for PUSCH repetition type A, the time domain window size is determined in the unit of slot.

- In case that the time domain window is determined/derived implicitly, the unit of the time domain window is not explicitly defined.

FFS: the unit of time domain window for PUSCH repetition type B.

FFS: the unit of time domain window for different TBs, if agreed.

FFS: the unit of time domain window for TBoMS, if agreed.

Feedback Form 28: Comments on proposal 12

1 – vivo Communication Technology first sub-bullet is not necessary at this moment. we can agree main bullet and FFS points are OK
2 – Shenzhen YZF Network Technolog [OPPO] the 1st and 2nd sub-bullet is not necessary. we can discuss after the relevant mechanisms are supported
3 – Nokia Solutions & Networks (I) Could we replace "if agreed" with "if supported" in the last two FFS bullets?

4 – Intel Deutschland GmbH

We are fine with the proposal in principle, but we do not need the first sub-bullet.

- For joint channel estimation for PUSCH repetition type A, the time domain window size is determined in the unit of slot.

~~- In case that the time domain window is determined/derived implicitly, the unit of the time domain window is not explicitly defined.~~

5 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]: Although we prefer to have same unit for all cases but for the sake of progress, we are fine with the principle. As suggested by Intel, the first sub-bullet is not needed.

6 – Qualcomm Incorporated

Units for TDW are necessary irrespective of implicit/explicit determination of its location. Dont think the sub-bullet is needed.

7 – Ericsson LM

Prefer an alternative proposal. We think the window should be in units of repetitions for Type A.

In this way, the UE only is required to maintain continuity/consistency for the duration of the repetitions, and the window is no larger than it needs to be. The window size is dynamic when repetition factor is dynamic. This maximizes the UEs' flexibility to update phase. gNB scheduler flexibility is also maximized, since the window always matches the size and location of the PUSCH that requires continuity/consistency.

If slots instead are used as the unit, additional overhead is needed if we want to dynamically indicate the window size and/or the window starting position. Furthermore, if slots are used, it is not clear what the start of the window is. The start could be with the first transmission of the PUSCH, but then if the length of the window covers all repetitions, it is equivalent to using units of repetitions.

8 – InterDigital France R&D

We also agree with other companies that the sub-bullet "In case that the time domain window is determined/derived implicitly, the unit of the time domain window is not explicitly defined." is not needed. We support the FL's proposal without the sub-bullet.

9 – Apple Computer Trading Co. Ltd

We share the view as Lenovo.

10 – NTT DOCOMO INC.

We do not support the proposal for the same reason Ericsson pointed out.

Within the time domain window, UE needs to maintain phase and power continuity. As this window confines the flexibility of power updating and frequency calibration, the time domain window should be as small as possible. If the unit of time domain window size is slot, the time domain window might be larger than actual PUSCH transmission occasion, which we should avoid for coverage performance. To solve this issue, the unit of time domain window should be repetition for PUSCH repetition type A and type B.

If the concept of nominal time domain window (duration indicated by gNB) and actual time domain window (duration UE maintain phase and power) are introduced, it is acceptable that the unit of nominal time domain window is a slot. However, the only agreed definition of time domain window is an actual time domain window so far. For those reasons, we cannot support the proposal.

11 – TCT Mobile Limited

Agree with Ericsson's comments. Prefer an alternative proposal .

12 – Samsung Electronics Co.

We are generally fine with the proposal. Regarding the 1st sub-bullet, we don't think that it is necessary – no need to link the unit of time domain window and time domain window determination.

We think that the unit of time domain window can be determined based on TDRA. For repetition type A, the unit of time domain window can be determined in the unit of slot or number of repetitions.

13 – CATT

We do not understand why the unit for TDW is respective to implicit/explicit determination. The 1st sub-bullet should be removed.

Fine with the other part of the proposal.

14 – Panasonic Corporation

We are fine with the proposal 12.

15 – LG Electronics Inc.

For the first FFS point, it should be removed since PUSCH repetition type B is supported for joint channel estimation if it reuses only those for PUSCH repetition type A according to agreement of previous meeting. A minor thing is that "if supported" seems more proper wording instead of "if agreed".

16 – China Mobile Com. Corporation

We do not support deleting the 1st sub-bullet. If the JCE indication is bundled with the indication of time domain resource allocation, there is no need to explicit define the unit of TWD.

17 – Beijing Xiaomi Mobile Software

The first bullet is no need. And the main bullet may be changed as:

For joint channel estimation for PUSCH repetition type A, the time domain window size is determined in the unit of slot by default.

18 – ZTE Corporation

Also agree the firs sub-bullet is not needed as a unit may be needed no matter how the time domain window is determined. We are fine to use slot as the unit, and it's not clear for us how the actual duration of the time domain window would be if repetition is used as the unit and the repetitions among slots are not consecutive.

19 – WILUS Inc.

We share the similar view with Ericsson. The unit of repetition is sufficient at least for repetition cases.

20 – HUAWEI TECHNOLOGIES Co. Ltd.

The main bullet is a bit confusing for us. If the time window is in unit of slot, then does it mean the UE should maintain phase contiguity for even the SRS transmission in the same slot?

In our understanding, the time window for repetition type A is implicitly derived from TDRA information, no need to further determine its unit. Therefore, we don't feel the proposal is agreeable.

Companies are encourage to provide views on the following aspects of the time domain window and the maximum duration.

Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?

What's the relation between the time domain window and the maximum duration?

For joint channel estimation for PUSCH repetition type A, how to determine the time domain window?

- Whether the time domain window can be explicitly configured or implicitly derived?

- How to determine the start of time domain window?

- How to determine the length of time domain window?

- Whether multiple time domain windows are needed?

For joint channel estimation for PUSCH repetition type B, how to determine the time domain window?

- Whether the time domain window can be explicitly configured or implicitly derived?

- How to determine the start of time domain window?

- How to determine the length of time domain window?

- Whether multiple time domain windows are needed?

Feedback Form 29: Comments on aspects of the time domain window and the maximum duration

1 – Nokia Solutions & Networks (I)

Question 1: From our understanding, the time domain window can be implicitly derived from at least the DL/UL configuration for unpaired spectrum. Other dependencies may become necessary, depending on how the remaining aspects of the JCE feature are designed.

