**3GPP TSG RAN WG1 #107-e R1-21xxxxx**

**e-Meeting, November 11th – 19th, 2021**

**Agenda Item: 8.8.1.3**

**Source: Moderator (China Telecom)**

**Title: [107-e-NR-R17-CovEnh-03] Email discussion regarding 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]*
		- *When applicable, based on similar mechanism(s) for enabling joint channel estimation for PUSCH*
* *Specify mechanism(s) to support Type A PUSCH repetitions for Msg3 [RAN1, RAN2]*

This contribution is a summary of the following email discussion.

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

* 1st check point: November 15
* Final check point: November 19
1. Summary of contributions

## 2.1 Conditions to keep power consistency and phase continuity

Based on the LSs between RAN1 and RAN4 [3]-[10], the conditions for UE to keep power consistency and phase continuity among PUSCH transmissions for different scenarios can be summarized as follows:

**Back-to-back transmissions with zero gap in-between adjacent transmissions**

In order to maintain phase continuity, the following conditions should be met:

* Modulation order does not change.
* RB allocation in terms of length and frequency position should not be changed, and intra-slot and inter-slot frequency hopping is not enabled within a repetition bundle.
* No change on transmission power level of its own CC, i.e., no change on the power control parameters specified in TS 38.213, and also when own CC is not impacted by other concurrent CC(s) that are configured for inter-band CA or DC for same UE with dynamic power sharing and no change in any configured CC s that are part of configured intra-band uplink CA or DC.
* No UL beam switching for FR2 UE occurs.
* Applying the same TPMI precoder across PUSCH transmissions.
* TA adjustment and UE uplink timing autonomous adjustments cause the phase to change. RAN4 is still investigating the full impacts of the detailed scenarios, and will provide a final view about this at the next RAN4 meeting.

**Non-back-to-back transmission with non-zero gap in-between adjacent transmissions**

For non-back-to-back transmission with non-zero gap in-between adjacent transmissions, RAN4 concluded that at least following additional condition also need to be met in addition to the conditions for Back-to-back transmissions:

* No downlink reception in-between the PUSCH or PUCCH repetition in the same band for TDD case.
	+ The “downlink reception” means downlink symbols with actual DL transmission from gNB to UE and/or DL monitoring with the assumption that UE is receiving information.
	+ Regarding whether “downlink reception” include downlink symbols without actual DL transmission from gNB to UE and without DL monitoring, it would be helpful if RAN1 could provide more information on the exact scenario.
	+ Phase discontinuity tolerance LLS is ongoing in RAN4 study and conditions of whether the phase continuity can be maintained in TDD case that has downlink reception in-between the PUSCH or PUCCH repetition could be revisited in future meeting with consideration of phase discontinuity tolerance. RAN4 is also still checking whether there are any optional UE antenna configurations where a UE could overcome this problem and still gain from using the feature.
* In scenario of no more than X un-scheduled OFDM symbols in-between the PUSCH or PUCCH repetition (e.g., X = 0, 1, 2, …, 14), RAN4 confirms the feasibility of phase continuity and power consistency 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. RAN4 has further agreed that the 13-symbol is the maximum length for the gap for all SCS, and that the 14-symbol or 1ms will not be discussed in RAN4 anymore for un-scheduled gap in Rel-17 [8].
* In scenario of other UL channels in-between PUCCH or PUSCH repetitions, e.g., SRS or other PUCCH, at least if the other scheduled signals/channels during the non-zero gap have the same settings in antenna port, allocated number and locations of PRBs transmitted, and PAPR and average power, e.g., PUSCH/PUCCH part of repetitions and SRS has same PAPR and average power, it is feasible to maintain the phase continuity and power consistency across the repetitions. RAN4 has agreed that it is not considered for UE to transmit other channels in the gap with different settings.
* RAN4 has not agreed detailed requirement for phase continuity and plans to revisit the above agreement in the scenario of other UL signals/channels in the gap once the requirement is defined. Therefore, RAN4 would like to ask RAN1 what are the consequences if phase continuity cannot be maintained in that scenario?

In [10], RAN1 provide the following information to RAN4 on the scenario when “downlink reception” from UE point of view includes downlink symbols without actual DL transmission from gNB to UE and UE is not assumed to do DL monitoring:

* In RAN1 understanding, regarding to the “downlink reception”, there are actually three scenarios:
	+ Scenario 1: downlink or flexible symbols with actual DL transmission from gNB to UE, with/without DL monitoring occasion configured.
	+ Scenario 2: downlink or flexible symbols without actual DL transmission from gNB to UE, but with DL monitoring occasion configured.
	+ Scenario 3: downlink or flexible symbols without DL monitoring occasion configured.

RAN1 further respectfully asks RAN4 to provide answer to the following question.

* Question 1: In additional to scenario 1 and 2, does the “downlink reception” in RAN4 reply LS R4-2103393 (“No downlink reception in-between the PUSCH or PUCCH repetition in the same band for TDD case”) further include scenario 3?

In [11], RAN1 provides the answer to RAN4:

* If phase continuity cannot be maintained in the case of UL transmissions of other signals/channels in the repetition gap, then DM-RS symbols transmitted before and after the transmission of such other signals/channels cannot be part of the same bundle from UE perspective. A new DMRS bundle may or may not start after the other UL signals/channel transmission in the repetition gap. Details are still under discussion in RAN1.

**The maximum duration**

In the latest LS from RAN4 [9], RAN4 replied RAN1’s questions related to the maximum duration and provided further agreement for the gap between PUSCH/PUCCH transmissions, details are listed as follows:

|  |  |
| --- | --- |
| **RAN1’s questions** | **RAN 4’s answers** |
| 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? | Yes, there is a maximum duration but RAN4 has not agreed how many slots it is. |
| What factors determine the maximum duration? | RAN4 has agreed that TA adjustment should be avoided across the PUSCH/PUCCH transmissions (i.e., from start of first transmission until the end of last transmission) for joint channel estimation. RAN4 is still investigating other factors impact in more detail. |
| Whether the maximum duration should be the same for different cases for both PUSCH and PUCCH? | Yes. |
| Whether the maximum duration is dependent on the modulation order of transmission, e.g., QPSK, 16QAM, 64QAM? | Considering the scenario of coverage extension, RAN4 recommends to only focus on modulation orders not higher than QPSK, i.e., focus on QPSK (PUCCH and PUSCH), Pi/2 BPSK (PUCCH and PUSCH), BPSK (PUCCH). RAN4 is still discussing whether maximum duration depends on modulation order for the above modulation schemes. |
| Whether the maximum duration is dependent on UL waveform (DFT-s-OFDM vs. OFDM)? | No. |
| Besides the factors listed above, whether or not the maximum duration is further dependent on UE capabilities (e.g., multiple possible values for a given set of factor(s)), and if so, whether the UE should report such a duration. | Still under discussion in RAN4. |

## 2.2 Use cases for joint channel estimation

RAN1 has identified the potential use cases for joint channel estimation for PUSCH.

* Use case 1: back-to-back PUSCH transmissions within one slot.
* Use case 2: non-back-to-back PUSCH transmissions within one slot.
	+ Use case 2a: no uplink transmission in the middle of two PUSCH transmissions
	+ Use case 2b: other uplink transmissions in the middle of two PUSCH transmissions
* Use case 3: back-to-back PUSCH transmissions across consecutive slots.
* Use case 4: non-back-to-back PUSCH transmissions across consecutive slots.
	+ Use case 4a: no uplink transmission in the middle of two PUSCH transmissions
	+ Use case 4b: other uplink transmissions in the middle of two PUSCH transmissions
* Use case 5: PUSCH transmissions across non-consecutive slots.
	+ Use case 5a: no uplink transmission in the middle of two PUSCH transmissions
	+ Use case 5b: other uplink transmissions in the middle of two PUSCH transmissions

Note: RAN1 assumes “back-to-back PUSCH transmission” has zero gap in-between adjacent PUSCH transmissions.

Note: intervening “other uplink transmissions” can be either on the same component carrier or a different component carrier.

In the past RAN1 meetings, it was discussed whether joint channel estimation can be applied to the above uses cases. In addition, during online discussion of RAN1 #106-e meeting, according to the guidance from Chair there would be no further discussion for transmissions with different TBs. Based on the discussion and agreements so far, the situation is summarized in the following table.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Use cases | Repetition type A for the same TB | Repetition type B for the same TB | Transmissions with different TBs | TBoMS |
| 1: B2B PUSCH transmission within one slot | / | Support | Not support | / |
| 2: Non-B2B PUSCH transmission within one slot | / | Not support | Not support | / |
| 3: B2B PUSCH transmissions across consecutive slots | Support | Support | **No further discussion** | Support |
| 4: Non-B2B PUSCH transmissions across consecutive slots | Support(4a) | Support(4a) | **No further discussion** | Support(4a) |
| TBD(4b) | TBD(4b) | TBD(4b) |
| 5: PUSCH transmissions across non-consecutive slots | Not support | Not support | Not support | Not support |

Thus, only Use case 4b remains to be discussed.

### 2.2.2 Use case 4b

For Use case 4b (other uplink transmissions in the middle of two PUSCH/PUCCH transmissions), there exist two sub-cases and companies’ views on the sub-cases are summarized as follows:

* **Use case 4b-1**: other UL transmission in the middle of two PUSCH/PUCCH transmissions has the same setting with PUSCHs.

**Support**: Nokia, NSB, TCL, CTC, xiaomi

**Not support**: LG, HW, HiSilicon, ZTE, Qualcomm, Ericsson, Sharp, CATT, WILUS, Panasonic

* **Use case 4b-2**: other UL transmission in the middle of two PUSCH/PUCCH transmissions has different settings than PUSCHs.

**Not support**: Nokia, NSB, vivo, CTC, xiao mi, CMCC, Sharp, LG, HW, HiSilicon, ZTE, Intel, Qualcomm, Ericsson, Sharp, CATT, WILUS, Panasonic

In RAN1 #106b-e, four options were discussed to handle Use case 4b-2 as follows:

* Option 1: Adapt the settings of the other UL transmission to make it be the same as PUSCHs.
* Option 2: Multiplex the data of the other UL transmission on PUSCH, if any.
* Option 3: Drop the other UL transmission with different settings.
* Option 4: Transmit the other UL transmission with different settings and break the phase continuity.

Based on the discussion in RAN1 #106b-e and contributions in RAN1#107-e, two companies (vivo, Panasonic) support Option 3 while majority companies (vivo, Panasonic, HW, HiSilicon, xiaomi, CTC, CATT, CMCC, Samsung, TCL, Lenovo, Motorola Mobility, Intel, Qualcomm, Panasonic, Sony) support Option 4.

### 2.2.4 Use case for UL CA

One company (ZTE) analyzes the benefit of using two carriers w/ Tx switching over single carrier under UL CA scenario. As shown in the following figure, there are two inter-band carriers with unaligned frame boundary. This is one main important deployment scenario and supported in Rel-16. It is also pointed out that the phase continuity can be kept for CA at least when PUSCH is only transmitted in one carrier at a given time.



Fig. Tx switching with unaligned frame boundary for CA

## 2.3 Time domain window for joint channel estimation

In RAN1 #104b-e meeting, a time domain window (TDW) was agreed to be specified, during which **UE is expected to** maintain power consistency and phase continuity among PUSCH transmissions subject to power consistency and phase continuity requirements. In RAN1 #105-e meeting, the maximum duration is defined to facilitate the discussion (whether it is specified is up to RAN4), during which **UE is able** to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements. In RAN1 #106-e meeting, a working assumption for the framework of TDW was achieved.

### 2.3.1 Configured time domain window

#### Issue #1: The window length *L* of the configured TDW

#### Issue #1-1: The maximum value of L

During past RAN1 meetings, it has been extensively discussed whether the maximum value of the window length *L* of the configured TDW(s) can be longer than the maximum duration during which UE is able to maintain power consistency and phase continuity. In RAN1 #106b-e, it was further discussed whether default value of *L* should be defined and the following agreement was achieved:

|  |
| --- |
| **Agreement:**Down-select one of the following options in this meeting:**Option 1**: * The maximum value of window length *L* of the configured TDW should not exceed the maximum duration, which is reported as UE capability as the duration where UE is able to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.

**Option 1’:** * The maximum value of window length L of the configured TDW should not exceed the maximum duration, which is reported as UE capability as the duration where UE is able to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.
	+ - If L is not configured, default behavior should be defined, e.g., the configured TDW length is equal to all repetitions

**Option 3’**: * Whether the window length *L* of the configured TDW can be longer than maximum duration is subject to UE capability.
	+ If UE is capable of *L* being longer than maximum duration,
		- The maximum value of the window length *L* of the configured TDW is the duration of all repetitions.
			* FFS: whether *L* cannot be other values other than the duration of all repetitions, if it is longer than the maximum duration.
		- If *L* is longer than the maximum duration, UE does not expect dynamic events.
			* FFS: details of dynamic events
 |

It was further discussed on above options via email and it seems companies tend to converge on option 1’:

|  |
| --- |
| **Option 1’-a:*** The maximum value of window length L of the configured TDW should not exceed the maximum duration, which is reported as UE capability as the duration where UE is able to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.
	+ - If L is not configured, the default value ~~and default behavior are~~ is to be discussed, with default value not exceeding the maximum duration.

**Option 1’-b:*** The maximum value of window length L of the configured TDW should not exceed the maximum duration, which is reported as UE capability as the duration where UE is able to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.
	+ - If L is not configured, the default value and default behavior are to be discussed, ~~with~~ where default value may or may not exceed~~ing~~ the maximum duration.
 |

Companies’ views on the above options are summarized as follows:

**Companies supporting Option 1**: Spreadtrum, NTT DOCOMO, LG, ZTE, CATT(1st), Intel, InterDigital, Qualcomm, MediaTek, vivo

**Companies supporting Option 1’**: CTC, CMCC, Sharp, LG, Lenovo, Motorola Mobility, Nokia, NSB, OPPO, Apple, Panasonic, xiaomi, Samsung, Sierra Wireless, HW, HiSilicon, CATT(2nd) , Qualcomm, WILUS, Ericsson

**Companies supporting Option 1’-a**: Panasonic, xiaomi, Samsung, Sierra Wireless, HW, HiSilicon, CATT(2nd) , Qualcomm, WILUS, Ericsson, CMCC

**Companies supporting Option 1’-b**: CTC, Sharp, Nokia, NSB, OPPO, Apple

**Apple** proposes to update Option 1’ and Option 3’ as:

|  |
| --- |
| **Updated Option 1’:** * The maximum value of window length L of the configured TDW should not exceed the maximum duration, which is reported as UE capability as the duration where UE is able to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.
	+ - If L is not configured, default behavior should be defined, ~~e.g., the configured TDW length is equal to all repetitions~~ i.e., TDW length and starting position of the TDW adapt to UL slots in UL/DL configuration.

**Updated Option 3’:** * Whether the window length L of the configured TDW can be longer than maximum duration is subject to UE capability.
* If UE is capable of *L* being longer than maximum duration, the maximum duration is consider as an event
* The maximum value of the window length *L* of the configured TDW is the duration of all repetitions.
* ~~FFS: whether~~ *~~L~~* ~~cannot be other values other than the duration of all repetitions, if it is longer than the maximum duration.~~ The TDW length and starting position of the TDW adapt to UL slots in UL/DL configuration.
* ~~If~~ *~~L~~* ~~is longer than the maximum duration, UE does not expect dynamic events.~~
* ~~FFS: details of dynamic events~~
 |

Nokia: The issue of error propagation, if any, could be handled by the gNB using at least one of the following options:

* If the gNB anticipates that there is a chance of missing DCI, it may configure a short configured TDW size L such that the impact of error propagation is minimized.
* The gNB may try to detect the dynamic event and know whether the actual TDWs are determined without or with the dynamic event by the UE and perform JCE accordingly.
* The gNB may apply a conservative approach by performing JCE only on the PUSCHs repetitions that are not impacted by the error propagation.