Question 2: From our understanding, the maximum duration is related to the UE capability (e.g., UE can only support JCE up to a certain number of consecutive physical slots due to some calibration, power support, etc). Irrespective of how it is configured, a single time domain window should not exceed maximum time duration (i.e., it can be equal to or smaller than the maximum time duration, please see our answer to Question 3-4 below).

We also would like to highlight that even when the time-domain window is configured and "in place", gNB can still decide to schedule a channel/signal that could break the phase continuity (e.g., a UL with different

settings in Use cases 2, 4 and 5). We think that this flexibility for the gNB should be kept. Therefore, in our view the time-domain window is simply the duration within which the UE is expected to operate according to joint CE mode. Of course, events like the one above could occur during the time domain window. For this reason, we think that it is reasonable to consider that multiple sub-windows may also be determined by UE, e.g., via a segmentation of the "original" time domain window, where the phase continuity can actually be guaranteed, depending on gNB scheduling.

Questions 3:

3-1: For PUSCH repetitions (both type A and type B), with the understanding as explained in our replies to Question 2, we can then define the time-domain window as the duration supposed to cover all the configured repetitions. This does not require any explicit indication of the time-domain window. This simply means that if there is no scheduling that may break phase continuity from the gNB then the UE can keep phase continuity within this window (i.e,, across the repetitions), provided that such window does not exceed the maximum time duration (which is a pre-requisite in all our answers).

3-2 and 3-3: In this case, the window starts from the first repetition and last until the last repetition, unless DL reception occurs in between, resulting in window segmentation, i.e., "multiple sub-windows" whose beginning/end would depend on the adopted segmentation mechanism/logic/rule.

3-4: There could be one or more than one time-domain windows, depending on (i) the reported "maximum duration", (ii) how time domain window(s) are configured, (iii) possible segmentation rules for a time domain window within which DL reception occurs.

- If the reported "maximum duration" is shorter than the duration spanned by the PUSCH repetitions, then multiple time-domain windows can be considered, each of them of size not larger than the "maximum duration" and placed back-to-back within the duration of repetitions. Therefore, if clear rules are defined (and RAN1 usually excels at this) there is no need for any explicit indication to take place.
- If the reported "maximum duration" is longer than or equal to the duration spanned by the PUSCH repetitions, then a single time-domain window which is the duration of repetitions can be considered, as long as no DL reception occurs in between (in which case, the logic explained above would apply).
- Question 4: Similar answers as for Question 3.

2 – Intel Deutschland GmbH

- Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?
- No.
- What's the relation between the time domain window and the maximum duration?
- Time domain window size <= maximum duration.
- For joint channel estimation for PUSCH repetition type A, how to determine the time domain window?
- Whether the time domain window can be explicitly configured or implicitly derived?
  - Partially. Details as follows
- How to determine the start of time domain window?
  - It is start of PUSCH transmission.
- How to determine the length of time domain window?

o Length of time domain window can be explicitly configured or implicitly determined, e.g., in case of inter-slot bundling. In the latter case, length of time domain window = bundle size

 Whether multiple time domain windows are needed?

o May not be needed.

3 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]:

- No, the time domain window is not implicitly derived. It is always explicitly indicated/configured
- Maximum duration is a UE capability and the time domain window sizeis always equal or less than the maximum duration
- The start of time domain window is determined based on the start of PUSCH transmission and the duration is explicitly indicated/configured
- Multiple time domain windows are not needed

4 – Qualcomm Incorporated

This discussion is highly dependent on whether we are talking about PUSCH transmissions across different TBs or PUSCH repetitions of the same TB. Should we restrict this discussion to PUSCH repetitions?

5 – Ericsson LM

Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?

We think the window size should be equal to that containing the transmissions that contain the same TB for repetition or TBoMS. The continuity/consistency requirements, such as from DL/UL configuration, then determines the subset of transmissions over which the UE actually maintains continuity/consistency.

What's the relation between the time domain window and the maximum duration?

The maximum duration is a requirement similar to the continuity/consistency requirements. It is applied to determine the subset of transmissions that the UE maintains continuity/consistency over. For example, if an FDD PUSCH is repeated 8 times, and the UE can maintain continuity/consistency over 4 slots, the UE could be required to maintain continuity/consistency over the first 4 and the second 4 repetitions, but no more than 4 repetitions together. Note here that 'could be' is because there can be additional requirements.

For joint channel estimation for PUSCH repetition type A, how to determine the time domain window?

- **Whether the time domain window can be explicitly configured or implicitly derived?**

The window size is implicitly derived according to the number of repetitions. See above.

- **How to determine the start of time domain window?**

The start is the first PUSCH transmission, and uses available or 'physical' slots according to the Type A configuration.

- **How to determine the length of time domain window?**

The window length is equal to the duration of all the repetitions.

- **Whether multiple time domain windows are needed?**

A single time window is sufficient for PUSCH.

For joint channel estimation for PUSCH repetition type B, how to determine the time domain window?

Shouldn't this be the same as for type A, given the agreement to reuse type A mechanisms?

6 – Apple Computer Trading Co. Ltd

For both PUSCH repetition type A and repetition type B

- Time domain window can be implicit derived for TDD, but it's subject to outcome of maximum duration from RAN4.
- Time domain window size is smaller or equal to maximum duration.
- The start of time domain window is from the first repetition and ending at the last slot of consecutive UL slots for TDD. The length of window is the consecutive UL slots for TDD
- One or two time domain window(s) is depending on one or dual TDD UL-DL patterns.

7 – NTT DOCOMO INC.

- Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?
  Not only DL/UL configuration. Also, it is better to have the unified design for unpaired spectrum and paired spectrum.
- What's the relation between the time domain window and the maximum duration?
  time domain window □ maximum duration

- how to determine the time domain window?
  indication by gNB and implicit derivation to satisfy the phase and power consistency.
- How to determine the start of time domain window?
  the first symbol of the repetition indicated by gNB
- How to determine the length of time domain window?
  the last symbol of the repetition indicated by gNB
- Whether multiple time domain windows are needed?
  Within PUSCH repetitions, multiple time domain windows are better. For example, when the number of repetition is 6, each time domain window can cover 2, 3 or 6 repetitions. These number should be indicated by gNB according to how JCE is applied on gNB side.

8 – InterDigital France R&D

Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?

- No, the time domain window is explicitly indicated/configured

What's the relation between the time domain window and the maximum duration?

- Maximum duration is the longest duration during which the UE is capable of maintain power and phase continuity. Time domain window is the duration the UE is expected to maintain power and phase continuity. We assume maximum duration >= time domain window duration

For joint channel estimation for PUSCH repetition type A, how to determine the time domain window?

- Whether the time domain window can be explicitly configured or implicitly derived?
  - Time domain window is explicitly configured
- How to determine the start of time domain window?
  - At the start of the PUSCH transmission
- How to determine the length of time domain window?

- The length of the window is also explicitly configured

- Whether multiple time domain windows are needed?
  - A single window is sufficient.

For joint channel estimation for PUSCH repetition type B, how to determine the time domain window?
Fundamentally, the same answer as for PUSCH repetition type A

- Whether the time domain window can be explicitly configured or implicitly derived?
  - Time domain window is explicitly configured
- How to determine the start of time domain window?
  - At the start of the PUSCH transmission
- How to determine the length of time domain window?
  - The length of the window is also explicitly configured
- Whether multiple time domain windows are needed?
  - A single window is sufficient.

9 – Samsung Electronics Co.

- Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?
  [Samsung]: No.

- What's the relation between the time domain window and the maximum duration?
  [Samsung]: We think that the time domain window can be equal to or smaller than the maximum duration.

- For joint channel estimation for PUSCH repetition type A/B, how to determine the time domain window?

- Whether the time domain window can be explicitly configured or implicitly derived?

  [Samsung]: In our view, both the explicit configuration and implicitly derived can be considered to determine the time domain window. The maximum duration can be determined explicitly based on the UE capability. Then, the time domain window can be implicitly derived to perform joint channel estimation by the gNB within the maximum duration. In case of explicit determination, the UE can apply the configured time domain window to preserve the power consistency and phase continuity instead of the maximum duration.

- How to determine the start of time domain window?

  [Samsung]: The start of time domain window can be determined based on the start of PUSCH transmission.

- How to determine the length of time domain window?

  [Samsung]: The time domain window can be determined by the gNB.

- Whether multiple time domain windows are needed?

  [Samsung]: We don't think that multiple time domain windows are necessary.

10 – Panasonic Corporation

Q1: Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?

A1: In our view, the time domain window can be implicitly indicated via an enhanced TDRA table, i.e., no need explicit field in DC. RRC is used to configure the enhanced TDRA table.

Q2: What's the relation between the time domain window and the maximum duration?

A2: The time domain window, which is configured to a UE to enable joint channel estimation, should be equal to or less than the maximum duration.

Q3: For joint channel estimation for PUSCH repetition type A/B, how to determine the time domain window?

A3: Please refer to A1.

Q4: Whether multiple time domain windows are needed?

A4: Yes. In order to have gains from both joint CE and inter-slot FH, a length of time domain window should be same or subset of a length of inter-slot FH depending on how frequency hopping is realized. For instance, if inter-slot frequency hopping and/or inter-slot precoder cycling are applied, the length of time

domain window should be equal to or the subset of the length of inter-slot FH. If the inter-slot frequency hopping and/or inter-slot precoder cycling are not applied, the length of time domain window can be same of the time domain resource allocation.

Q5: How to determine the start of time domain window?

A5: It is a start of the first PUSCH transmission within the time domain window.

11 – vivo Communication Technology

- Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?

A: yes, the configured window length can be longer than number of consecutive slots, in which case, the actual time domain window, in which UE can actually maintain phase continuity is implicitly determined from the DL/UL configuration.

- What's the relation between the time domain window and the maximum duration?

A: the time domain window, no matter explicit indicated or implicitly derived, is not longer than the maximum duration.

The above understanding can be applied to both type-A and type-B PUSCH repetitions.

12 – CATT

Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?

- Yes, partially. Since the number of continuous physical slots for UL transmission is restricted by DL/UL configuration, time domain window is more or less depending on it.

What's the relation between the time domain window and the maximum duration?

- We think the only reasonable relationship is 'time domain window duration <= maximum duration'.

For joint channel estimation for PUSCH repetition type A, how to determine the time domain window?

- Whether the time domain window can be explicitly configured or implicitly derived?
  - At least explicitly configuration is needed for paired spectrum. For unpaired spectrum, both explicit and implicit method can be considered.
- How to determine the start of time domain window?
  - At the start of the transmission
- How to determine the length of time domain window?

- Depends on it is explicitly configured or implicitly derived.

- Whether multiple time domain windows are needed?
  - From UE's view, a single window seems sufficient. From gNB's view, if the time domain window is explictly configured, several different lengths of TDW may be defined and configured to different UEs.

For the repetition type B case, we think there is no difference with type A.

13 – LG Electronics Inc.

From our understanding, enhancement for coverage enhancement is targeting for PUSCH repetition type A with same TB. Based on that,

1. No. The time domain window implicitly derived from the DL/UL configuration may lead misunderstanding between UE and gNB if use case 4 and 5 are supported.

2. Time domain window should be configured to be equal to or less than maximum duration if the maximum duration is reported to gNB.

3. Considering gNB configures to UE for PUSCH repetition with size of time domain window for joint channel estimation, the start of window is natural to be the start of repetition. Multiple window is not needed.

4. Since it is not agreed to enhance specific mechanism for PUSCH repetition type B, it do not need to be discussed.

14 – SHARP Corporation

Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?

A: Yes, time domain window should at least depend on the UL/DL configuration.

What's the relation between the time domain window and the maximum duration?

A: Length of time domain window should be smaller than the maximum duration.

For joint channel estimation for PUSCH repetition type A, how to determine the time domain window?

- Whether the time domain window can be explicitly configured or implicitly derived?

A: For FDD, the time domain window should be explicitly configured. For TDD, the explicit indication can be optional. On top of that, for TDD, UL/DL configuration should be referred to derive the time domain window.

- How to determine the start of time domain window?

A: Start of PUSCH allocation.

- How to determine the length of time domain window?

A: It depends on explicit configuration and PUSCH allocation for FDD. It depends on UL/DL configuration and PUSCH allocation for TDD.

- Whether multiple time domain windows are needed?

A: We dont think so for now.

15 – Beijing Xiaomi Mobile Software

Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?