**Ericsson:** When L is not configured the value of L is set to the lesser of the maximum duration and the duration of the PUSCH repetition.

**Ericsson** analyzes the probability of length of actual TDWs and have the following observations.

* Whether L is larger than the maximum duration may not have a big impact on ATDW length
	+ Allowing L > max duration can increase the probability of longer window lengths
	+ Careful choice of L can also increase the probability of longer window lengths
	+ The choice L does not affect smaller window sizes, at least when both L and the max duration is a significant fraction of the number of repetitions.

**Ericsson** discusses the issue of possible segment of UL slots for TDD and have the following observations.

* Requiring L ≤ max duration can in principle prevent JCE over some TDD back-to-back slots, if PUSCH repetition type A counting based on physical slots is used.
* It seems such issues can be avoided by instead using PUSCH repetition type A counting based on available slots and/or by supporting max duration ≥ 5 slots.
	+ Hence, L > max duration is not needed to support specific TDD configurations, and its complications can be avoided.





**Qualcomm:**

Default UE behaviour when $L$ is not configured, or when $L$ exceeds the duration of PUSCH Type A repetitions is specified as follows. Let max duration indicated by the UE be $D$ and let the number of PUSCH/PUCCH repetitions be $M$. To differentiate between the configured value of $L$ and the actual value of $L$, denote the parameters as $L\_{actual}$ and $L\_{config}$. Assume all parameters are in units of slots.

Case (i) value of $L$ is not configured i.e., $L\_{config}$ is not available:

1. In this case, set $L\_{actual}=min⁡(M,D)$.

Case (ii) value of L is configured i.e., $L\_{config}$ is available to the UE and $L\_{config}\leq D$:

1. If value of $L\_{config}$ exceeds the total repetitions, i.e., $ L\_{config}>M$,
	1. in this case set $L\_{actual}=M$.
2. Number of repetitions exceeds $L\_{config}$,
	1. in this case, $L\_{actual} = L\_{config}$.

#### Issue #1-2: Configuration/Indication of L

In RAN1 #106b-e, following agreements were achieved for the configuration/indication of configured window length L:

|  |
| --- |
| **Agreement*** For DG-PUSCH, Type1 CG-PUSCH and Type2 CG-PUSCH, the window length L of the configured TDW is at least configured by RRC.
* FFS: For DG-PUSCH and Type2 CG-PUSCH, whether the window length *L* of the configured TDW can be indicated by DCI or indicated by TDRA table with one additional entry.

**Agreement*** The window length L of the RRC configured TDW is configured separately for PUSCH and PUCCH.
	+ For PUSCH, *L* is configured per BWP.
* FFS whether the window length L can be configured with each row in the TDRA table
 |

The remaining issue is whether the configured window length L can be configured/indicated dynamically by DCI or TDRA table. Companies’ views are summarized as follows:

**Companies supporting DCI indication:** Spreadtrum

**Companies supporting TDRA indication:** Panasonic, NTT DOCOMO

**Companies not supporting dynamic indication:** Nokia, NSB, Samsung, Lenovo, Motorola Mobility, HW, HiSilicon

NTT DOCOMO analyses the benefit of dynamic indication of L: for semi-static window length indication, only single value can be configured regardless of the number of allocated slots for one TB. This restriction cannot provide the desired window length based on time domain resource allocation. One example is illustrated in the following figure showing that dynamic window length indication makes it possible to balance the length of multiple TDWs or adjust the window length so that one TDW can cover the whole duration of repetitions.



Fig. Comparison between semi-static window length indication and dynamic window length indication, when the number of allocated slots for PUSCH changes

#### Issue #1-3: Candidate values of L

Regarding the candidate value of L, LG proposes that the minimum value of L is 2. ZTE proposes the window length L of the configured TDW can be set to any integer value that is larger than 1 and no larger than the maximum duration.

#### Issue #1-4: Counting of L based on available slots

Nokia proposes one issue to clarify: For configured TDWs determination of PUSCH repetition type A counting based on available slots, RAN1 to further clarify that the configured time domain window length L is counted on available slots.

### 2.3.2 Actual time domain window

#### Issue #2: The determination of actual TDW

#### Issue #2-1: The start/end of the actual TDW

In RAN1 #106b-e, the following working assumption was achieved for the start/end of the actual window:

|  |
| --- |
| **Working assumption:*** The start of the first actual TDW is the first ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for the first PUSCH transmission in an available slot within the configured TDW.
* The end of the actual TDW is
	+ the last ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for the last PUSCH transmission in an available slot within the configured TDW if the actual TDW reaches the end of the last PUSCH transmission within the configured TDW.
	+ the last ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ of the PUSCH transmission right before the event if an event occurs that violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.
* For UE capable of restarting DM-RS bundling, the start of the new actual TDW is the first ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for PUSCH transmission after the event violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.
 |

**Spreadtrum** proposes to update the working assumption as:

|  |
| --- |
| **Working assumption:*** The start of the first actual TDW is the first symbol ~~(at least determined by TDRA table)~~ for the first PUSCH transmission in an available slot within the configured TDW.
	+ Determined by TDRA table
	+ Starting symbol of a slot
	+ Starting symbol after an event
* The end of the actual TDW is
	+ the last symbol ~~(at least determined by TDRA table)~~ for the last PUSCH transmission in an available slot within the configured TDW if the actual TDW reaches the end of the last PUSCH transmission within the configured TDW.
		- Determined by TDRA table
		- Ending symbol of a slot
	+ the last symbol (at least determined by TDRA table) of the PUSCH transmission right before the event if an event occurs that violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.
	+ For UE capable of restarting DM-RS bundling, the start of the new actual TDW is the first symbol (at least determined by TDRA table) for PUSCH transmission after the event violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.
 |

**WILUS**: If a collision occurs between DL reception/monitoring occasion and dynamically scheduled PUSCH in the set of symbols of the slot within the configured TDW, the DL reception/monitoring can be considered as not the event to determine the start of the actual TDW as illustrated in the following figure.



Fig. Actual TDW determination if a collision occurs between DL reception/monitoring occasion and PUSCH.

#### Issue #2-2: Events that violate power consistency and phase continuity

In RAN1 #106b-e, the following agreement was achieved for events that violate power consistency and phase continuity.

|  |
| --- |
| **Agreement*** Support at least the following events that violate power consistency and phase continuity.
	+ Dropping/cancellation based on Rel-15/16 collision rules.
	+ FFS: Rel-17 collision rules.
	+ DL slot or DL reception/monitoring based on semi-static DL/UL configuration for unpaired spectrum.
	+ FFS: Other UL transmission in between PUSCH/PUCCH transmissions.
	+ Gap between two PUSCH/PUCCH transmissions exceeds 13 symbols.
	+ FFS: Transmission parameters need to be changed due to network-indicated operations, including: Tx power, UL beam/TPMI, and RB allocation.
	+ FFS: TPC command.
	+ FFS: TA adjustment.
	+ FFS: The actual TDW reaches the maximum duration.
	+ FFS: Frequency hopping.
	+ FFS: Precoder cycling.
	+ FFS: other events.
	+ FFS: whether events are semi-static events or dynamic events.
	+ FFS: the time duration of an event.
 |

Regarding the FFS parts, companies’ views are summarized as follows:

|  |  |  |
| --- | --- | --- |
| **Potential events** | **Support as an event** | **Not support as an event** |
| Rel-17 collision rules | Ericsson |  |
| Other UL transmission in between two successive PUSCH/PUCCH transmissions has **different settings** than PUSCHs | Nokia, NSB, vivo, CTC, xiaomi, CMCC, Sharp, LG, HW, HiSilicon, ZTE, Intel, Qualcomm, Ericsson, Sharp, CATT, WILUS, Panasonic |  |
| Other UL transmission in between two successive PUSCH/PUCCH transmissions has the **same setting** with PUSCHs | LG, HW, HiSilicon, ZTE, Qualcomm, Ericsson, Sharp, CATT, WILUS, Panasonic | Nokia, NSB, TCL, CTC, xiaomi |
| Action of TPC commands | Spreadtrum, ZTE | vivo, OPPO, Panasonic, CTC, xiaomi, CMCC, Samsung, HW, HiSilicon, CATT, InterDigital, Nokia, NSB, Sharp, NTT DOCOMO, Intel, Ericsson, LG |
| Action of TA commands | Spreadtrum, HW, HiSilicon, ZTE，CATT(1st) | Samsung, vivo, Panasonic, CTC, xiaomi, CMCC, Apple, Sharp, CATT(2nd), InterDigital, NTT DOCOMO, Intel, Ericsson |
| The actual TDW reaches the maximum duration | It depends on whether L can be larger than maximum duration. |
| Frequency hopping | Spreadtrum, xiaomi, Sharp, ZTE, InterDigital, Ericsson, Nokia, NSB, CTC, LG, Qualcomm | vivo, CMCC, Samsung, HW, HiSilicon, NTT DOCOMO |
| Precoder cycling | Nokia, NSB | Sharp, CMCC, CATT, Ericsson |

For changing of transmission parameters and precoder cycling, companies’ views are summarized as follows:

**Transmission parameters need to be changed due to network-indicated operations, including: Tx power, UL beam/TPMI, and RB allocation.**

**Support as an event:** vivo, Spreadtrum, xiaomi, Sharp, ZTE, Intel, Qualcomm

**Not support as an event:** CMCC, Ericsson

**Nokia**: This event type would need further discussion in RAN1. At least, it is unclear what is the network-indicated operation for Tx power and what is the difference with TPC command. In addition, the difference between UL beam/TPMI and precoder cycling is unclear. Moreover, for PUSCH repetition type A (and also PUSCH repetition type B and TBoMS), it is unclear why RB allocation is changed across PUSCH repetitions.

**LG**: Discuss prioritizations for transmission power reductions with joint channel estimation.

**Precoder cycling**

**Sharp:** For precoder cycling, the UE should not implicitly change precoder for PUSCH repetitions within at least the actual TDW because the gNB cannot identify that.

**Ericsson:** In our understanding, a UE can use precoder cycling according to implementation for PUSCHs/PUCCHs that are not bundled together. This can be when DMRS bundling is not configured or between different frequency hopping positions. The gNB will not be aware of such cycling. Therefore, precoder cycling should not be an event.

**CMCC:** The precoding cycling is transparent to gNB. And precoding cycling should not be considered as an event.

Apart from the above discussion, there are two additional issues to be discussed:

**Whether events are semi-static events or dynamic events?**

This issue is related to Issue #2-3. Companies (Nokia, NSB, vivo, OPPO, CTC, xiaomi, Sierra Wireless, Sharp, HW, HiSilicon, ZTE, CATT, LG) supporting Option 1 for Issue #2-3 support to differentiate semi-static events and dynamic events.

**Ericsson:** if L>max duration is not supported, it is already sufficient to define what conditions are events, without labeling them as semi-static or dynamic events.

**Apple:** Actual time domain window is determined in the order of event triggered by semi-static signaling, then event triggered by dynamic signaling.

**The time duration of an event**

**LG:** define either time duration of events or UE should report the start of actual time domain window after the event.

**Ericsson:** there is no need to further define the duration of an event beyond the working assumption on actual TDW determination.

**Other considerations:**

**Samsung**: Support the same RV within time domain window (at least for PUSCH repetitions Type A).

**Intel**: The events that violate power consistency and phase continuity may further include:

* If a PUSCH overlaps with PUCCH and UCI is multiplexed on the PUSCH repetition.
* If a UE needs to transmit another uplink channel/signal in a different carrier simultaneously.

**Sony** proposes to categorize the events into 4 subgroups, as:

1. **Events that can be handled by a UE**, relate to configurations that are not time critical and can be applied outside an active TDW or actual TDW. The specification impact relates to UE behavior.
2. **Scheduled events**, relate to events when both the UE and the gNB side is aware of the occurrence. Each time they happen a new TDW/actual TDW will be started. The specification impact is that scheduled events needs to be listed.
3. **UE capability conditioned events**, similar as for the scheduled events, both the UE and the gNB are aware of them and if the UE needs to restart a TDW/actual TDW is up to the UE capability. The specification impact is both the definition of the capability and, the conditioned behavior.
4. **Isolated events**, relates to events the UE need to perform instantaneously but where the gNB is not aware. If such events are present and how to be handled is not clear.

#### Issue #2-3: UE capability of restarting DMRS bundling

In RAN1 #106 b-e meeting the following agreement was achieved for UE capability of restarting DMRS bundling:

|  |
| --- |
| **Agreement**Down-select one of the following options:* **Option 1:** If DM-RS bundling is supported, UE is mandatory to support restarting DM-RS bundling due to semi-static events. UE capability of restarting DMRS bundling is applied only to dynamic events.
* **Option 2:** UE capability of restarting DMRS bundling is applied to both semi-static events and dynamic events.
 |

Companies’ views are summarized as follows:

**Companies supporting Option 1**: Nokia, NSB, vivo, OPPO, CTC, xiaomi, Sierra Wireless, Sharp, HW, HiSilicon, ZTE, CATT, LG

**Companies supporting Option 2**: Spreadtrum, Panasonic, CMCC, Lenovo, Motorola Mobility, MediaTek

**Sierra Wireless**: There have been no agreements made WRT which events are considered semi-static vs dynamic events. Thus, assuming semi-static event are events which are known before the start of the transmission and dynamic events are only known after the start of the transmission then we support Option 1.

**Nokia**: RAN1 to clarify whether the UE capability of restarting DM-RS bundling is applicable per configured TDW or across all configured TDW.

**LG**: If UE is mandatory to support restarting DM-RS bundling due to semi-static event, working assumptions in RAN1#106-e and RAN1#106b-e should be revisited to describe the start of the other actual time domain window.

## 2.4 Inter-slot frequency hopping with inter-slot bundling

In RAN1 #104b-e meeting, two options were agreed to be down selected about the bundle size of inter-slot frequency hopping with inter-slot bundling.

* Option 1: The bundle size (time domain hopping interval) equals to the time domain window size.
* Option 2: The bundle size (time domain hopping interval) can be different from the time domain window.

In RAN1 #106b-e, the following agreement was made.

|  |
| --- |
| **Agreement:** For the interaction between inter-slot frequency hopping and DMRS bundling for PUCCH/PUSCH repetitions, a UE perform the “hopping intervals determination”, “configured TDW determination”, and “actual TDW determination” in a sequential ordering. One option of the following options is to be selected. * Option 1: “hopping intervals determination” -> “configured TDW determination” -> “actual TDW determination”
* Option 2: “configured TDW determination” -> “hopping intervals determination” -> “actual TDW determination”
* Option 4: “configured TDW determination” -> “actual TDW determination” and “hopping intervals determination”

Note: option 1 and 2 assume a hopping interval can be different than an actual TDW. Option 4 assumes a hopping interval is the same as an actual TDW.  |

The above three options are illustrated below:



Fig.1 Illustration of the configured hopping interval smaller than the window length of the configured TDWs for option 1



Fig.2 Illustration of the configured hopping interval larger than the window length of the configured TDWs for option 1



Fig.3 Illustration of the hopping interval equal to the window length of the configured TDWs for option 2



Fig.4 Illustration of the hopping intervals equal to the window length of the actual TDWs for option 4

**FL comments:** This issue is discussed under AI 8.8.2.

## 2.5 TPC command

In RAN1#106bis-e meeting, the handling of TPC command was discussed extensively [12]. During the discussion, accumulated TPC commands and absolute TPC commands were discussed separately as follows.

|  |
| --- |
| **Accumulate TPC commands:*** The action of TPC commands does not constitute an event that violates power consistency and phase continuity.
	+ If UE is configured to accumulate TPC commands, down select one of the following options.
		- Option 1: If UE receives TPC commands that would take into effect during an actual TDW, UE accumulates TPC commands without taking effect during the current actual TDW. TPC commands take effect after the current actual TDW.
		- Option 2: If UE receives TPC commands that would take into effect during a configured TDW, UE accumulates TPC commands without taking effect during the current configured TDW.

**Absolute TPC commands:*** If UE is not configured to accumulate TPC commands, down select one of the following alternatives.
	+ Alt 1: the last TPC command that would take effect within a configured TDW supersedes all previous TPC commands that take effect within that configured TDW and only the last TPC command is applied by the UE.
		- FFS: no more than 1 TPC command is expected to take effect during a configured TDW.
	+ ~~Alt 2: no more than 1 TPC command is expected to take effect during a configured TDW.~~
	+ Alt 3: the last TPC command that would take effect within an actual TDW supersedes all previous TPC commands that take effect within that actual TDW and only the last TPC command is applied by the UE.
		- FFS: no more than 1 TPC command is expected to take effect during an actual TDW.
	+ ~~Alt 4: no more than 1 TPC command is expected to take effect during an actual TDW.~~
	+ Alt 5: The UE applies TPC commands after a configured TDW. It is left to UE implementation which TPC commands to apply from those that would take effect within the configured TDW.
	+ Alt 6: The UE applies TPC commands after an actual TDW. It is left to UE implementation which TPC commands to apply from those that would take effect within the actual TDW.
 |

For accumulate TPC commands, companies’ views are summarized as follows:

**Companies supporting Option 1**: vivo, OPPO, Panasonic, CTC, xiaomi, CMCC, Samsung, HW, HiSilicon, CATT, InterDigital, LG

**Companies supporting Option 2**: Nokia, NSB, Sharp, NTT DOCOMO, Intel, Ericsson

For absolute TPC commands, companies’ views are summarized as follows:

**Companies supporting Alt 1**: Sharp

**Companies supporting Alt 3**: vivo, OPPO, CMCC, Samsung, HW, HiSilicon

**Companies supporting Alt 4**: CATT

**Companies supporting Alt 5**: Ericsson

**Other considerations**

**Apple**: Clarify power control for PUSCH repetition first, then determine whether new power control mechanism is introduced for DMRS bundling.

**LG**: Select one of the following alternatives for TPC command without accumulation when joint channel estimation is enabled.

* Alt. 1: TPC without accumulation is semi-static event with 1 slot time duration.
* Alt. 2: Enabling joint channel estimation implies enabling of TPC accumulation.

**Qualcomm**: A UE is not expected to receive TPC commands that take effect during a configured time domain window.

**Nokia/NSB:** for paired spectrum, wherein the reception/monitoring of a DL transmission does not break power consistency and phase continuity (at least no agreement in both RAN1 and RAN4 exists that prevents such scenario for paired spectrum), then the PDCCH carrying the DCI that contains TPC command could be considered as an event. However, if TPC command is applied in the next configured TDW instead of the next actual TDW, then it is not necessary to consider TPC command as an event, even for paired spectrum.

## 2.6 TA adjustment

In RAN1#106bis-e meeting, the handling of TA adjustment was discussed extensively. The latest FL’s proposals on this topic are as follows [12].

|  |
| --- |
| * The action of TA commands does not constitute an event that violates power consistency and phase continuity, down select one of the following options.
	+ Option 1: UE performs TA adjustment after the actual TDW if it receives any TA command indicating TA adjustment during the actual TDW.
		- FFS: UE receives no more than 1 TA command whose action time falls within an actual TDW.
	+ Option 2: UE performs TA adjustment after the configured TDW if it receives any TA command indicating TA adjustment during the configured TDW.
		- FFS: UE receives no more than 1 TA command whose action time falls within a configured TDW.
 |

**Companies supporting Option 1**: vivo, Panasonic, CTC, xiaomi, CMCC, Apple, Sharp, CATT(2nd), InterDigital

**Companies supporting Option 2**: NTT DOCOMO, Intel, Ericsson

**LG**:

**gNB indicated TA adjustment：**

Select one of the following options for the gNB indicated TA adjustment when joint channel estimation is enabled.

* Opt. 1: gNB indicated TA adjustment is semi-static event without time duration.
* Opt. 2: gNB indicated TA adjustment that taking effect during the configured or actual time domain window is applied right after the end of the time domain window.

To support above Opt. 2, select one of the following options for the multiple gNB indicated TA adjustment during a time domain window.

* Alt. 1: UE expects only single TA adjustment is indicated during the time domain window.
* Alt. 2: UE applies multiple TA adjustments right after the end of time domain window in the indicated order.
* Alt. 3: UE applies only single TA adjustment during the time domain window even multiple indicated.

**UE autonomous TA adjustment：**

UE should report the end of the actual time domain window when it is terminated by the UE autonomous TA adjustment.

Discuss whether the reduced slot due to TA adjustment is included in the time domain window or not.

**CATT**: 1st preference is that the action of TA command constitutes a dynamic event.

**Qualcomm**: A UE is not expected to receive TA commands indicating TA adjustment during a configured time domain window.

**Nokia/NSB:** The action of TA commands does not constitute an event that violates power consistency and phase continuity, down select one of the following options.

* Option 1: UE performs TA adjustment after the actual TDW if it receives any TA command indicating TA adjustment during the actual TDW.
	+ FFS: in which actual TDW after the current actual TDW the TA adjustment is applied.
* Option 2: UE performs TA adjustment after the configured TDW if it receives any TA command indicating TA adjustment during the configured TDW.

## 2.7 JCE for PUSCH repetition type B and TBoMS

Companies (Nokia, NSB, CTC, Samsung) propose that the time domain window determination procedure agreed for PUSCH repetition type A is also applicable for PUSCH repetition type B and TBoMS.

Nokia proposes that the configured TDWs determination procedure for PUSCH repetition type A counting based on physical slots is applied for PUSCH repetition type B and the configured TDWs determination procedure for PUSCH repetition type A counting based on available slots is applied for TBoMS.

Panasonic thinks PUSCH repetition Type B cannot be supported as it does not reuse only those joint channel estimation specification enhancements defined to support repetition Type A considering that the terminology of "available slot" is not used for PUSCH repetition Type B specified in current Rel. 15/16.

InterDigital proposes to support joint channel estimation for TBoMS repetition. The DMRS bundling restarting behavior for actual TDW needs to be modified correspondingly. For joint channel estimation for TBoMS repetitions, the earliest actual TDW occurs at the first symbol of the next ToT (TBoMS transmission occasion) as illustrated in the following figure.



Figure. Joint channel estimation for TBoMS repetitions (N=4, m=3), actual TDW is denoted by “A-TDW”

## 2.8 Others

**Coherent transmission indication**

**LG**: The coherent transmission indication using DMRS resource (e.g., DMRS port, DMRS phase) should be reported at least for the end of the actual time domain window due to the dynamic event.

**Qualcomm**: UE signals a bundling indication in the UCI multiplexing with PUSCH transmission to indicate whether a PUSCH transmission is coherent with respect to the other PUSCH transmission. The motivation of the coherent transmission indication is due to the fact that some events on the UE side may impact the phase continuity but such change may not be known to the gNB. These events may include: frequency error correction, timing correction, RF calibration, antenna virtualization and etc.

**Phase drifting**

**CMCC**: The impact of phase drifting to the performance of joint channel estimation under a large number of consecutive slots should be studied.

**PTRS:**

**InterDigital:** Support to include PTRS in a DMRS bundle. Parameters of PTRS in the DMRS bundle depend on duration of the time window, SCS, bandwidth for PUSCH, and MCS used with DMRS bundling.

**Qualcomm:** Support different criteria for activation of PTRS or its density for the case of joint channel estimation.

1. Email discussion (1st round)

## 3.1 Use cases for joint channel estimation

**Use case 4b:**

**Proposal 1:**

* For non-back-to-back PUSCH/PUCCH transmissions across consecutive slots, the other uplink transmission in the middle of two PUSCH/PUCCH transmissions constitutes an event that violates power consistency and phase continuity.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| NTT DOCOMO | Support the proposal. |
| ZTE | Support |
| QC | Support.  |
| Spreadtrum | Support |
| Nokia/NSB | We prefer to wait until receiving a new LS from RAN4. |
| Intel | Share similar view as Nokia.  |
| CMCC | General fine. Since only other UL transmissions with the same bandwidth, precoding, antenna ports and ect, will not interrupt the power consistency and phase continuity, which is a very restrict limitations. We can accept to a bigger step that any other uplink transmission is forbidden or the power consistency and phase continuity will be broken.  |
| Lenovo, Motorola Mobility | Support |
| Samsung | We are fine with FL’s proposal 1. |
| LG | Support |
| WILUS | We support the proposal. |
| Panasonic  | We are fine with the proposal 1. |
| CATT | Support. |
| Xiaomi | Support |
| Sharp | Support |
| TCL | Support |
| Apple | Ok |
| Huawei, HiSilicon | Support. |
| Ericsson | Support |

## 3.2 Time domain window

**Proposal 2: Confirm the following working assumption**

|  |
| --- |
| **Working assumption:**For joint channel estimation for PUSCH repetition type A of PUSCH repetitions of the same TB, all the repetitions are covered by one or multiple consecutive/non-consecutive configured TDWs.* Each configured TDW consists of one or multiple consecutive physical slots.
* The window length *L* of the configured TDW(s) can be explicitly configured with a single value ~~and~~ *~~L~~* ~~is no longer than the maximum duration~~.
	+ FFS: The maximum value of *L* ~~is the duration of all repetitions~~
	+ FFS: Solutions to error propagation issue if ~~for~~ *L* is longer than the maximum duration is to be discussed further.
	+ FFS: The window length *L* is configured per UL BWP
* The start of the first configured TDW is the first PUSCH transmission
	+ FFS: The first available slot/symbol, or the first physical slot/symbol for the first PUSCH transmission.
* The start of other configured TDWs can be implicitly determined prior to first repetition.
	+ FFS: The configured TDWs are consecutive for paired spectrum/SUL band
	+ FFS: The start of the configured TDWs for unpaired spectrum is implicitly determined based on semi-static DL/UL configuration.
* The end of the last configured TDW is the end of the last PUSCH transmission.
	+ FFS: The end of the configured TDW is the last available slot/symbol, or the last physical slot/symbol for the last PUSCH transmission.
* Within one configured TDW, one or multiple actual TDWs can be implicitly determined:
	+ The start of the first actual TDW is the first PUSCH transmission within the configured TDW.
		- FFS: The first available slot/symbol, or the first physical slot/symbol for the first PUSCH transmission.
	+ After one actual TDW starts, UE is expected to maintain the power consistency and phase continuity until one of the following conditions is met, then the actual TDW is ended.
		- The actual TDW reaches the end of the last PUSCH transmission within the configured TDW.
			* FFS: The end of the actual TDW is the last available slot/symbol, or the last physical slot/symbol for the last PUSCH transmission.
		- An event occurs that violates power consistency and phase continuity
			* FFS: The events may include e.g., a DL slot based on DL/UL configuration for unpaired spectrum, the actual TDW reaches the maximum duration, DL reception/monitoring occasion for unpaired spectrum, high priority transmission, frequency hopping, precoder cycling.
			* FFS: The end of the actual TDW is the last available slot/symbol of the PUSCH transmission right before an event such that the power consistency and phase continuity are violated.
	+ If the power consistency and phase continuity are violated due to an event, whether a new actual TDW is created is subject to UE capability of supporting restarting DMRS bundling.
		- If UE is capable of restarting DM-RS bundling, one new actual TDW is created after the event,
			* FFS: The start of the new actual TDW is the first available slot/symbol for PUSCH transmission after the event.
		- If UE is not capable of restarting DM-RS bundling, no new actual TDW is created until the end of the configured TDW.
		- FFS: UE capability of restarting DMRS bundling is applied only to dynamic event or not

Note 1: A ‘configured TDW’ refers to a time domain window whose length can be configured to ‘L’ and whose start and end is determined as described above. Note 2: An ‘actual TDW’ refers to a time domain window during whose entire duration the DM-RS bundling is actually applied. An ‘actual TDW’ duration is always less than or equal to the ‘configure TDW’ duration.Note 3: Whether the terms ‘configured TDW’ and ‘actual TDW’ are revised to other terms and if such terminology is used in specifications is to be further discussed. |

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| NTT DOCOMO | Support the proposal. |
| ZTE | Support  |
| QC | Support in principle but prefer to wait for resolution on L <= max duration. |
| vivo | Support the proposal. |
| Spreadtrum | Support |
| Nokia/NSB | Support the FL’s proposal. |
| Intel | We are fine with the proposal.  |
| CMCC | We still think it is good enough as a working assumption, as part of the contents are still under discussion in section 3.3.1 and 3.3.2 and without a conclusion. As there are still lots of FFSs inside, then it is more proper as a working assumption. |
| Lenovo, Motorola Mobility | Support, but would prefer to also resolve on the value of L, whether it can be longer than max duration or not |
| Samsung | Support to confirm the above WA in principle. |
| LG | Agree with QC. We can revisit it after the maximum value of configured TDW is settled. |
| WILUS | We share the similar view with Qualcomm and CMCC. It can be confirmed according to further discussion and conclusion. |
| Panasonic  | Support the proposal 2  |
| CATT | Support. |
| Xiaomi | Support to confirm the above WA. |
| Sharp | Support |
| TCL | Support |
| Apple | Support |
| Huawei, HiSilicon | OK to confirm it if the following subbullet is not FFS anymore, which is quite straightforward and has been checked for multiple meetings.* + FFS: The configured TDWs are consecutive for paired spectrum/SUL band
 |
| Ericsson | Support |

### 3.2.1 Configured TDW

#### Issue #1: The window length *L* of the configured TDW

#### Issue #1-1: The maximum value of L

**FL comments:** Based on the discussion in RAN1 #106b-e, companies tend to converge on option 1’. In addition, based on the guideline in R1-2111193, default values are primarily important for cases where the NW has not yet provided a (UE-specific) configuration. In other cases, it can help clarify what the UE does when a parameter or feature is not configured. Thus, let’s focus on the discussion on option 1’. There are two sub-options for option 1’. To make each option clearer, they are modified as follows.

**Option 1’-a:**

* If L is configured, the maximum value of window length L of the configured TDW should not exceed the maximum duration, which is reported as UE capability as the duration where UE is able to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.
* If L is not configured, the default value of L = min (maximum duration, duration of all PUSCH repetitions)

**Option 1’-b:**

* If L is configured, the maximum value of window length L of the configured TDW should not exceed the maximum duration, which is reported as UE capability as the duration where UE is able to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.
* If L is not configured, the default value of L is the duration of all PUSCH repetitions.