Yes ,but it is not the only method. Time domain window can also be explictly configured.

What's the relation between the time domain window and the maximum duration?

time domain window <= maximum duration.

For joint channel estimation for PUSCH repetition type A, how to determine the time domain window?

- Whether the time domain window can be explicitly configured or implicitly derived?

Yes

- How to determine the start of time domain window?

implicitly derived from the first avaliable UL slots according DL/UL configuration

explictly determined by gNB indication.

- How to determine the length of time domain window?

determined by gNB indication or equal to maximum duration.

- Whether multiple time domain windows are needed?

Yes

For joint channel estimation for PUSCH repetition type B, how to determine the time domain window?

- Whether the time domain window can be explicitly configured or implicitly derived?

Yes

- How to determine the start of time domain window?

implicitly derived from the first avaliable UL slots according DL/UL configuration

- How to determine the length of time domain window?

determined by gNB indication or equal to maximum duration.

- Whether multiple time domain windows are needed?

Yes

16 – ZTE Corporation

A time domain window smaller than the maximum duration is configured by gNB. For instance, if UE can maintain phase continuity within 8 slots, while gNB may not want to do joint channel estimation for that long time considering the channel conditions or gNB complexity. Then, a time domain window, e.g., 4 slots, can be configured.

After configuring the time domain window, the actual duration that the UE should maintain phase continuity can be determined not only by the TDD configuration but also all other factors which impact the phase continuity as defined by RAN4.

For the start of the time domain window, we think either a fixed start or determined by the start of the first PUSCH transmission can be considered.

Above procedures can be applied to both repetition type A and type B or other use cases if agreed.

17 – China Mobile Com. Corporation

Q1:

Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?

Q1:

According to the reply from RAN4, at least the consecutive uplink slots based on the DL/UL configuration have the opportunity to maintain the power consistency and phase continuity. No downlink reception in-between the PUSCH or PUCCH repetition in the same band for TDD case. If the other conditions could be fulfilled and the maximum duration is larger than the 2 or 3 consecutive slots, there is no need to explicit indicate the TDW but bundling with the indication of time domain resource allocations.

Q2:

What's the relation between the time domain window and the maximum duration?

Q2:

From our understanding, the current defined time domain window is for the indication to UEs on exactly how many slots (or other units) should UE to maintain to facilitate gNB to use JCE.

And the maximum duration which is subject to the TDW, is an UE capability which should be reported to gNB the maximum time duration the UE could maintain to support the JCE based on its hardware condition.

Q3:

For joint channel estimation for PUSCH repetition type A, how to determine the time domain window?

- Whether the time domain window can be explicitly configured or implicitly derived?
- How to determine the start of time domain window?
- How to determine the length of time domain window?
- Whether multiple time domain windows are needed?

Q3 (repetition type A time domain window) :

Our proposal is to indicated the TDW along with the scheduling of PUSCH repetition type A, with the additional indication that the JCE is required by gNB. Then the TDW size(s) should be equal to consecutive uplink slots where the actual repetitions happen indicated by the PUSCH repetition type A.

Then the start of the TDW could be the 1st uplink transmission or the 1st uplink slots in the consecutive slots.

The length of the TDW is the length of consecutive uplink repetitions.

Since the uplink consecutive repetitions within one PUSCH repetition type A indication could be two or three consecutive uplink slots, there could be different time domain window sizes. But as it is implicitly indicated, there is no need to explicitly define or indication multiple time domain windows.

Q4:

For joint channel estimation for PUSCH repetition type B, how to determine the time domain window?

- Whether the time domain window can be explicitly configured or implicitly derived?
- How to determine the start of time domain window?
- How to determine the length of time domain window?
- Whether multiple time domain windows are needed?

Q4 (repetition type B time domain window):

The time domain window could also be indicated implicitly. The situation is similar as PUSCH repetition type A. The consecutive symbols within the repetition indication could be used for the JCE. And if the time duration is interrupted by downlink reception (at the UE side) or the length of invalid symbols are beyond the requirement of non-zero gap of JCE, the two subset of symbols could be considered as two time domain windows.

The start of the TDW should be the 1st uplink transmission of the repetitions or the start symbols of one subset of the consecutive symbols.

The length depends on invalid symbols or the interruptions of JCE.

Multiple time domain window happens in this situation. But there is no need to define or indicate the multiple window.

18 – WILUS Inc.

Q1. Whether the time domain window can be implicitly derived from the DL/UL configuration for unpaired spectrum?

Both explicit and implicit configuration can be applied, e.g., consecutive UL slots are implicitly determined as a window that do not exceed the explicitly configured length.

Q2. What's the relation between the time domain window and the maximum duration?
The size of time domain window is smaller than or equal to the maximum duration.

Q3. For joint channel estimation for PUSCH repetition type A/B, how to determine the time domain window?

Q3-1. Whether the time domain window can be explicitly configured or implicitly derived?
Same with Q1. Both explicit and implicit configuration can be applied.

Q3-2. How to determine the start of time domain window?
The first symbol/slot of the PUSCH repetition.

Q3-3. How to determine the length of time domain window?

Repetitions within consecutive UL slots that do not exceed the configured length.

Q3-4. Whether multiple time domain windows are needed?
For the PUSCH repetition case, single time domain window is sufficient.

4.3 Optimization of DMRS location in time domain

FL comments: For DMRS located in special slots, it seems more discussion is needed. The proponents are encouraged to provide the detailed mechanism and the spec impacts.

Feedback Form 30: Comments on DMRS in special slots

1 – Ericsson LM

In light of the spec impact, restricted use cases, and limited gains, we do not yet see the benefit of DMRS in the special slot.

We would also like to take this opportunity to highlight another aspect. Special slots often contain SRS and PUCCH, and the interference statistics for these channels is in general different from PUSCH. Therefore, if DMRS in the special slot is used to help determine weights for an interference suppressing receiver such as MMSE-IRC, the interference suppression performance can be worse than if only DMRS in the normal uplink slot is used. Please see further discussion in R1-2105657.

2 – InterDigital France R&D

We provided our views on spec impact during the 2nd round of discussion.

3 – LG Electronics Inc.

Following conclusion was made during previous GTW session.

Conclusion:

- The following agreement in RAN1#104-e is applied to all slots including special slots.

Agreements:

For defining available slots: a slot is determined as unavailable if at least one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with the symbol not intended for UL transmissions.

FFS details

Based on the conclusion above, to allocate DMRS in special slot, the special slot should be available which means every symbols indicated by TDRA should be available in the special slot. It means that, even it is supported, it is very unlikely to be happened to transmit DMRS in special slot. Furthermore, as pointed out by many companies before, it will lead significant specification impact. We really do not see the reason why we need this.

4 – China Mobile Com. Corporation

The use case could be like this. The special slot is scheduled for the PUSCH transmission. And in the following two slots, the UE is also be scheduled. And due to the propagation environment does not change too much, the UE could be scheduled in the same MCS and PRB allocations. And since the special slot and the two slots are consecutive, JCE could be used for the 3 PUSCH transmissions.

5 Email discussion (4th round)

FL comments: Regarding the time domain window, we hold on the discussion on the unit and focus on the discussion on proposal 13 and 14.

Proposal 13: Down select the following alternatives:

For joint channel estimation for PUSCH repetition type A for paired spectrum.

Alt 1: Single time domain window covers all the repetitions

- The start of the window is the first PUSCH transmission

- FFS: how to handle the case if the maximum duration is shorter than the length of the window, e.g., sub-window.

Alt 2: One or multiple time domain windows covers all the repetitions

- The start of the first window is the first PUSCH transmission

- Multiple windows are consecutive.

- The length of each window is not longer than the maximum duration.

- FFS: how to determine the length of each window

Feedback Form 31: Comments on proposal 13

1 – HUAWEI TECHNOLOGIES Co. Ltd.

Firstly, we prefer a unified solution for all bands. Especially, RAN4 is not sure if phase contiguity can be maintained across non-consecutive slots with DL slots in the middle. In case it cannot, separate proposals seem not necessary.

Secondly, if we have to go this way, please add SUL to the main bullet, i.e. ”for paired spectrum and SUL.”

2 – CATT

We feel that these two alternatives are not precluding each other. If one time domain window is configured to a UE, it seems both of them may be useful, depends on the actual scheduled number of repetitions (take repetition for example).

3 – China Telecommunications

@CATT, the difference between Alt 1 and Alt 2 is that for Alt 1 only one window is configured, while for Alt 2, gNB has freedom to configure one or multiple windows.

4 – Ericsson LM

We also think that a unified mechanism should be supported if possible. We therefore would prefer a higher level proposal that covers both 13 and 14 the different duplexing options.

What seems to be common among all alternatives in proposals 13 and 14 is

- A window starts with the first PUSCH transmission
  - FFS: if only one vs. multiple windows for the repeated transmissions of a TB is supported
- All repetitions are covered by the window(s)

Can we use these bullets as a high level proposal and then work the details for the different duplexing options?

Regarding consecutive windows in Alt 2: If multiple windows are exactly back to back, it's not obvious that the UE will have enough time to update the phase/gain. While this is something RAN4 should address, if there are transients or processing time, this could impact the ability to support windows that are very close together in time. Therefore, we would like to leave this point FFS.

5 – Qualcomm Incorporated

Letting gNB to configure multiple TDWs might be useful. The UE may take this to be implicit indication to pursue transparent antenna switching or precoder cycling across bundles. Also, as other companies have pointed out, there is a trade-off between bundling and diversity. Letting a gNB choose a shorter TDW allows striking the right balance.

6 – InterDigital France R&D

Assuming down-selection happens during the next meeting, we are ok with the alternatives.

7 – WILUS Inc.

We share the similar view with Huawei and Ericsson. The necessity of band-biased solution is unclear. A unified window can be applied for both TDD and FDD (also include SUL case), e.g., consecutive UL slots to transmit PUSCH repetitions are determined as a window that do not exceed the maximum length, where the maximum length can be additionally configured or predefined according to UE capability. A single window is determined when consecutive UL slots exceed the maximum length. Otherwise, multiple windows are determined at the boundary of maximum length.

8 – China Mobile Com. Corporation

We share similar view that we need a unified design and as band or XDD agnostic. And from our thinking, we should avoid the case that the JCE window (no matter single or multiple window) is shorter than repetition. It means that, for some repetitions the JCE are not indicated at all and parts of repetitions could use JCE and the other parts cannot.

Similar view that the down selection should be scheduled to the next meeting, considering this is new proposal and we do not have much time to discuss.

9 – Samsung Electronics Co.

Seeing large commonality between Proposal 13 and 14, it would be better to make a generalized proposal. See the detailed comment under proposal 14.

10 – vivo Communication Technology

Suggest to discuss the case of unpaired spectrum first, which seems more complicated. JCE on paired spectrum can reuse the framework from paired spectrum by not considering some factors, e.g. DL/UL configuration.

11 – Panasonic Corporation

We also prefer to have a unified solution to cover both paired and unpaired bands. We are not clear the reason why the concept of non-consecutive windows only depends on DL/UL configurations.

12 – SHARP Corporation

We are OK with FL proposal. We prefer Alt 2. Multiple windows would be required if the maximum duration is shorter than the number of repetitions.

13 – NTT DOCOMO INC.

We prefer unified approach for paired spectrum and unpaired spectrum.

Even though at most two UL consecutive slots are assumed as target scenarios for CovEnh, there is no harm to have explicit indications for unpaired spectrum.

14 – Nokia Solutions & Networks (I)

As pointed out by the majority, we should strive to have a unified design for both paired and unpaired spectrum, if possible. Combining Proposals 13 and 14 into a generic proposal as suggested by Samsung could be a good starting point to this end. In addition, if companies need time to check before making down-selection in the next meeting, we are also fine to add ”Other alternatives are not precluded” as suggested by Qualcomm.

15 – Motorola Mobility Germany GmbH

We agree with the companies that we should strive for a unified design for both the unpaired and paired spectrum, as much as possible. We support the suggestion by Samsung

16 – Shenzhen YZF Network Technolog

[OPPO] We also agree to have a unified design between FDD and TDD.

17 – ZTE Corporation

It’s not very clear to us whether the time domain window is the one configured by gNB or the one explicitly determined by the requirements to maintain phase continuity after gNB configuration. In addition, we also agree to have a unified design for both TDD and FDD, as the PUSCH transmissions could also be non-consecutive for FDD.