Pros and cons for each options are summarized below.

|  |  |  |
| --- | --- | --- |
|  | Pros | Cons |
| **Option 1’-a** | Error propagation is restricted within one configured TDW. | May cause segment of UL slots for counting based on physical slots for TDD. |
| **Option 1’-b** | Can achieve best performance if no dynamic events | May have error propagation across configured TDWs in case of dynamic events. |

Companies are encouraged to provide further views on the above two options.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| NTT DOCOMO | We do not support either option. The default behaviour should not be supported for joint channel estimation. According to LS from RAN2 (R1-1905937), RAN2 requested RAN1 not to define default values for UEs in RRC connected mode. @FL In what scenario do you assume UE applies DMRS-bundling without RRC configuration? We only assume DMRS-bundling is applied after UE acquires RRC configuration. Otherwise, it is not clear how UE determines whether to enable or disable DMRS-bundling. |
| ZTE | Suggest not to define a default value as commented by NTT DOCOMO. If defined, Option 1 a’ is preferred.  |
| QC  | Prefer additional clarity on what RAN2 guidance is. If they are okay with us providing a default behavior, then we can go with Option 1’-a |
| vivo | In our understanding, there is no necessity to discuss the default value for configured window length. According to the following agreement,

|  |
| --- |
| **Agreement**   Introduce two RRC parameters to indicate enabling of DM-RS bundling and the window length of the configured TDW respectively. |

Based on this agreement, NW have to provide configured window length to enable DMRS bundling. And the window length should provide the window lengthbased on required performance and resource configuration e.g. DL-UL-configuration. The default value may not be the expected one, which bring in the better performance, why not to configure the expected one?From RRC parameter perspective, it can be easily solved by add some description, such as, *PUSCH-TimeDomainWindowLength* should be configured if *PUSCH-DMRS-Bundling* is set to ‘enabled’, which can be left to RAN2 discussion. We think there is no necessity to discuss the default value. |
| Spreadtrum | Agree with NTT DOCOMO, default value is not preferred.  |
| Nokia/NSB | We share the same view as NTT DOCOMO that a default value is not needed. If a default value is defined, we prefer Option 1’-b.  |
| Intel | Share similar view as NTT DOCOMO and prefer the original Option 1. If majority companies think that a default value is needed, we can make compromise to support Option 1’-a.  |
| CMCC | We are open for the discussion about the default value issue raised by RAN2. And if it is allowed, the option 1’-a is preferred. I am not sure if this is the exactly the case raised by RAN2, if we consider the repetition numbers is kind of implicit indication of the duration of L. With the consideration of TDD-UL-DL configuration and repetition numbers are already configured by RRC, they are more like a candidate value. We do not have strong views about this. |
| Lenovo, Motorola Mobility | In principle, we are fine with both options, but have higher preference for option 1a’ |
| Samsung | We prefer Option 1’-a. Option 1’-a seems to be the most appropriate way to determine the window length L of the configured TDW without potentially introducing an additional event. In addition, we don’t see Option 1’-b would outperform Option 1’-a. |
| InterDigital | We have the same view as NTT Docomo and we prefer Option 1. |
| FL | We have achieved the agreement on issue #1-1, no further discussion is needed. |

#### Issue #1-2: Configuration/Indication of L

**FL comments:** It seems the majority do not support dynamic indication of the window length L of the configured TDW.

**Proposal 3:**

* Dynamic indication of the window length *L* of the configured TDW by DCI or indicated by TDRA table with one additional entry is not supported.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| NTT DOCOMO | We do not support the proposal. The desired window length is dependant on TDRA. As LS from RAN2(R1-1905937), the default behaviour is not recommended by RAN2. Then, how can we adjust the configured time domain window according to TDRA? As dynamic window length indication apparently achieves better coverage performance than only single value, we cannot support this proposal.  |
| ZTE | Support. The window length L can be separately configured with TDRA.  |
| QC | We acknowledge the issue flagged by DCM. Setting same value of L for 4 repetitions vs. 32 repetitions may not be ideal. We are open to simpler solutions via RRC where L value is provided as a function of number of repetitions.  |
| Vivo | Support the proposal. |
| Nokia/NSB | We support the FL’s proposal. We do not see the need of dynamically modifying the configured TDW length, given that it’s just nominal duration. In addition, adding more information to TDRA table would make the configuration of TDRA table being too restrictive. |
| Intel | We are fine with the proposal.  |
| Lenovo, Motorola Mobility | Support the proposal |
| Samsung | OK with the proposal |
| LG | Support the proposal. The motivation of dynamic indication of window length is not clear. |
| WILUS | We support the proposal. |
| Panasonic  | We share similar view with DOCOMO. In addition, we would like to highlight that the TDRA table approach possibly provides an alignment with the period of an inter-slot frequency hopping and/or inter-slot precoder cycling with joint channel estimation. Depending on the repetition number, which can be dynamic indication by DCI, the window length *L* can be adjusted. |
| CATT | Agree with the proposal. |
| Xiaomi | Fine with the proposal |
| Sharp | Support the proposal |
| Apple | Support this proposal |
| Huawei, HiSilicon | Support the proposal. |
| Ericsson | Support the proposal. The window already adapts to the PUSCH duration as well as to the TDD or FH patterns, etc. We expect this is sufficient for Rel-17.  |

#### Issue #1-3: Candidate values of L

**FL comments:** The candidate values of L depend on the maximum duration. Based on RAN4 discussion, RAN4 is studying the impact of enabling up to 32 slots for maximum duration and other numbers beyond 32 slots are not analyzed in RAN4.

**Proposal 4:**

* The candidate values of the window length *L* of the configured TDW can be any integer value that is larger than 1 and no larger than the maximum duration.
* FFS: candidate values if *L* can be larger than the maximum duration.

|  |  |
| --- | --- |
| **Companies** | **Comments** |
| NTT DOCOMO | The candidate value should include 1 so that the window length can implicitly indicate either DMRS-bundling enabling or disabling. |
| ZTE | Fine with the proposal with removing the whole FFS bullets. We have agreed to use a separate RRC to enable or disable DMRS bundling. So, there is no need to set L to 1.  |
| QC | Support |
| vivo | The FFS part should be removed. |
| Spreadtrum | Support. |
| Nokia/NSB | On the one hand, the candidate values for maximum duration is unclear, and we still need to wait until receiving further LS from RAN4. On the other hand, what is clear is that L can be equal to the repetition duration (otherwise, it’s contradicts again the intention of having a middle ground WA). Therefore, we prefer to either postponing this discussion until receiving further LS from RAN4 or we modify the proposal as follows:**Proposal 4:**The minimum candidate value for the window length L should be the minimum supported maximum time duration value as per RAN4 indication. Other ~~The~~ candidate values of the window length *L* of the configured TDW can be any integer value larger than the minimum value of L from the candidate values for number of repetitions defined for PUSCH repetition type A ~~that is larger than 1 and no larger than the maximum duration~~. FFS: whether the maximum value of L is 16 or 32. |
| Intel | We are fine the proposal by removing the FFS part.  |
| CMCC | Fine with the proposal. |
| Lenovo, Motorola Mobility | Support without the FFS |
| Samsung | We are fine with the 1st bullet of proposal 4, and with deleting the FFS bullet. |
| LG | Fine with the proposal. |
| FL | Since we have agreed L cannot be larger than the maximum duration. Proposal 4 is updated as follows.**Proposal 4-v2:*** The candidate values of the window length *L* of the configured TDW can be any integer value that is larger than 1 and no larger than the maximum duration.
 |
| WILUS | We support the FL’s updated proposal 4-v2. |
| Panasonic  | We only support the proposal without FFS or the FL’s updated proposal 4-v2. |
| CATT | Fine with the FL’s updated proposal. |
| Xiaomi | Support the proposal after being updated. |
| Sharp | Support the updated proposal |
| TCL | Support |
| Apple | Support the updated proposal |
| Nokia/NSB | We are fine with FL’s proposal 4-v2, given the agreement made in the previous GTW. |
| Samsung | Support |
| Huawei, HiSilicon | Support the updated proposal. |
| Ericsson | Support the updated proposal. |

#### Issue #1-4: Counting of L based on available slots

**FL comments:** From FL understanding, based on the working assumption, each configured TDW consists of one or multiple consecutive physical slots, regardless of the counting based on physical slots or available slots.

Companies are encouraged to provide views whether it is necessary to the configured time domain window length L is counted on available slots as proposed in R1-2110865.

|  |  |
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| **Companies** | **Comments** |
| NTT DOCOMO | We support the working assumption and share the same view with FL. Each configured TDW consists of consecutive physical slots regardless of the counting way. It is just the starting and ending symbols of configured TDW are determined based on available slot when the available slot counting is applied. |
| ZTE | We share the same understanding with FL. If the configured TDW is based on available slot, it will end up with L larger than maximum duration even if L is configured. This is not aligned with our discussion in Issue#1-1. |
| QC | We share FL’s understanding. Configured TDWs are across consecutive physical slots. |
| vivo | Agree with FL. It is Not necessary to consider the configured window based on available slots. In our understanding, the configured window is just a nominal window, while the actual window determines performance of JCE . Even though the configured window is determined based on available slots, the configured window may also be segmented into multiple actual window due to the unavailable slots within the duration of the configured window.  |
| Spreadtrum | We think it is a good clarification for configured TDW length L. Because we only clearly defined the start of the first configured TDW, the end of the last configured TDW. The other TDWs are given based on the end of the previous TDW, which is not quite clear. Actually, we are more prefer configured time domain window length L is counted on available slots when PUSCH repetition is based on available slots. Because we only support consecutive slots cases for JCE, do not support dis-consecutive slots. When there is unavailable slots within a configured window, anyhow UE should treated as an event, which means the actual TDW would be end before the event, and a new actual TDW would be start later depends on the UE capability. Therefore, total length of L larger than maximum duration does not break anything, UE never holds the actual TDW window larger than max duration. On the other hand, in order to maintain continuous slots as long as possible, these unavailable slots should not be counted in window length L.  |
| Nokia/NSB | The ambiguity stems from the highlighted text from the agreement:*Agreement** *For PUSCH repetition type A counting based on physical slots*
	+ *The configured TDWs are consecutive, where the start of other configured TDWs is the first physical slot right after the last physical slot of a previous configured TDW.*
* *For PUSCH repetition type A counting based on available slots*
	+ *The configured TDWs are determined based on available slots, where start of a configured TDWs is the first available slot after the last available slot of a previous configured TDW.*

*Note: The determination of available slots for PUSCH repetition Type A is defined in AI 8.8.1.1*It is indeed a bit unnatural to have that each TDW consists of consecutive slots and is determined based on available slots for PUSCH repetition type A counting based on available slots. Clarification is needed. |
| Intel | We suggest to keep the agreement. It is natural to consider the configured TDW based on available slots for PUSCH repetition type A counting based on available slots |
| CMCC | Counting based on the available slot is more efficient for the available slot based repetitions. Though for the duration in the unpaired spectrum, the duration of L could be larger that the maximum duration. But it could not break any joint channel estimation. And if in the paired spectrum, as the available slot would be consecutive, then L should not be larger than the maximum duration. |
| Lenovo, Motorola Mobility | Similar understanding as FL, that configured TDW span across consecutive physical slots |
| Samsung | We share a similar view with FL. If available slot is configured, there will be multiple actual TDWs within a configured TDW separated by slots that are not available.  |
| InterDigital | We have the same view as the FL. |
| LG | Our view is different from FL’s understanding. The unit for counting slot is the slots that constitutes TDW, i.e., each configured TDW consists of one or multiple consecutive for consecutive available slots if the counting based on available slots. It is our understanding that is the reason why we agreed on counting based on physical/available slots separately. |
| WILUS | In our understanding, it can be different w.r.t. the slot counting method. According to the agreement that Nokia/NSB attached, it was agreed to support determination of configured TDWs based on available slots when *AvailableSlotCounting* is enabled. The WA can be revised if this issue is clarified. |
| Panasonic  | We share a similar view with FL. The configured TDW includes consecutive physical slots regardless of the counting way. The only difference between the counting based on physical slots or available slots is about the determination of the start/end of the configured TDW. |
| CATT | We have sympathy with Nokia that this is a bit ambiguity, since we agreed that ‘For PUSCH repetition type A counting based on available slots, the configured TDWs are determined based on available slots’. Clarification on the relationship between ‘determined based on available slots’ and ‘consists consecutive physical slots’ is needed. |
| Xiaomi | We share a same view with FL’s understanding. Configured TDWs are across consecutive physical slots. |
| Sharp | The one configured TDW should consist of L consecutive physical slots. For example, the configured TDWs (expressed as square brackets) are determined when L = 4 and the number K of repetitions = 4 (whose positions are expressed as underline) in DDDSUDDSUU as the following:DDDS[UDDS][UUDD]DS[U]DDSUU |
| Apple | We share the same understanding as FL. But some clarifications are needed as pointed out by Nokia. |
| Huawei, HiSilicon | We would like to echo Nokia’s comment. More discussions are encouraged because it is trying to clarify the end of a configured TDW which has not been clearly described yet. For example, assuming DDDSUDDSUU, if a UE is configured with L=5 and is scheduled with a PUSCH repetition Type A in length of 3 available slots and 13 symbols each slot, then the scheduled slots are U + UU. Which one below is the common understanding on configured TDW now?Alt 1: the first configured TDW is U (in DDDSU), and the second configured TDW is UU (in DDSUU), since it is based on available slot.Alt 2: the first configured TDW is UDDSU and the second configured TDW is UDDDS. As a result, two actual TDWs are immediately split within the first configured TDW as two separate U, while in the second configured TDW, it is U.From performance perspective, Alt 1 is better than Alt 2 because Alt 2 unnecessarily avoids JCE on the consecutive UU.Therefore, we propose a clarification***Proposal***:*For PUSCH repetition type A counting based on available slots, a configured TDWs with length L are determined based on available slots and comprises only no more than L consecutive available slots.*  |
| Ericsson | Agree we may need some clarification.The units of the maximum duration should match those of the configured value L. I expect that RAN4 will define the maximum duration in slots rather than available slots. On the other hand, the TDW is sized by the PUSCH repetitions, and so it does make sense to define the windows by available slots when these are used to transmit the PUSCH. I expect it is not too difficult to constrain the TDWs using units of (‘physical’) slots. |

### 3.2.2 Actual time domain window

#### Issue #2: The determination of actual TDW

#### Issue #2-1: The start/end of the actual TDW

**Proposal 5: Confirm the following working assumption**

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| **Working assumption:*** The start of the first actual TDW is the first ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for the first PUSCH transmission in an available slot within the configured TDW.
* The end of the actual TDW is
	+ the last ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for the last PUSCH transmission in an available slot within the configured TDW if the actual TDW reaches the end of the last PUSCH transmission within the configured TDW.
	+ the last ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ of the PUSCH transmission right before the event if an event occurs that violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.
* For UE capable of restarting DM-RS bundling, the start of the new actual TDW is the first ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for PUSCH transmission after the event violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.
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| **Companies** | **Comments** |
| NTT DOCOMO | Support the proposal. |
| ZTE | Support |
| QC | Support |
| Spreadtrum | Considering this definition of actual TDW is not only for PUSCH repetition type A, but also for PUSCH repetition type B, we would like to check the “at least determined by TDRA table” part first before confirm it. In our paper, we gives some examples for the other cases beside first or last symbol is not determined by TDRA table for PUSCH repetition type B, but determined by slot boundary or events. So two methods could be fine: Method1: Clarify there are other cases for first/end symbol besides determined by TDRA table, which can be FFS.Method2: Study further for all the cases for first/end symbol firstly, and then confirm the WA.  |
| Nokia/NSB | Support the FL’s proposal. |
| Intel | We are fine with FL proposal.  |
| CMCC | Support  |
| Lenovo, Motorola Mobility | Fine to support |
| Samsung | Support to confirm the WA. |
| InterDigital | Support |
| LG | As we pointed out in our contribution, the reduced slot due to TA adjustment may not include the symbol indicated by TDRA table. Discussion regarding it should be taken. |
| WILUS | We support the proposal. |
| Panasonic  | Support the proposal 5. |
| CATT | We support the proposal. |
| Xiaomi | Support |
| Sharp | Support |
| TCL | If the UE indicates the capability of [partialCancellation], only partial PUSCH transmission is cancelled. However another part of PUSCH transmission is not included in any actual TDW based on the current proposal. |
| Apple | Support |
| Huawei, HiSilicon | Support. |
| Ericsson | Support |

#### Issue #2-2: Events that violate power consistency and phase continuity

**FL comments:** Regarding the change of transmission parameters, some companies think it is not necessary to discuss this type of event, since some parameters will not change while other parameters are covered by other events.

* Transmission parameters need to be changed due to network-indicated operations, including: Tx power, UL beam/TPMI, and RB allocation.

Companies are encouraged to answer the following questions.

Q1: Whether it is necessary to consider the change of transmission parameters as an event?

Q2: If the answer to Q1 is yes, which parameters should be considered while not covered by other events?