18 – LG Electronics Inc.

As we are currently in the discussion on whether to support different TB or not, this proposal should be about same TB. It should be clarified, and since the operation to report the maximum duration is currently FFS, it is better to subtract the second bullet of Alt.2 for now.

19 – Beijing Xiaomi Mobile Software

We support to have a unified design for TDD and FDD firstly. As for Alt 2, we don’t think multiple time windows must be consecutive.

Proposal 14: Down select the following alternatives:

For joint channel estimation for PUSCH repetition type A for unpaired spectrum.

Alt 1: Single time domain window covers all the repetitions

- The start of the window is the first PUSCH transmission

- FFS: how to handle non-consecutive physical slots for UL transmission due to DL/UL configuration

- FFS: how to handle the case if the maximum duration is shorter than the length of the window, e.g., sub-window.

Alt 2: One or multiple time domain windows covers all the repetitions

- The start of the first window is the first PUSCH transmission

- Multiple windows depends on DL/UL configuration

Alt 3: One or multiple time domain windows covers all the repetitions

- The start of the first window is the first PUSCH transmission

- Multiple windows are consecutive.

- The length of each window is not longer than the maximum duration.

- FFS: how to determine the length of each window

- FFS: how to handle non-consecutive physical slots for UL transmission due to DL/UL configuration

Feedback Form 32: Comments on proposal 14

1 – CATT Thanks FL for the guidance. But we are not sure it's a proper time to do the down-selection. To us, several issues are still not clear. For example, one issue is, if TDW=3 slots, but only 2 repetitions are scheduled in the first 2 slots, will the UE required to maintain power and phase in the 3rd slot? And, if possible, we prefer a unified manner to apply time domain window for both paired and unpaired spectrum.
2 – China Telecommunications @CATT, we are not going to make down selection in this meeting. The main purpose it to make each alternative clear and make down selection in the future meetings. A unified solution is desired, but it seems not easy before companies align the understandings for each alternative.
3 – Ericsson LM We think 'FFS: how to handle the case if the maximum duration is shorter than the length of the window, e.g., sub-window.' from Alt 1 should also apply to Alts 2 & 3, since the minimum window size can be smaller than the window size in the multiple window case. In such cases, if the window is split into smaller windows, or JCE does not apply, etc. need to be determined. Regarding Alt 1, we think the FFS can be replaced with a narrower description: Alt 1: Single time domain window covers all the repetitions
- The start of the window is the first PUSCH transmission

- ~~FFS: how to handle non-consecutive physical slots for UL transmission due to DL/UL configuration~~

- PUSCH transmissions for which UE is expected to maintain phase continuity and power consistency are determined according to phase continuity and power consistency requirements.

- FFS: how to handle the case if the maximum duration is shorter than the length of the window, e.g., sub-window.

For Alt 2, it's not clear what 'depends on UL/DL configuration means'. Is the following the intention?

- Each window consists of at least two adjacent uplink slots according the UE's DL/UL configuration

For Alt 3, If multiple windows are exactly back to back, it's not obvious that the UE will have enough time to update the phase/gain. While this is something RAN4 should address, if there are transients or processing time, this could impact the ability to support windows that are very close together in time. Therefore, we would like to leave the bullet 'Multiple windows are consecutive' FFS.

4 – Qualcomm Incorporated

Does DL/UL configuration include the cases of intervening uplink transmissions and DL reception?

We think the last three sub-bullets are also applicable to Alt 2.

Assuming we downselect in the next meeting, can we say other alternatives are not precluded?

5 – InterDigital France R&D

Assuming down-selection happens during the next meeting, we are ok with the alternatives. For the "Multiple windows depends on DL/UL configuration" in Alternative 2, just to be on safe side, we may replace it with "FFS : details related to dependency of configurations of time windows on DL/UL configuration" to understand better about how one/multiple windows can be configured depending on the DL/UL configuration. One of the relevant working assumptions for this discussion is "For the non-back-to-back PUSCH transmissions, it is defined as at least when there is no UL transmission between the two successive PUSCH transmissions." In addition, as Qualcomm suggested, we also support to indicate in the proposal that other alternatives are not precluded.

6 – WILUS Inc.

Same comment with Proposal 13.
A unified window can be applied for both TDD and FDD (also include SUL case), e.g., consecutive UL slots to transmit PUSCH repetitions are determined as a window that do not exceed the maximum length, where the maximum length can be additionally configured or predefined according to UE capability. A single window is determined when consecutive UL slots exceed the maximum length. Otherwise, multiple windows are determined at the boundary of maximum length.

7 – Samsung Electronics Co.

We envision that if the duration of all PUSCH repetitions is larger than the time domain window, multiple time domain windows are needed to perform joint channel estimation. Otherwise, single time domain window is used.

Regarding the Alt.3, we think that the 2nd sub-bullet should be removed. The 2nd sub-bullet "Multiple windows are consecutive" is related to the last FFS. We don't think that there is any need to make such restriction especially in the case of unpaired spectrum.

To align the Alt.2 with Alt.3, we would like to suggest to put the Alt.3's last three sub bullets into Alt.2.

As we commented for proposal 13, we suggest to combine above proposal 13 and 14 into single proposal:

Combined Proposal 13&14

For joint channel estimation for PUSCH repetition type A for ~~paired spectrum and unpaired spectrum~~.

-

Alt 1: Single time domain window covers all the repetitions

- The start of the window is the first PUSCH transmission

 FFS: how to handle the case if the maximum duration is shorter than the length of the window, e.g., sub-window.

 FFS: how to handle non-consecutive physical slots for UL transmission due to DL/UL configuration in the case of unpaired spectrum.

-

Alt 2: One or multiple time domain windows covers all the repetitions

 The start of the first window is the first PUSCH transmission

 The length of each window is no longer than the maximum duration.

 In the case of unpaired spectrum, multiple windows depend on DL/UL configuration

 FFS: how to determine the length of each window

 FFS: how to handle non-consecutive physical slots for UL transmission due to DL/UL configuration in the case of unpaired spectrum.

-

Alt 3: One or multiple time domain windows covers all the repetitions

 The start of the first window is the first PUSCH transmission

 ~~Multiple windows are consecutive~~.