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| **Companies** | **Comments** |
| ZTE | Q1: Yes. As long as the transmission parameters could violate the phase continuity, it should be considered as event.Q2: In our view, Tx power, UL beam/TPMI, RB allocation, and Tx/BWP switching should be considered.  |
| QC | Yes, it should be included. It provides clarity on UE behavior. Examples include change in RB allocation due to frequency hopping or change in UL beam due to mTRP operation. |
| Vivo | Q1: Yes. Except that we do not understand ‘RB allocation’ change due to NW indicated operation?Q2: Not sure whether we need to consider CA cases. When CA is enabled, events on other serving cell may also impact phase continuity.One example is power sharing between multiple UL carriers. The Tx power may be not changed for one serving cell but total tx power is changed, the phase continuity may be changed. Besides, reception on other serving cell also leads to violation of phase continuity.If JCE is enabled only for single carrier operation, a conclusion is needed. |
| Spreadtrum | Q1:YesQ2: RB allocation in case of frequency hopping.  |
| Nokia/NSB | It is unclear to us what are the other transmission parameters. At least, the following questions need to be clarified:* What is the network-indicated operation for Tx power and what is the difference with TPC command?
* What is the use case of having different UL beam/TPMI (other than precoder cycling) across the PUSCH repetitions?
* For PUSCH repetition type A (and also PUSCH repetition type B and TboMS), what is the use case of changing RB allocation across PUSCH repetitions? Please note that this would not be possible according to agreements for TboMS in AI 8.8.1.2. Is this about FH?
 |
| Intel | Q1: yesQ2: We also suggest to include SRI in case of multi-TRP operation.  |
| CMCC | Q1: yesQ2: legacy frequency hopping should be considered as an event. |
| Lenovo, Motorola Mobility | Q1: Yes, any transmission parameter that can affect the phase continuity and power consistency should be considered as an eventQ2: Frequency hopping, RB allocation, beam switch |
| LG | Q1: No. According to agreement, since TPC command and frequency hopping separately listed, it is our understanding that all other parameters cannot be changed during repetition, they are only configured when scheduling. |
| Panasonic  | Q1: Yes. It provides a clear behaviour to UE.Q2: Tx power, UL beam/TPMI. Regarding RB allocation aspect, does FL intend to interact with FH pattern? If yes, we suggest considering this aspect with the discussion on the interaction with FH and joint channel estimation. |
| CATT | Q1: Y.Q2: Possibly Tx power (TPC command activation) and RB (frequency hopping). But we do not see the need to consider UL beam/TPMI change. |
| Xiaomi | Q1:YesQ2: Frequency hopping also should be included besides Tx power, UL beam/TPMI, and RB allocation. |
| Sharp | Q1: YesQ2: UL beam |
| Apple | It’s not fully clear the question here. Are these parameter changes is triggered by other DCI? such as TPC, it is discussed in another section. What does it mean of RB allocation change? It is changed by scheduling DCI with frequency hopping? Or by other means.  |
| Huawei, HiSilicon | Q1: No.Similar view as LG. |
| Ericsson | Q1: In short, no. If these transmission parameters could change, then they would naturally be events. However, if as LG points out they are set once for all repetitions, then they are not events. Regarding UL M-TRP, we would like to understand why it is sufficient to not configure DMRS bundling. Also, can companies clarify what is meant by ‘UL/beam TPMI’: is this a change in SRI or something else? |

**FL comments:** Based on companies’ views, whether precoder cycling is used is up to UE implementation and it is transparent to gNB. UE should not change precoder within the actual TDW because the gNB cannot identify that.

**Proposal 6:**

* Precoder cycling does not constitute an event that violates power consistency and phase continuity.
* UE should not perform procoder cycling within the actual TDW.

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| **Companies** | **Comments** |
| ZTE | Fine with the proposal.  |
| QC | Can we go with just the second statement. First statement by itself doesn’t seem accurate as precoder cycling does impact power consistency and phase continuity. |
| Vivo | Not sure the meaning of precoding cycling. Hope proponents can clarify.Based on our understanding for PUCCH&PUSCH transmission in Rel-16, for codebook based PUSCH transmission, the precoder is indicated by TPMI, and precoder is not changed across PUSCH repetitions. For non-codebook based PUSCH transmission, the precoder follows the same antenna port of SRS. For PUCCH, the antenna port follows the indicated spatial relation info. Hence, we do not find any cases that precoder can be cycled across PUSCH/PUCCH repetitions. If our understanding is wrong, hope companies can correct us.In Rel-17 MIMO, beam switching every repetition or every 2 repetitions are supported. If it is considered as ‘Precoder cycling’ in the FL proposal, we are fine to consider it as an event. Otherwise, we do not think precoder cycling is an event, based on our understanding on Rel-16. |
| Nokia/NSB | We are fine with the proposal. |
| Intel | We share similar view as Vivo. If this is for multi-TRP operation, precoder cycling should be considered as an event.  |
| CMCC | Precoder cycling is transparent to spec. When the implementation is not clear, we cannot consider it as an event or not. But if the UE reports to support JCE, the precoding cycling should not impact |
| Lenovo, Motorola Mobility | Similar view as QC. Basically, if precoder cycling is done, it will be an event. Agree to keep second bullet for clarity |
| LG | Fine with proposal. |
| Panasonic  | The fist bullet seems inaccurate because when precoder cycling is performed, it will be an event as mentioned by some companies. In this sense, we think a precoder cycling is performed within an actual TDW in order to maximize performance again. |
| CATT | Fine with proposal. |
| Sharp | Support the proposal |
| Huawei, HiSilicon | Precoder cycling does not have to violate phase contiguity, a UE should be allowed to perform precoder cycling but not violate JCE requirements. Therefore, we propose to remove the second bullet, or revise the second bullet as* UE is not expected to violate power consistency and phase continuity ~~should not perform procoder cycling~~ within the actual TDW due to any precoder cycling.
 |
| Ericsson | Given the interpretation of multi-TRP from vivo, we support the proposal. |

**FL comments:** Regarding whether events are semi-static events or dynamic events, it depends on whether UE capability of restarting DMRS bundling is applied only to dynamic events. Companies are encouraged to provide views on how to differentiate semi-static events or dynamic events if the differentiation is necessary.

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| **Companies** | **Comments** |
| ZTE | In general, our thinking is as long as an event is associated with a DCI, it is a dynamic event. For instance, if the dropping/cancellation is due to dynamic SFI, it is considered as dynamic events. Otherwise if the dropping/cancellation is due to DL-UL RRC configuration, it is a semi-static event.  |
| QC | Suggest avoiding this classification. Its going to be a rather difficult exercise. |
| Vivo | In our understanding, if the event is caused by semi-static configuration, then it is semi-static events. Otherwise, it belongs to dynamic events. |
| Nokia/NSB  | We share similar view with ZTE that as long as an event is associated with a DCI, it is a dynamic event. |
| Intel | If this is associated with a DCI, then it is dynamic event. Suggest to resolve the issue for restarting DMRS bundling first.  |
| CMCC | Similar views as above companies. The event that is triggered through DCI, then it is a dynamic event.  |
| Samsung | It is not clear that there is a need for such differentiation. |
| LG | Since down-selection between restarting DMRS bundle after semi-static event is mandated or not is already agreed, it is our understanding that we should differentiate dynamic/semi-static events.If there is no possible misunderstanding regarding the time when event happens between gNB and UE, it can be defined as semi-static event. And if there is any possibility for misunderstanding regarding the time when event happens between gNB and UE, it can be defined as dynamic event. |
| CATT | We share similar view with ZTE. There will be difference, for example, error propagation may happen by dynamic events due to DCI missing. |
| Sharp | In our view, semi-static events are events identified by higher-layer configuration and the DCI which schedules the PUSCH repetition, and dynamic events are events identified by another DCI. |
| Apple | Share the similar view as ZTE and Sharp.One clarification question, why restarting the DMRS bundling after dynamic event is a UE capability? Whatever the event is semi-static or dynamic, if UE can re-start the transmission, then there is timeline issue, no power adjustment issue otherwise UE will not re-start the transmission. Maybe I missed something here? |
| Huawei, HiSilicon | We share the similar view with ZTE, Nokia. |
| Ericsson | We would prefer to first understand why there is a need to distinguish dynamic vs. semi-static events, especially given that we have agreed to Option 1’-a for the TDW definitions. |
| FL | This issue can be discussed together with issue#2-3. |

**FL comments:** Regarding the time duration of an event, Companies are encouraged to answer the following questions.

Q1: Is it necessary to define the time duration of an event?

Q2: If the answer to Q1 is yes, how to define the time duration of an event?

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| **Companies** | **Comments** |
| ZTE | Q1: Seems not necessary. Defining the start of each actual TDW is sufficient.  |
| QC | Don’t see need to define time duration of an event. |
| Vivo | Q1: unnecessary. |
| Nokia/NSB | Q1: Not necessary. |
| Intel | Q1: not necessary.  |
| CMCC | Q1: it is not necessary.  |
| Samsung | Q1: No |
| LG | Q1: Depending on UE indicating coherent transmission, it is necessary due to possible misunderstanding of the start of actual TDW after event.Q2: Slot-level events can be introduced. |
| Panasonic | Q1: No, it is not necessary. |
| CATT | Q1: Not necessary.  |
| Xiaomi | Q1: Not necessary |
| Sharp | Q1: Not necessary |
| Huawei, HiSilicon | Q1: unnecessary. |
| Ericsson | Q1: We think current agreements are sufficient. |
| FL | It seems the majority think it’s not necessary to consider the time duration of an event. |

Any other comments about events?

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| **Companies** | **Comments** |
| LG | UE autonomous TA should be an event and the timing of it is not known to gNB. We should define UE behaviour regarding UE autonomous TA when joint CE enabled. |
| WILUS | As we described in our contribution [39], the UE transmits dynamically scheduled PUSCH in the set of symbols of the slot which overlaps with DL reception/monitoring according to current specification.However, since DL reception/monitoring is regarded as an event that violates power consistency and phase continuity, symbols of PUSCH rep#4 that overlaps with DL reception/monitoring cannot be determined as a same actual TDW with PUSCH rep#5 and #6 even if they are actually transmitted without cancellation.Therefore, if a collision occurs between DL reception/monitoring occasion and dynamically scheduled PUSCH in the set of symbols of the slot within the configured TDW, the DL reception/monitoring can be considered as not the event to determine the start of the actual TDW. |
| Ericsson | We think autonomous TA is already covered (but agree UE should not change it during a CTDW).**Agreement*** UE should not perform TA adjustment during the time domain window.

‐   FFS: UE does not expect to receive TA command to indicate TA adjustment during the TDW.‐   FFS: UE ignores any TA command which indicates TA adjustment during the TDW.‐   FFS: UE performs TA adjustment after the TDW if it receives any TA command indicating TA adjustment during the TDW.We think the following should be events:* Dropping/cancellation based on Rel-17 collision rules.
* Other UL transmission in between PUSCH/PUCCH transmissions.
* Frequency hopping.
 |

#### Issue #2-3: UE capability of restarting DMRS bundling

**FL comments:** Regarding UE capability of restarting DMRS bundling, two options are discussed to be down selected. From FL understanding, as we have agreed that DL slot or DL reception/monitoring based on semi-static DL/UL configuration for unpaired spectrum is regarded as an event. For option 2, for UE not capable of restarting DMRS bundling, DMRS bundling cannot be supported after DL slot within the configured TDW. This seems a drawback of option 2.

* **Option 1:** If DM-RS bundling is supported, UE is mandatory to support restarting DM-RS bundling due to semi-static events. UE capability of restarting DMRS bundling is applied only to dynamic events.

**Support:** Nokia, NSB, vivo, OPPO, CTC, xiaomi, Sierra Wireless, Sharp, HW, HiSilicon, ZTE, CATT, Panasonic

* **Option 2:** UE capability of restarting DMRS bundling is applied to both semi-static events and dynamic events.

**Support:** Spreadtrum, ~~Panasonic~~, CMCC, Lenovo, Motorola Mobility, MediaTek, Intel

Companies are encouraged to provide pros and cons of the above two options.

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| **Companies** | **Option 1** | **Option 2** |
| NTT DOCOMO | Pros: some UE can restart DMRS bundling only due to semi-static events, which could reduce the UE burden with achieving JCE gains because UE does not have to restart DMRS bundling according to the dynamic signaling. | Pros: Since there is no need to define semi-static and dynamic events, it is simple. |
| ZTE | Pros: For semi-static events, a UE could well know where it needs to restart DMRS bundling once it is scheduled with PUSCH/PUCCH transmissions. From implementation point of view, it is the same as restart DMRS bundling between different configured TDWs (which is also semi-statically configured). So, as long as the UE can support DMRS bundling, it should be able to support restart DMRS bundling due to semi-static events. |  |
| QC |  | Classification of events is not straightforward. Suggest going with a simple approach. |
| Vivo | Pros: better performance. NW does not need to switch to per slot channels estimation due to semi-static events. | Cons: Degraded performance due to semi-static events. And NW also have to switch JCE granularity due to semi-static events, leading to higher complexity. |
| Spreadtrum |  | Pros: UE can use unified solution for restarting DMRS bundling. And what is the benefit to differ the semi-static or dynamic events?  |
| Nokia/NSB | Pros: If Option 1 is adopted, then the spirit of the three options listed for the inter-slot FH with inter-slot bundling in the agreement made under AI 8.8.2 holds (see the cons of Option 2 on the same issue in next column). | Cons: * For a UE that reports the capability of supporting JCE but it does not support restarting DM-RS bundling due to semi-static events, then JCE can only be applied in the first bundle of PUSCH transmissions for FH and cannot be applied across any bundle of PUSCH transmissions after the first frequency hopping, within a configured TDW. Therefore, if Option 2 is adopted, then the inter-slot FH with inter-slot bundling specified under AI 8.8.2 is incomplete, which does not fulfil the requirement in the WID.
* Assuming a (semi-static) event that happens right after the first PUSCH repetition, then it is meaningless for a UE to report the capability of supporting JCE if it doesn’t have capability of restarting after semi-static events (and so as for dynamic events), since JCE cannot be applied across any bundle of PUSCH transmission in this scenario.
 |
| Intel |  | It is not necessary to differentiate semi-static and dynamic event. Note that current list of events is already very comprehensive, it is not beneficial to further differentiate these two to complicate the spec.  |
| Lenovo, Motorola Mobility |  | Pros: Straightforward to not categorize events |
| InterDigital | Pro : If it’s not mandatory, the UE may not be able to restart the window at many occasions, preventing the DMRS bundling from occurring. |  |
| LG | According to the definition of semi-static event, which is no misalignment of event timing, possibly have the largest number of time domain window. The detailed list of semi-static events should be defined. | The detailed list of events whether it is semi-static or dynamic is not necessary. However the UE without capability always have single actual TDW within configured TDW, and the length of it is likely to be reduced due to the event. |
| CATT | Pros: Provide better performance since gNB can continue to apply JCE to the left PUSCH transmissions after the semi-static event in the current configured TDW. | Pros: No need to differentiate semi-static events or dynamic events. |
| Sharp | Pros: First, both options are the same if UE is capable to restart DMRS bundling. If UE is not capable to restart DMRS bundling, Option 1 achieves more DMRS bundling gain than options 2 because UE of option 1 can restart DMRS bundling after semi-static events (e.g., overlapping with P-CSI on PUCCH with repetition). |  |
| Ericsson | Pros: May simplify some UEs.Cons: May complicate the definition of events. | Pros: Allows a unified definition of events, which is already very complex. |

Companies are encouraged to provide comments on whether UE should be mandatory to support restarting DM-RS bundling at least due to some of the events, e.g., DL slot or DL reception/monitoring based on semi-static DL/UL configuration for unpaired spectrum?

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| **Companies** | **Comments** |
| QC | On FL’s comment on the drawback of Option 2, we don’t think this is an issue. A gNB is unlikely to ever configure a UE with an L such that it spans uplink slots separated by multiple DL slots (think of L=8 for TDD band with DDDUU slot pattern). Smaller values of L should should alleviate this concern. Setting L = 2 in the above example ensures issues don’t occur. |
| Nokia/NSB | Aside from the pros and cons above, the main concern and reason for introducing UE capability of restarting after an event is that the UE may not be able to quickly react to a dynamic event and hence may not be able to support the restarting of DM-RS bundling after a dynamic event, depending on its capability. In contrast, all semi-static events are known to the UE before the first transmissions. Please also note that the semi-static events are not subject to the missing DCI problem. Therefore, the motivation for introducing a separate capability of restarting DM-RS bundling after semi-static events, independently from the JCE capability, is unclear. |
| Samsung | We don’t see a technical reason for restarting DM-RS bundling based on the type of event. When DM-RS bundling restarts, it is a new DM-RS bundle, so even the duration of the event seems not to have an impact. |
| LG | It is our understanding that “whether UE should be mandatory to support restarting DM-RS bundling at least due to some of the events” is equal to option 1 when the “some of events” is “semi-static events”. In this regard, detailed list of semi-static events should be discussed. |
| Apple | As we commented in the previous question. We fail to see the necessity to define a UE capability. why restarting the DMRS bundling after dynamic event is a UE capability? Whatever the event is semi-static or dynamic, if UE can re-start the transmission, then there is timeline issue, no power adjustment issue otherwise UE will not re-start the transmission. Maybe I missed something here? |
| Ericsson | Similar to Apple’s question, not sure why we need to worry about the UE capability so much. Dynamic events naturally do imply tighter timing than semi-static ones, but the timing itself will be according to existing features. So at least from our perspective, there is not an obvious need to differentiate semi-static and dynamic events. |

## 3.3 TPC command

**FL comments:** In RAN 1#106b-e, we almost reached the consensus that the action of TPC commands does not constitute an event and down select one of the following options for accumulate TPC commands. Considering this is the last meeting before RAN1 freeze, let’s focus the discussion on the following two options.

* The action of TPC commands does not constitute an event that violates power consistency and phase continuity.
	+ If UE is configured to accumulate TPC commands, down select one of the following options.
		- Option 1: If UE receives TPC commands that would take into effect during an actual TDW, UE accumulates TPC commands without taking effect during the current actual TDW. TPC commands take effect after the current actual TDW.
		- Option 2: If UE receives TPC commands that would take into effect during a configured TDW, UE accumulates TPC commands without taking effect during the current configured TDW.

Companies are encouraged to provide pros and cons of the above two options.

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| **Companies** | **Option 1** | **Option 2** |
| ZTE | We are not sure why TPC cannot be regarded as an event. Some companies argued that gNB may send TPC very frequently and make the TDW too segmented. But, in our view, in coverage limited scenario, UE is also power limited and may already reach its maximum power. gNB would not send TPC very frequently. Thus, we suggest to simply consider TPC as an event without introduce additional rules for TPC reception.  | Same comments as for Option 1.  |
|  |  | This is a general comment since we are not comfortable with with either option; placed here since no other options were available.We have been open to TPC command deferral in the past hoping for a strong use case to emerge. We unfortunately do not see a clear justification offered by any of the companies. We wonder why a gNB will ever send TPC commands to a UE configured with PUSCH repetitions. We think UE tx power will have been maxed out in such a scenario. In fact we think a UE reporting 0 dB power headroom would be the catalyst for a gNB to schedule PUSCH repetitions. In such a scenario we wonder if there is any value at all to adding additional procedures in the spec whose practical use case is negligent. Does the FL see a clear value to establishing this new procedure?We request the FL to bring back the option where a UE is not expected to receive TPC commands. |
| vivo | Pros: Apply the TPC command as early as possible | Cons: possible large latency due to the configured window length |
| Nokia/NSB | Cons: Option 1 is not applicable for unpaired spectrum. The notion of current actual TDW would be unclear in this case, given that **the reception of a PDCCH does not occur during an actual TDW for unpaired spectrum.**@ZTE: it does not make sense to consider TPC as an event because the event is the downlink reception of the DCI. | Pros: Option 2 can be used as a unified solution for both paired and unpaired spectrum. |
| Intel | Con: this may have mis-alignment issue between gNB and UE for actual TDW due to mis-detection of dynamic event.  | Pro. More robust than aligning with actual TDW.  |
| CMCC | Compared with configured TPC, the actual TDW  |  |
| Samsung | Pros: better performanceThere can be multiple actual TDWs within a configured TDW, and transmit powers for TDWs after the first TDW should be changed to improve performance. | Cons: lower performanceRequiring same transmit power for different DMRS bundles is not a requirement for a gNB to perform joint channel estimation within a DMRS bundle. |
| InterDigital | Pro : Application of TPC at the earliest opportunity |  |
| LG | It is our understanding since TPC command is group common DCI, joint channel estimation enabled UE can receive it.The pros and cons depends on the length of configured TDW. If the length of configured TDW is large enough, option 1 would have advantage compared to option 2 since the delayed time of applying TPC command is reduced. On the other hand, option 2 has advantage that the length of configured TDW can be described directly. | Same comment as for option 1. |
| Xiaomi | Compared with configured TDW, actual TDW has less latency |  |
| Sharp | Pros: the accumulated TPC commands are applied as earlier as possible | Pros: More robust than aligning with actual TDW |
| Ericsson | Pros: Quicker power control. | Pros: Simpler designs.Note: we do sympathize with Qualcomm’s comments. The network should not generally rely on power control, since it is precluded during ATDWs. If group common TPC is to be supported, then having it be an event would be fine in our view. Scheduling group common TPC commands may be more difficult than UE specific so we prefer somewhat to have TPC be an event rather than it not being expected, if that can still be considered. |

**FL comments:** Regarding absolute TPC commands. It seems no company supports Alt 6. Let’s focus the discussion on Alt 1, Alt 3 and Alt 5.

* If UE is not configured to accumulate TPC commands, down select one of the following alternatives.
	+ Alt 1: the last TPC command that would take effect within a configured TDW supersedes all previous TPC commands that take effect within that configured TDW and only the last TPC command is applied by the UE.
		- FFS: no more than 1 TPC command is expected to take effect during a configured TDW.
	+ ~~Alt 2: no more than 1 TPC command is expected to take effect during a configured TDW.~~
	+ Alt 3: the last TPC command that would take effect within an actual TDW supersedes all previous TPC commands that take effect within that actual TDW and only the last TPC command is applied by the UE.
		- FFS: no more than 1 TPC command is expected to take effect during an actual TDW.
	+ ~~Alt 4: no more than 1 TPC command is expected to take effect during an actual TDW.~~
	+ Alt 5: The UE applies TPC commands after a configured TDW. It is left to UE implementation which TPC commands to apply from those that would take effect within the configured TDW.
	+ ~~Alt 6: The UE applies TPC commands after an actual TDW. It is left to UE implementation which TPC commands to apply from those that would take effect within the actual TDW.~~

Companies are encouraged to provide pros and cons of the above options

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| **Companies** | **Alt 1** | **Alt 3** | **Alt 5** |
| QC | Please see comment to earlier proposal |  |  |
| vivo | Cons: possible large latency due to the configured window length | Pros: much less latency, and the occasion after an actual window can be available to apply the TPC commend. Further comment: No need to add the FFS to restrict the NW behavior.  | Cons: potential misalignment, which is not beneficial for the subsequent power control. |
| CMCC |  | Alt 3 has less latency. |  |
| Samsung | Cons: lower performance by using configured TDW | Pros: Can identify the UE behavior clearly and achieve better performance by using actual TDW.FFS is not needed. Power cannot be changed within an actual TDW. | Cons: lower performance by using configured TDW |
| LG | As we pointed out in our contribution, the transmit power due to the TPC command without accumulation, i.e., absolute TPC command, is different from the previous and after that transmission.In other words, if the transmit power is changed due to absolute TPC command, no other transmission can be included within a same actual TDW. That is, only the transmission constitutes and actual TDW. We should discuss it before how we supersedes TPC command. |  |  |
| Xiaomi |  | Alt a has less latency |  |
| Sharp | Pros: More robust than aligning with actual TDW. | Pros: a TPC command is applied as earlier as possible. |  |
| Ericsson | Pros:* Simpler design than Alt 3

Cons: * New power control behavior. (The FFS may simplify.)
* Slower response than ATDW.
 | Pros: * faster response than Alt 1

Cons: * New power control behavior. The FFS may simplify.
* More complicated power control, since events can affect when PC commands apply.
 | We’re not sure our intention is clear with this proposal. If the network sends only one command, there will be no ambiguity, and the UE will not have to select among the commands. If the UE does receive multiple commands, then of course the Pros: * Simplified UE implementation, and equivalent performance to Alts. 1& 3.
* More flexible gNB implementation, since gNB can send its single command at any time that meets the timeline for the end of the window.
 |

#### Updated proposal after GTW Nov. 11th.

**FL comments:** Based on the discussion during GTW session, proposal 10 on TPC commands is revised as follows.

**Proposal 10:**

* The action of common TPC commands does not constitute an event that violates power consistency and phase continuity.
	+ If UE is configured to accumulate TPC commands, down select one of the following options.
		- Option 1: If UE receives TPC commands that would take into effect during an actual TDW, UE accumulates TPC commands without taking effect during the current actual TDW. TPC commands take effect after the current actual TDW.
		- Option 2: If UE receives TPC commands that would take into effect during a configured TDW, UE accumulates TPC commands without taking effect during the current configured TDW.
	+ If UE is not configured to accumulate TPC commands, down select one of the following alternatives.
		- Alt 1: the last TPC command that would take effect within a configured TDW supersedes all previous TPC commands that take effect within that configured TDW and only the last TPC command is applied by the UE.
			* FFS: no more than 1 TPC command is expected to take effect during a configured TDW.
		- Alt 3: the last TPC command that would take effect within an actual TDW supersedes all previous TPC commands that take effect within that actual TDW and only the last TPC command is applied by the UE.
			* FFS: no more than 1 TPC command is expected to take effect during an actual TDW.
		- Alt 5: The UE applies TPC commands after a configured TDW. It is left to UE implementation which TPC commands to apply from those that would take effect within the configured TDW.
* The action of UE specific TPC commands, if supported, constitutes an event that violates power consistency and phase continuity.

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| **Companies** | **Comments** |
| CATT | We are somehow making the situation more and more complicated by differentiating the category of TPC commands. If possible, a unified solution is preferred. The current logic on TPC and JCE is also a little unreasonable. If a TPC command is increasing the Tx power by, e.g. 3 dB, it seems comparable with the performance gain brought by JCE. On the other hand, if a TPC command is decreasing the Tx power, it means the channel condition is good enough, so it may not be important to keep DMRS bundling at this moment. So we do not see strong need to prioritize JCE than TPC command activation.More importantly, if TPC command action does not constitute an event, it means newly introduced JCE procedure has higher order than legacy TPC control logic, so legacy procedure on power control (which is already very complicated) is changed. Eventually, allowing TPC command action constitutes an event is a simpler choice. |
| NTT DOCOMO | Support the proposal.  |
| Sharp | Support the proposal 10. |
| CMCC | For the 2nd one, the UE specific TPC command cannot be an event. The UE specific TPC command is the DCI with a scheduling of PUSCH. It is the beginning of the PUSCH transmission when the TPC taking effect, which is also the beginning of a JCE or the actual TDW. Then it will not take effect during the TDW and break the joint channel estimation.  |
| Nokia/NSB | We are fine with the proposal. |
| InterDigital | We are ok with the proposal. |
| Samsung | The TPC command not being an event is the most straightforward solution for capturing the benefits from having a TDW. As the TDW can be over several slots, the probability that the UE power needs to be tracked at the end of TDW is large and the periodicity of DCI format 2\_2 for tracking fading at low UE speeds (e.g. 10-20 msec) is such that it is likely to coincide with the TDW. That is not possible to avoid by the gNB and it is not even desirable to avoid. The spec impact from applying the TPC command at the end of the TDW and having an up-to-date CLPC state is trivial and smaller than the spec impact from having the TDW broken by TPC commands. There is no impact in practice from delaying application of a TPC command by a few slots. There is no actual change in the UL PC procedure other than delaying an update for the CLPC state. In summary, 1. It is not possible (at least for DCI 2\_2), and it would be detrimental, for a NW to not be able to issue TPC commands during a TDW.
2. It is detrimental for a UE to have an invalid CLPC state by ignoring TPC commands, and it is also detrimental to have to break a TDW in order to immediately process a TPC command.
3. The specification impact is trivial – consider the TDW as the transmission occasion or apply the TPC command at the end of the TDW, there is no new procedure.
 |
| Huawei, HiSilicon | For the action of common TPC commands,* If UE is configured to accumulate TPC commands, we prefer Alt 1 with better performance. We think there is no reason to apply the TPC commands after the configured TDW, because it is a good timely opportunity to apply TPC commands after an actual TDW.
* If UE is not configured to accumulate TPC commands, we prefer Alt 3 for better performance and a consistent mechanism with that UE is configured to accumulate TPC commands. Besides, before the end of a TDW, whether a TPC command is the last one is uncertain. Our understanding is that the last TPC command is applied after the current TDW. We suggest to add “after the current configured/actual TDW” to the end of Alt 1 and Alt 3 to make them clear.
	+ - Alt 1: the last TPC command that would take effect within a configured TDW supersedes all previous TPC commands that take effect within that configured TDW and only the last TPC command is applied by the UE after the current configured TDW.
			* FFS: no more than 1 TPC command is expected to take effect during a configured TDW.
		- Alt 3: the last TPC command that would take effect within an actual TDW supersedes all previous TPC commands that take effect within that actual TDW and only the last TPC command is applied by the UE after the current actual TDW.
			* FFS: no more than 1 TPC command is expected to take effect during an actual TDW.

For the action of UE specific TPC commands,* We prefer a common design for both PUSCH and PUCCH. The proposal seems incorrect for PUCCH. Firstly, only non-zero TPC command has potential impact. Secondly, in TDD, each PUCCH slot in PUCCH repetition can be associated with multiple DL DCIs in multiple DL slots. Because all of the DCIs are received before the first PUCCH slot, the multiple TPC commands in these DL DCIs should not trigger any event that violates power consistency and phase continuity. Thirdly, for PUSCH with UE-specific TPC, the proposal is unnecessary if such event never occurs.
 |
| QC | We think we are over complicating things here. We want to make some clarifying remarks.A group-common DCI is addressed to a group of UEs (via TPC-PUSCH RNTI; this RNTI can be commonly assigned to a group of UEs). It carries multiple payloads, but each payload is meant for a unique UE. The portion of the payload that is relevant to a UE is indicated by the higher layer parameter *tpc-index*. Thus, while the delivery mechanism (DCI signaling) is shared across many UEs, the message itself is unique to a UE.In this sense, there are only UE-specific TPC commands. We are not saying that such DCIs cannot be sent. We are only saying that the payload meant for a UE engaging in bundling should not require a tx power change. I don’t think Proposal 10 is helping matters here. We should either choose to treat TPC as an error case (i.e., UE does not expect TPC commands to take effect during a bundling TDW) or treat it as an event and start a new bundle. |
| Ericsson | Support the proposalRegarding Alt 5: We’re not sure our intention is clear with this proposal. If the network sends only one command, there will be no ambiguity, and the UE will not have to select among the commands. If the UE does receive multiple commands, then of course the We think the benefits could be: * Simplified UE implementation, and equivalent performance to Alts. 1& 3.
* More flexible gNB implementation, since gNB can send its single command at any time that meets the timeline for the end of the window.

On the other hand, we do sympathize with comments that it would be simpler to make group common power control commands events. |

## 3.4 TA adjustment

**FL comments:** In RAN 1#106b-e, the majority support that the action of TA commands does not constitute an event and down select one of the following options. Let’s focus on the discussion on the following two options.