 The length of each window is no longer than the maximum duration.

 FFS: how to determine the length of each window

 FFS: how to handle non-consecutive physical slots for UL transmission due to DL/UL configuration in the case of unpaired spectrum.

---

8 – vivo Communication Technology

Alt 3 is aligned with what we have in mind, with minor revision as follows. Since, it is difficult to restrict the multiple windows to be consecutive in TDD spectrum.

 Alt 3: One or multiple time domain windows covers all the repetitions

 The start of the first window is the first PUSCH transmission

 Multiple windows are consecutive or non-consecutive.

 The length of each window is not longer than the maximum duration.

 FFS: how to determine the length of each window

 FFS: how to handle non-consecutive physical slots for UL transmission due to DL/UL configuration.

9 – Panasonic Corporation

Please refer to our above comment for the proposal 13.

10 – China Mobile Com. Corporation

As commented in the last proposal, We should try to avoid the situation that the allocated TDW longer than the maximum duration.

If a single and long window is allocated, the single window could be divided into multiple windows considering the DL-UL configuration. And the multiple windows may have different size. Then from the point of multiple windows allocation, it is not easy to indicate the starting point and length of the windows.

We may also think some implicit window indication based on indicated repetitions and UL-DL configurations could work in this situation. And in the TDD band, single window could be divided autonomously. And in the FDD and SUL, the single window could directly work. Currently we do not have any preference for the single or multiple windows.

11 – Nokia Solutions & Networks (I)

As pointed out by the majority, we should strive to have a unified design for both paired and unpaired spectrum, if possible. Combining Proposals 13 and 14 into a generic proposal as suggested by Samsung could be a good starting point to this end. In addition, if companies need time to check before making down-selection in the next meeting, we are also fine to add ”Other alternatives are not precluded” as suggested by Qualcomm.

12 – Motorola Mobility Germany GmbH

We support the combined proposal from Samsung

13 – Shenzhen YZF Network Technolog

[OPPO] even for TDD, may be different alts may be needed for different cases. So, here the target shall not be down-select to one alt.

we also propose other alternatives shall not be precluded.

14 – Apple Computer Trading Co. Ltd

For Alt2, we think the time domain window size is the same as the number of consecutive UL slots in the TDD UL-DL pattern. According to current specification, only one or two TDD UL-DL patterns can be configured. Then correspondingly there are one or two time domain windows for this alternative.

-

Alt 2: One or ~~multiple~~ two time domain windows covers all the repetitions

15 – ZTE Corporation

Fine to combine proposal 13 and 14 together. Alt 3 is more aligned with our thinking and we agree with the updates from vivo on Alt 3.

16 – LG Electronics Inc.

Like the previous proposal, it should be specified that it is for the same TB, and sub-bullets related to the maximum duration should be excluded.

17 – Beijing Xiaomi Mobile Software We prefer alt 3.

FL comments: Based on the comments from vivo during the GTW session, the main bullet is rephrased in the same manner as the agreements for PUCCH.

Proposal 11:

~~Joint channel estimation for PUSCH transmissions is enabled or disabled via RRC configuration.~~

Subject to the prerequisites of joint channel estimation for PUSCH transmissions, support enabling joint channel estimation for PUSCH transmissions via RRC configuration.

- FFS: whether additional dynamic signaling is needed to enable/disable joint channel estimation for PUSCH transmissions.

Note: Enabling/disabling of joint channel estimation for PUSCH transmissions means enabling/disabling of DMRS bundling for PUSCH transmissions under the condition of power consistency and phase continuity.

Feedback Form 33: Comments on proposal 11

1 – Intel Deutschland GmbH we are fine with the proposal. Or we can explicitly say ”subject to power consistency and phase continuity requirements”. either way is fine with us
2 – CATT Fine with the proposal.
3 – Ericsson LM We support the original version (i.e. with the 1st bullet as “Joint channel estimation for PUSCH transmissions is enabled or disabled via RRC configuration”). If the prerequisites refer to e.g. same mcs/power/antenna port, no DL reception, etc, these may be dynamically determined and so should not a prerequisite for JCE. We can be open to an FFS, e.g. “FFS: if enabling joint channel estimation for PUSCH transmission is subject to any prerequisites”
4 – Qualcomm Incorporated Support
5 – InterDigital France R&D We support the FL’s proposal.
6 – WILUS Inc. We are fine with the proposal.

7 – Samsung Electronics Co.

Support the proposal.

8 – vivo Communication Technology

fine with the proposal

9 – Panasonic Corporation

RAN1 agreed the following in the past.

Working assumption:

- For back-to-back PUSCH transmissions across consecutive slots, support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following case:
  - Over back-to-back PUSCH transmissions for ~~TB processing~~ one TB processed over multiple slots
    - It's subject to UE capability

"Joint channel estimation for PUSCH transmission" is gNB operation. Instead of "DMRS banding", our preference is to follow the previous agreement. So we propose to modify note as follows

Note: Enabling/disabling of joint channel estimation for PUSCH transmissions means enabling/disabling of ~~DMRS bundling for PUSCH transmissions~~ the design aspects to enable joint channel estimation under the condition of power consistency and phase continuity.

10 – SHARP Corporation

We support FL proposal.

11 – China Mobile Com. Corporation

fine with the current version.

12 – Nokia Solutions & Networks (I)

Support the FL's proposal.

13 – NTT DOCOMO INC.

Support the proposal

14 – Motorola Mobility Germany GmbH

Support the proposal

15 – Shenzhen YZF Network Technolog

[OPPO]support

16 – ZTE Corporation

Support the proposal.

17 – LG Electronics Inc.

From our understanding, DMRS bundling and joint channel estimation is the operation of gNB, and it is the time domain window for joint channel estimation that related to UE behavior. In order to avoid confusion in terms, it would be good to clarify them well.

18 – Beijing Xiaomi Mobile Software

Fine with the proposal

19 – HUAWEI TECHNOLOGIES Co. Ltd.

In our understanding, enabling joint channel estimation contains two steps,

1) a mode of joint channel estimation is configured by RRC

2) If time window is implicitly derived, then subjects to RAN4 requirements on phase contiguity, the functionality of joint channel estimation is enabled during the derived time window. If time window is explicitly indicated, once the mode of JCE is configured, the UE may monitor a DCI for the information of time window requested by a gNB. With the information of time window and subject to RAN4 requirements, the functionality of JCE is enabled during the indicated time window.