* The action of TA commands does not constitute an event that violates power consistency and phase continuity, down select one of the following options.
	+ Option 1: UE performs TA adjustment after the actual TDW if it receives any TA command indicating TA adjustment during the actual TDW.
		- FFS: UE receives no more than 1 TA command whose action time falls within an actual TDW.
	+ Option 2: UE performs TA adjustment after the configured TDW if it receives any TA command indicating TA adjustment during the configured TDW.
		- FFS: UE receives no more than 1 TA command whose action time falls within a configured TDW.

Companies are encouraged to provide pros and cons of the above two options.

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| **Companies** | **Option 1** | **Option 2** |
| ZTE | Similar as our comment to TPC. We suggest to simply consider TA as an event without introducing additional rules. This is because, TA is indicated by MAC CE, and would not happen frequently during PUSCH/PUCCH repetitions. | Same comments as for Option 1.  |
| QC | This is a general remark. Similar to our comment on TPC commands, the only meaningful justification we have received was from Huawei who said this needs to be treated as an event since the gNB is probably sending this due to issues with uplink multi-user operation. Barring this, we see no reason why a gNB should be sending TA commands. So here again we expect gNB to exercise some restraint. We should either treat this as an error case or as an event. |  |
| vivo | Pro: apply the TA adjustment as early as possible | Cons: possible large latency due to the configured window length |
| Nokia/NSB | Cons: Option 1 is not applicable for unpaired spectrum. The notion of current actual TDW would be unclear in this case, given that **the reception of a PDSCH carrying MAC CE does not occur during an actual TDW for unpaired spectrum.**@ZTE: it does not make sense to consider TA command as an event because the event is the reception of the PDSCH carrying the MAC CE. | Pros: Option 2 can be used as a unified solution for both paired and unpaired spectrum. |
| Intel | Same comment for TPC command.  |  |
| CMCC | Pro: the actual TDW has less latencies compared with the configured TDW |  |
| Samsung | Pros: better performance | Cons: lower performance |
| InterDigital | Pro : Application of TA at the earliest opportunity |  |
| LG | The time duration for gNB expects for UE not to adjust the TA command is shorter than option 2. | It could be simpler to be described since the the length of configured TDW is indicated by gNB. |
| Xiaomi | Pro: actual TDW has less latency compared with configured TDW |  |
| Sharp | Pros: It can perform TA adjustment faster than Option 2 |  |
| Ericsson | Pros: It could in theory allow TA to be faster, but this is only relevant when PUSCH has long repetitions. Cons: The design needs to take into account events and ATDWs. | Pros: Better matched to the use case: TA changes very slowly.Simpler than relying on events.Timing may be more straightforward to define. |

#### Updated proposal after GTW Nov. 11th.

**FL comments:** Based on the discussion during GTW session, the proposed working assumption by Chair can be a starting point for discussion.

**Proposed Working assumption**

* Based on the assumption the timeline of TA in effect is deterministic, the action of TA commands constitutes an event that violates power consistency and phase continuity
* Note: if the timeline of TA in effect is not is deterministic, the working assumption will be revisited.

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| **Companies** | **Comments** |
| CATT | OK to make it a working assumption.We do not think DMRS bundling will be beneficial if the TA mis-alignment is un-tolerable from gNB’s point of view. The gNB may be unable to perform correct channel estimation regardless DMRS are bundled or not. UE reaction to TA command shall be as soon as possible. Allowing TA constitutes an event makes TA procedure unchanged, so legacy behaviour is not affected by the newly introduced JCE feature. |
| NTT DOCOMO | Although we prefer not to treat the action of TA command as an event, but we are fine with the proposal for the sake of progress.Just need to correct the typo as follow * Note: if the timeline of TA in effect is not ~~is~~ deterministic, the working assumption will be revisited.
 |
| Nokia/NSB | Support the proposed working assumption with the minor typo correction from NTT DOCOMO. |
| Samsung | A TA should not be an event that interrupts the TDW. When the time to apply the TA (based on legacy TA timeline) happens to be within a TDW, the application of the TA can be postponed to after the TDW. The infrequent MAC CE based TA command should not be viewed in a same manner as the DCI-based relatively frequent TPC commands that, for DCI 2\_2, it is impossible for a NW to avoid and it is important for a UE to maintain a current CLPC state by updating at the end of the TDW. |
| Huawei, HiSilicon | Support the proposal. Different from TPC adjustment, TA adjustment should be an event. If it is not considered as an event, the TA adjustment cannot respond immediately. It impacts not only the current PUSCH transmission, but also the uplink transmissions from other UEs due to ICI. Secondly, TA adjustment impacts on both PUCCH and PUSCH. If a gNB is required not to send TA within any configured TDW, then the gNB may never have a chance to send it because the configured TDWs of PUSCH and PUCCH may never be aligned especially in case that configured TDW were agreed per PUCCH resource. Thirdly, since the effective timing of TA command is fixed and in reference to PDSCH slot carrying the TA command, a gNB may not find any DL slot to send TA command that can be effective in a given UL slot because of TDD UL/DL configuration, e.g. DSUU where S has very few DL symbols for PDCCH only. |
| Ericsson | Since TA changes slowly, we think there is no need to make a more complicated design based on events and ATDWs. However, we can accept the WA for progress. (After some checking we expect the timeline should not be an issue). |

## 3.5 JCE for PUSCH repetition type B and TBoMS

**FL comments:** Based on the agreements, joint channel estimation (DM-RS bundling) is supported for PUSCH repetition type B and TBoMS. One issue raised about the configured TDW determination for PUSCH repetition type B and TBoMS is the counting method. There are two counting methods for PUSCH repetition type A, i.e., counting based on physical slots and counting based on available slots.

**Proposal 7:**

* The TDW determination procedure agreed for PUSCH repetition type A is applicable for PUSCH repetition type B and TBoMS.
	+ The configured TDWs determination procedure for PUSCH repetition type A counting based on physical slots is applied for PUSCH repetition type B.
	+ The configured TDWs determination procedure for PUSCH repetition type A counting based on available slots is applied for TBoMS.
* No additional specification enhancements for PUSCH repetition type B and TBoMS.

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| **Companies** | **Comments** |
| NTT DOCOMO | Support the proposal. |
| ZTE | Support  |
| vivo | Support the proposal.  |
| Spreadtrum | The main bullet can be limited to the configured TDW procedure, with the revision below:The configured TDW determination procedure agreed for PUSCH repetition type A is applicable for PUSCH repetition type B and TBoMS |
| Nokia/NSB | Can we remove the “configured” from the above proposal? Similar to FL’s proposal 8, the whole TDW determination procedure for PUSCH repetition type A should be reused, not only the configured TDW determination procedure. Therefore, we propose to modify the proposal as follows.**Proposal 7:*** The TDW determination procedure agreed for PUSCH repetition type A is applicable for PUSCH repetition type B and TBoMS.
	+ The ~~configured~~ TDWs determination procedure for PUSCH repetition type A counting based on physical slots is applied for PUSCH repetition type B.
	+ The ~~configured~~ TDWs determination procedure for PUSCH repetition type A counting based on available slots is applied for TBoMS.
* No additional specification enhancements for PUSCH repetition type B and TBoMS.
 |
| Intel | We are fine with the proposal.  |
| Samsung | We are okay with Proposal 7. |
| InterDigital | Support |
| LG | It is our understanding that counting based on physical slot is supported for TBoMS. Moreover since it is already agreed to support PUSCH repetition type B and TBoMS if it reuses enhancements for PUSCH repetition type A. |
| WILUS | We support the proposal. |
| CATT | Support the proposal. |
| Xiaomi | Support the proposal |
| Sharp | We are OK with the proposal. |
| TCL | Support the proposal. |
| Apple | Ok with this Proposal. |
| Ericsson | Ok with the proposal |

**FL comments:** Another issue is whether DM-RS bundling and TDW determination can be applied to repetition of TBoMS.

**Proposal 8:**

* DM-RS bundling for repetition of TBoMS is supported.
* The TDW determination procedure agreed for PUSCH repetition type A is applicable for repetition of TBoMS.

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| **Companies** | **Comments** |
| NTT DOCOMO | Support the proposal. |
| ZTE | Support the proposal, with the following suggested revisions.The TDW determination procedure agreed for PUSCH repetition type A counting based on available slots is applicable for repetition of TBoMS. |
| vivo | Agree with revision from ZTE. |
| Spreadtrum | Support the revision from ZTE. |
| Nokia/NSB | Support the FL’s proposal. Modification from ZTE seems to be correct. |
| Intel | We are fine with the update from ZTE. Suggest to add “No additional specification enhancement is needed” |
| Samsung | Fine with proposal 8. |
| InterDigital | @FLWe have a clarification question. We have the following restarting behaviour which was agreed.“For UE capable of restarting DM-RS bundling, the start of the new actual TDW is the first ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for PUSCH transmission after the event violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.”Regarding the above restarting behavior, when it is applied to TBoMS repetitions, does “...the first ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for PUSCH transmission after the event” correspond to the first PUSCH transmission of the next TBoMS transmission occasion after the event? |
| LG | Similar comment as proposal 7. |
| Panasonic  | We support with the proposal 8 with the modification from ZTE. |
| CATT | Support the proposal.  |
| Xiaomi | Fine with the proposal. |
| Sharp | We are OK with the proposal. |
| Apple | Ok with this proposal |
| Huawei, HiSilicon | ZTE’s version seems better.  |
| Ericsson | Also prefer ZTE’s version |

1. Email discussion (2nd round)

## 4.1 Use cases for joint channel estimation

**FL comments:** It seems the majority are fine with proposal 1.

@Nokia/NSB, Intel: Though from FL understanding, if other uplink transmission in the middle of two PUSCH/PUCCH transmissions has the same setting with PUSCH transmission, DMRS bundling can be supported as long as power consistency and phase continuity can be maintained. However, considering the clear majority support of proposal 1 and we are running out of time and the latest LS R4-2120002 from RAN4 does not cover this issue, it seems the best choice is to make it as an event.

**Proposal 1:**

* For non-back-to-back PUSCH/PUCCH transmissions across consecutive slots, the other uplink transmission in the middle of two PUSCH/PUCCH transmissions constitutes an event that violates power consistency and phase continuity.

**Support:** DOCOMO, ZTE, Qualcomm, Spreadtrum, CMCC, Lenovo, Motorola Mobility, Samsung, LG, WILUS, Panasonic, CATT, Xiaomi, Sharp, TCL, Apple, Huawei, HiSilicon, Ericsson

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| **Companies** | **Comments** |
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## 4.2 Time domain window

### 4.2.1 Configured TDW

#### Issue #1: The window length *L* of the configured TDW

#### Issue #1-2: Configuration/Indication of L

**FL comments:** It seems the majority support proposal 3.

@DOCOMO, Panasonic: From FL understanding, it may be beneficial to support dynamic indication of the window length. However, considering the clear majority support of proposal 3 and lack of simulation results, it seems difficult to support dynamic indication.

**Proposal 3:**

* Dynamic indication of the window length *L* of the configured TDW by DCI or indicated by TDRA table with one additional entry is not supported.

**Support:** ZTE, vivo, Nokia/NSB, Intel, Lenovo, Motorola Mobility, Samsung, LG, WILUS, CATT, Xiaomi, Sharp, Apple, Huawei, HiSilicon, Ericsson

**Not support:** DOCOMO, Panasonic

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| **Companies** | **Comments** |
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#### Issue #1-3: Candidate values of L

**FL comments:** It seem the majority support proposal 4-v2. Regarding whether L can be equal to 1, for PUSCH repetition type A and TBoMS, it depends on whether dynamic indication of L is supported. If dynamic indication is supported, supporting L=1 means dynamic switching between JCE and non-JCE is supported. Otherwise, it seems not necessary to support L=1. For PUSCH repetition type B, supporting L=1 means JCE within one slot is supported while JCE across slots is not supported.

**Proposal 4-v2:**

* The candidate values of the window length *L* of the configured TDW can be any integer value that is larger than 1 and no larger than the maximum duration.

**Support:** ZTE, Qualcomm, vivo, Spreadtrum, Intel, CMCC, Lenovo, Motorola Mobility, Samsung, LG, WILUS, Panasonic, CATT, Xiaomi, Sharp, TCL, Apple, Nokia/NSB, Samsung, Huawei, HiSilicon, Ericsson

Considering L=1 is beneficial for PUSCH repetition type B, companies are encouraged to provide views whether L=1 can be supported.

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| **Companies** | **Comments** |
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#### Issue #1-4: Counting of L based on available slots

**FL comments:** From FL understanding, based on the working assumption, each configured TDW consists of one or multiple consecutive physical slots, regardless of the counting based on physical slots or available slots. While the start of the configured TDW depend on the counting method, i.e., physical slots or available slots. However, it seems it is necessary to clarify the agreement for PUSCH repetition type A counting based on available slots.

According to the agreed WF (R4-2120003) in RAN4, the number of slots for maximum duration means the consecutive slots. In case of non-scheduled gap and/or other channel transmission, the duration of the non-scheduled gap and/or other channel should be counted.

**Proposal 12:** The following agreement is clarified as follows.

* For PUSCH repetition type A counting based on available slots,
	+ One configured TDW consists of one or multiple consecutive physical slots.
	+ “The configured TDWs are determined based on available slots” in the agreement means “The start of the configured TDWs is determined based on available slots”

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| **Agreement*** For PUSCH repetition type A counting based on physical slots
	+ The configured TDWs are consecutive, where the start of other configured TDWs is the first physical slot right after the last physical slot of a previous configured TDW.
* For PUSCH repetition type A counting based on available slots
	+ The configured TDWs are determined based on available slots, where start of a configured TDWs is the first available slot after the last available slot of a previous configured TDW.
	+ Note: The determination of available slots for PUSCH repetition Type A is defined in AI 8.8.1.1.
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| **Companies** | **Comments** |
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### 4.2.2 Actual time domain window

#### Issue #2: The determination of actual TDW

#### Issue #2-1: The start/end of the actual TDW

**FL comment:** It seems the majority are fine with proposal 5.

@ Spreadtrum, LG, TCL, From FL understanding, the raised issues can be discussed separately from the confirmation of the working assumption.

**Proposal 5: Confirm the following working assumption**

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| **Working assumption:*** The start of the first actual TDW is the first ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for the first PUSCH transmission in an available slot within the configured TDW.
* The end of the actual TDW is
	+ the last ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for the last PUSCH transmission in an available slot within the configured TDW if the actual TDW reaches the end of the last PUSCH transmission within the configured TDW.
	+ the last ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ of the PUSCH transmission right before the event if an event occurs that violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.
* For UE capable of restarting DM-RS bundling, the start of the new actual TDW is the first ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for PUSCH transmission after the event violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.
 |

**Support:** DOCOMO, ZTE, Qualcomm, Nokia/NSB, Intel, CMCC, Lenovo, Motorola Mobility, Samsung, InterDigital, WILUS, Panasonic, CATT, Xiaomi, Sharp, Apple, Huawei, HiSilicon, Ericsson.

Companies are encourage to provide views on the following issues.

1. The first/last symbol determined other than TDRA table raised by Spreadtrum.
2. The reduced slot due to TA adjustment raised by LG.
3. Partial PUSCH cancellation raised by TCL.

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| **Companies** | **Comments** |
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#### Issue #2-2: Events that violate power consistency and phase continuity

**FL comments:** Regarding the change of transmission parameters, it seems controversial whether it should be regard as an event. Note that whether action of TPC command or frequency hopping is an event is discussed separately. Regarding UL CA, as we discussed in previous meetings, most companies think UL CA is not the typical case for coverage enhancements. As commented by some companies, at least the following issues should be clarified.

1. For PUSCH repetition type A/B and TBoMS, why UL beam/TPMI, BWP, Tx, RB allocation would be changed?
2. The action of TPC commands is under discussion, what’s the difference between Tx power and TPC commands?
3. Is it necessary to consider UL beam switching for multi-TRP operation?

The proponents are encouraged to answer the first two questions and companies are encouraged to answer the last question.