With this understanding, we share similar view with Ericsson that the RRC configuration is not subject to prerequisite of JCE, but it is up to gNB.

Also the meaning of the prerequisites is unclear here. It seems to refer to RAN4 requirements or time window or both.

Therefore, we sugguest,

”A mode of joint channel estimation for PUSCH transmissions is configured by RRC configuration. If the mode is configured, enabling joint channel estimation for PUSCH transmissions is subject to the prerequisites of joint channel estimation for PUSCH transmissions. FFS: details of the prerequisites”

FL comments: The intention of proposal 11a is to exclude the case that joint channel estimation is enabled while the time domain window is disabled. To avoid mis-understanding, the sub-bullets are removed.

Proposal 11a:

For joint channel estimation for PUSCH, the time domain window is not explicitly enabled or disabled separately from joint channel estimation.

Feedback Form 34: Comments on proposal 11a

1 – Intel Deutschland GmbH

we are fine with the proposal

2 – CATT

Fine with the proposal.

3 – Ericsson LM

Support the proposal

4 – Qualcomm Incorporated

Support

5 – InterDigital France R&D

For the proposal, would it be better to use the clarification text from the FL? For us, it is easier to understand the intention of the proposal. We propose the following modified proposal:

Proposal : Joint channel estimation should not be enabled when the time domain window is not enabled.

6 – WILUS Inc.

We are fine with the modification of InterDigital.

7 – Samsung Electronics Co.

Based on the FL's comments, we do not see that this use case is feasible. From our perspective, if joint channel estimation is enabled, the time domain window is determined either explicitly configured or implicitly derived.

No need for the above proposal.

8 – vivo Communication Technology

In our understanding time domain window is configured to UE which allows JCE at gNB, as we commented earlier we don't think separate RRC parameter for enabling/disabling of JCE is needed. Is this proposal assuming there are 2 separate parameters? Even with proposal from IDC, it is not clear whether there is 1 parameter or 2 parameters?

9 – Panasonic Corporation

We support the proposal 11a.

10 – China Mobile Com. Corporation

Support

11 – NTT DOCOMO INC.

We are fine with the modification of InterDigital.

12 – Nokia Solutions & Networks (I)

Support the FL's proposal.

13 – Motorola Mobility Germany GmbH

Support the proposal

14 – Shenzhen YZF Network Technolog [OPPO]support
15 – ZTE Corporation Fine with the proposal.
16 – LG Electronics Inc. Support the proposal.
17 – Apple Computer Trading Co. Ltd We are fine with this proposal.
18 – Beijing Xiaomi Mobile Software Support the proposal
19 – HUAWEI TECHNOLOGIES Co. Ltd. We may not fully understand the proposal but we don't feel the proposal is necessary before we have consensus on explicit or implicit indication for time window for the following reason, 1) In case of implicit indication, once the mode of JCE is configured, and a series of PUSCH transmissions is scheduled, both a UE and a gNB have the same understanding on the duration when a JCE can be performed. So the proposal is not needed. 2) In case of explicit indication, once the mode of JCE is configured, a UE monitors a DCI or something to get a time window. If the UE receives no DCI or a DCI indicating explicitly no need of time window, time window is kind of disable for the concerned PUSCH transmission. The proposal seems to preclude this case.

6 Reference

3GPP RP-202928, "New WID on NR coverage enhancements", China Telecom, RAN#90e, December 7th – 11th, 2020.

3GPP RP-210855, "Revised WID on NR coverage enhancements", China Telecom, RAN#91e, March 16th – 26th, 2021.

3GPP R1-2009784, "LS on PUCCH and PUSCH repetition", Qualcomm, RAN1#103-e, October 26th – November 13th, 2020.

3GPP R4-2103393, "Reply on LS on PUCCH and PUSCH repetition", Qualcomm, RAN4#98-e, January 25th – February 5th, 2021.

3GPP R4-2105417, "Reply LS on PUCCH and PUSCH repetition", Qualcomm, RAN4#98b-e, April 12th – 20th April, 2021.

R1-2104241 Discussion on joint channel estimation for PUSCH Huawei, HiSilicon

R1-2104332 Discussion on joint channel estimation for PUSCH ZTE

R1-2104378 Discussion on Joint channel estimation for PUSCH vivo

R1-2104437 Discussion on joint channel estimation for PUSCH Spreadtrum Communications

R1-2104539 Discussion on joint channel estimation for PUSCH CATT

R1-2104627 Discussion on joint channel estimation for PUSCH CMCC

R1-2104687 Joint channel estimation for PUSCH Qualcomm Incorporated

R1-2104794 Consideration on Joint channel estimation for PUSCH OPPO

R1-2104848 Discussion on joint channel estimation for PUSCH China Telecom

R1-2104861 Joint channel estimation for PUSCH InterDigital, Inc.

R1-2104882 Discussion on joint channel estimation for PUSCH TCL Communication Ltd.

R1-2104921 Discussion on joint channel estimation for PUSCH Intel Corporation

R1-2105121 Discussion on joint channel estimation for PUSCH Apple

R1-2105176 Joint channel estimation for PUSCH Sony

R1-2105327 Joint channel estimation for PUSCH Samsung

R1-2105394 Discussion on joint channel estimation for PUSCH MediaTek Inc.

R1-2105397 Discussion on joint channel estimation for PUSCH Panasonic Corporation

R1-2105490 Discussions on joint channel estimation for PUSCH LG Electronics

R1-2105509 Design Considerations for Joint channel estimation for PUSCH Sierra Wireless, S.A.

R1-2105577 Joint channel estimation for PUSCH Xiaomi

R1-2105642 Joint channel estimation for multi-slot PUSCH Sharp

R1-2105654 Joint Channel Estimation for PUSCH Ericsson

R1-2105713 Joint channel estimation for PUSCH NTT DOCOMO, INC.

R1-2105775 Enhancements for joint channel estimation for multiple PUSCH Lenovo, Motorola Mobility

R1-2105879 Discussion on joint channel estimation for PUSCH WILUS Inc.

R1-2105903 Joint channel estimation for PUSCH coverage enhancements Nokia, Nokia Shanghai Bell