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| **Companies** | **Comments** |
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**FL comments:** It seems companies have different understandings on precoder cycling. Based on companies’ views, there seems two kinds of precoder cycling, i.e., UE implementation based precoder cycling and UL beam switching for multi-TRP operation.

**Proposal 6-v2:**

* UE should not perform UE implementation based precoder cycling within the actual TDW.
* If DMRS bundling and UL beam switching for multi-TRP operation can be supported simultaneously, UL beam switching for multi-TRP operation constitutes an event that violates power consistency and phase continuity.

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| **Companies** | **Comments** |
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#### Issue #2-3: UE capability of restarting DMRS bundling

**FL comments:** As pointed out by Nokia, the main concern and reason for introducing UE capability of restarting after an event is that the UE may not be able to quickly react to a dynamic event and hence may not be able to support the restarting of DM-RS bundling after a dynamic event, depending on its capability. In contrast, all semi-static events are known to the UE before the first transmissions. The semi-static events are not subject to the missing DCI problem. Considering the motivation of introduced UE capability of restarting DMRS bundling, the analysis of pros and cons for each option, option 1 has better performance, as well as option 1 receives more support, I suggest to support option 1 with a note to clarify the definition of semi-static events and dynamic events.

* **Option 1:** If DM-RS bundling is supported, UE is mandatory to support restarting DM-RS bundling due to semi-static events. UE capability of restarting DMRS bundling is applied only to dynamic events.

**Support:** Nokia, NSB, vivo, OPPO, CTC, xiaomi, Sierra Wireless, Sharp, HW, HiSilicon, ZTE, CATT, Panasonic, InterDigital, LG(?)

* **Option 2:** UE capability of restarting DMRS bundling is applied to both semi-static events and dynamic events.

**Support:** Spreadtrum, CMCC, Lenovo, Motorola Mobility, MediaTek, Intel, Qualcomm

The pros and cons for each option are summarized the table below.

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| **Option 1** | **Option 2** |
| **Pros:** Better performance than option 2**Cons:** need to differentiate semi-static and dynamic eventsSome companies think classification of events is straightforward while some companies don’t think so. | **Pros:** a unified definition of events, no need to differentiate semi-static and dynamic events**Cons:** * worse performance than option 1;
* JCE can only be applied in the first bundle of PUSCH transmissions for FH and cannot be applied across any bundle of PUSCH transmissions after the first frequency hopping, within a configured TDW.
 |

**Proposal 13:**

* If DM-RS bundling is supported, UE is mandatory to support restarting DM-RS bundling due to semi-static events. UE capability of restarting DMRS bundling is applied only to dynamic events.
* Note: An event is regarded as a dynamic event if it is associated with a DCI, otherwise it is regarded as a semi-static event.

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| **Companies** | **Comments** |
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## 4.3 TPC command

**FL comments:** In last RAN1 meeting, almost all companies are fine with the following proposal. In this meeting, it is really surprising that there are a lot of concerns on this proposal.

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| * The action of TPC commands does not constitute an event that violates power consistency and phase continuity.
	+ If UE is configured to accumulate TPC commands, down select one of the following options.
		- Option 1: If UE receives TPC commands that would take into effect during an actual TDW, UE accumulates TPC commands without taking effect during the current actual TDW. TPC commands take effect after the current actual TDW.
		- Option 2: If UE receives TPC commands that would take into effect during a configured TDW, UE accumulates TPC commands without taking effect during the current configured TDW.
 |

**FL comment:** We have already spent great efforts on issues. From my understanding, it can work properly with either considering the action of common TPC commands as an event or not. The main difference is the UE behavior while different companies have different views. After last GTW, it seems a compromise to treat common TPC commands and UE specific non-zero TPC commands separately. Please note that this is the last RAN1 meeting before RAN1 freeze. We need to finalize this issue in this meeting. Proposal 10 is updated taking into account the comments from Huawei. **If you still have strong concerns, please do not just say you are not in favor of this proposal. Please provide constructive comments and persuade the other group to accept your proposal.**

**Proposal 10-v2:**

* The action of common TPC commands does not constitute an event that violates power consistency and phase continuity.
	+ If UE is configured to accumulate TPC commands, down select one of the following options.
		- Option 1: If UE receives TPC commands that would take into effect during an actual TDW, UE accumulates TPC commands without taking effect during the current actual TDW. TPC commands take effect after the current actual TDW.
		- Option 2: If UE receives TPC commands that would take into effect during a configured TDW, UE accumulates TPC commands without taking effect during the current configured TDW.
	+ If UE is not configured to accumulate TPC commands, down select one of the following alternatives.
		- Alt 1: the last TPC command that would take effect within a configured TDW supersedes all previous TPC commands that take effect within that configured TDW and only the last TPC command is applied by the UE after the current configured TDW.
			* FFS: no more than 1 TPC command is expected to take effect during a configured TDW.
		- Alt 3: the last TPC command that would take effect within an actual TDW supersedes all previous TPC commands that take effect within that actual TDW and only the last TPC command is applied by the UE after the current configured TDW.
			* FFS: no more than 1 TPC command is expected to take effect during an actual TDW.
		- Alt 5: The UE applies TPC commands after a configured TDW. It is left to UE implementation which TPC commands to apply from those that would take effect within the configured TDW.
* The action of UE specific TPC commands with non-zero values, if supported, constitutes an event that violates power consistency and phase continuity.

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| **Companies** | **Comments** |
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## 4.4 TA adjustment

**FL comments:** After checking the timeline, it seems the majority are fine with the proposed working assumption. Similar with TPC commands, we need to finalize this issue in this meeting. **If you still have strong concerns, please do not just say you are not in favor of this proposal. Please provide constructive comments and persuade the other group to accept your proposal.**

**Proposed Working assumption**

* Based on the assumption the timeline of TA in effect is deterministic, the action of TA commands constitutes an event that violates power consistency and phase continuity
* Note: if the timeline of TA in effect is not deterministic, the working assumption will be revisited.

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| **Companies** | **Comments** |
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## 4.5 JCE for PUSCH repetition type B and TBoMS

**FL comments:** It seems all companies are basically fine with proposal 7.

@Nokia, Agree that the whole TDW determination procedure for PUSCH repetition type A should be reused, which is the intention of the first main bullet. Regarding the sub-bullets, since only the determination of configured TDW depends on the counting method. To be complete, one sub-bullet for the determination of actual window can be added.

@LG, From FL understanding, TBoMS supports counting based on available slots for unpaired spectrum and supports counting based on physical slots for paired spectrum/SUL. To make it clearer, proposal 7 is updated.

**Proposal 7-2:**

* The TDW determination procedure agreed for PUSCH repetition type A is applicable for PUSCH repetition type B and TBoMS.
	+ The configured TDWs determination procedure for PUSCH repetition type A counting based on physical slots is applied for PUSCH repetition type B.
	+ The configured TDWs determination procedure for PUSCH repetition type A counting based on available slots is applied for TBoMS for unpaired spectrum.
	+ The configured TDWs determination procedure for PUSCH repetition type A counting based on physical slots is applied for TBoMS for paired spectrum/SUL.
	+ The actual TDWs determination procedure for PUSCH repetition type A is applied for PUSCH repetition type B and TBoMS.
* No additional specification enhancements for PUSCH repetition type B and TBoMS.

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| **Companies** | **Comments** |
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**FL comments:** Similar with proposal 7, only the determination of configured TDW depends on the counting method. And as pointed out by LG, TBoMS also supports counting based on physical slots for paired spectrum/SUL. Therefore, the suggested revision by ZTE seems not inclusive.

@InterDigital, It seems companies have different understandings on the transmission occasion of TBoMS, i.e., one slot or N slots of a single TBoMS. If the transmission occasion of TBoMS refers to one slot, then it corresponds to the first PUSCH transmission of the next TBoMS transmission occasion after the event. If the transmission occasion of TBoMS refers to N slots of a single TBoMS, it seems not reasonable to correspond to the first PUSCH transmission of the next TBoMS transmission occasion after the event.

**Proposal 8-v2:**

* DM-RS bundling for repetition of TBoMS is supported.
	+ The TDW determination procedure agreed for PUSCH repetition type A is applicable for repetition of TBoMS.
	+ No additional specification enhancement is needed.

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| **Companies** | **Comments** |
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1. Agreements at RAN1#107-e

**Agreement:**

**Support Option 1’-a**

**Option 1’-a:**

* If L is configured, the maximum value of window length L of the configured TDW should not exceed the maximum duration, which is reported as UE capability as the duration where UE is able to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.
* If L is not configured, the default value of L = min (maximum duration, duration of all PUSCH repetitions)
1. Agreements at RAN1#106b-e

**Agreement:**

* For PUSCH repetition type A counting based on physical slots
	+ The start of the first configured TDW is the first physical slot for the first PUSCH transmission.
	+ The end of the last configured TDW is the last physical slot for the last PUSCH transmission.
* For PUSCH repetition type A counting based on available slots
	+ The start of the first configured TDW is the first available slot for the first PUSCH transmission.
	+ The end of the last configured TDW is the last available slot for the last PUSCH transmission.
	+ Note: The determination of available slots for PUSCH repetition Type A is defined in AI 8.8.1.1.

**Conclusion:**

* Joint channel estimation over PUSCH transmissions across non-consecutive slots is not supported in Rel-17.

**Agreement:**

Down-select one of the following options in this meeting:

**Option 1**:

* The maximum value of window length *L* of the configured TDW should not exceed the maximum duration, which is reported as UE capability as the duration where UE is able to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.

**Option 1’:**

* The maximum value of window length L of the configured TDW should not exceed the maximum duration, which is reported as UE capability as the duration where UE is able to maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.
	+ - ~~If L is not configured, the configured TDW length is equal to all repetitions~~
		- If L is not configured, default behavior should be defined, e.g., the configured TDW length is equal to all repetitions

**Option 3’**:

* Whether the window length *L* of the configured TDW can be longer than maximum duration is subject to UE capability.
	+ If UE is capable of *L* being longer than maximum duration,
		- The maximum value of the window length *L* of the configured TDW is the duration of all repetitions.
			* FFS: whether *L* cannot be other values other than the duration of all repetitions, if it is longer than the maximum duration.
		- If *L* is longer than the maximum duration, UE does not expect dynamic events.
			* FFS: details of dynamic events

**Agreement**

* For DG-PUSCH, Type1 CG-PUSCH and Type2 CG-PUSCH, the window length L of the configured TDW is at least configured by RRC.
* FFS: For DG-PUSCH and Type2 CG-PUSCH, whether the window length *L* of the configured TDW can be indicated by DCI or indicated by TDRA table with one additional entry.

**Agreement**

* The window length L of the RRC configured TDW is configured separately for PUSCH and PUCCH.
	+ For PUSCH, *L* is configured per BWP.
* FFS whether the window length L can be configured with each row in the TDRA table

**Agreement**

* For PUSCH repetition type A counting based on physical slots
	+ The configured TDWs are consecutive, where the start of other configured TDWs is the first physical slot right after the last physical slot of a previous configured TDW.
* For PUSCH repetition type A counting based on available slots
	+ The configured TDWs are determined based on available slots, where start of a configured TDWs is the ~~next~~ first available slot after the ~~conclusion~~ last available slot of a previous configured TDW.
	+ Note: The determination of available slots for PUSCH repetition Type A is defined in AI 8.8.1.1.

**Working assumption:**

* The start of the first actual TDW is the first ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for the first PUSCH transmission in an available slot within the configured TDW.
* The end of the actual TDW is
	+ the last ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for the last PUSCH transmission in an available slot within the configured TDW if the actual TDW reaches the end of the last PUSCH transmission within the configured TDW.
	+ the last ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ of the PUSCH transmission right before the event if an event occurs that violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.
* For UE capable of restarting DM-RS bundling, the start of the new actual TDW is the first ~~available~~ symbol (at least determined by TDRA table) ~~in available slot~~ for PUSCH transmission after the event violates power consistency and phase continuity, and the PUSCH transmission is in an available slot.

**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 case:
	+ Over back-to-back PUSCH transmissions for one TB processed over multiple slots
		- It’s subject to UE capability
		- if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A

**Agreement**

* For non-back-to-back PUSCH transmissions across consecutive slots (no uplink transmission in the middle of two PUSCH transmissions), support necessary design aspects (under the condition of power consistency and phase continuity) to enable joint channel estimation for the following case:
	+ Over non-back-to-back PUSCH transmissions for one TB processed over multiple slots
		- It’s subject to UE capability
		- if it reuses only those joint channel estimation specification enhancements defined to support repetition Type A

**Agreement**

Down-select one of the following options:

* **Option 1:** If DM-RS bundling is supported, UE is mandatory to support restarting DM-RS bundling due to semi-static events. UE capability of restarting DMRS bundling is applied only to dynamic events.
* **Option 2:** UE capability of restarting DMRS bundling is applied to both semi-static events and dynamic events.

**Agreement**

* Support at least the following events that violate power consistency and phase continuity.
	+ Dropping/cancellation based on Rel-15/16 collision rules.
	+ FFS: Rel-17 collision rules.
	+ DL slot or DL reception/monitoring based on semi-static DL/UL configuration for unpaired spectrum.
	+ FFS: Other UL transmission in between PUSCH/PUCCH transmissions.
	+ Gap between two PUSCH/PUCCH transmissions exceeds 13 symbols.
	+ FFS: Transmission parameters need to be changed due to network-indicated operations, including: Tx power, UL beam/TPMI, and RB allocation.
	+ FFS: TPC command.
	+ FFS: TA adjustment.
	+ FFS: The actual TDW reaches the maximum duration.
	+ FFS: Frequency hopping.
	+ FFS: Precoder cycling.
	+ FFS: other events.
	+ FFS: whether events are semi-static events or dynamic events.
	+ FFS: the time duration of an event.

**Agreement**

* Introduce two RRC parameters to indicate enabling of DM-RS bundling and the window length of the configured TDW respectively.

**Agreement**

* Introduce a new RRC parameter for when UE restarts a PUSCH bundling window
1. Agreements at RAN1#106-e

**Agreement: Confirm the following working assumption.**

**Working assumption:**

* For non-back-to-back PUSCH transmissions (at least for the case of the same TB) 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
	+ 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
	+ Subject to UE capability with details FFS (e.g., separate vs. joint capability for type A & type B, w.r.t. OFF power requirements, etc.)
* FFS: Joint channel estimation over non-back-to-back PUSCH transmissions with other uplink transmissions between the two successive PUSCH transmissions across consecutive slot.

**Conclusion**

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

**Agreement**

* Joint channel estimation for PUSCH transmissions and the time domain window are jointly enabled or disabled via RRC configuration for a UE.
	+ 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.

**Agreement**

**Make down-selection between the following two alternatives:**

* Alt 1: UE is not expected to receive TPC commands during the current time domain window.
* Alt 2: UE receives and accumulates TPC commands without taking effect during the current time domain window.

**Agreement**

* UE should not perform TA adjustment during the time domain window.
	+ FFS: UE does not expect to receive TA command to indicate TA adjustment during the TDW.
	+ FFS: UE ignores any TA command which indicates TA adjustment during the TDW.
	+ FFS: UE performs TA adjustment after the TDW if it receives any TA command indicating TA adjustment during the TDW.

**Working assumption:**

For joint channel estimation for PUSCH repetition type A of PUSCH repetitions of the same TB, all the repetitions are covered by one or multiple consecutive/non-consecutive configured TDWs.

* Each configured TDW consists of one or multiple consecutive physical slots.
* The window length *L* of the configured TDW(s) can be explicitly configured with a single value ~~and~~ *~~L~~* ~~is no longer than the maximum duration~~.
	+ FFS: The maximum value of *L* ~~is the duration of all repetitions~~
	+ FFS: Solutions to error propagation issue if ~~for~~ *L* is longer than the maximum duration is to be discussed further.
	+ FFS: The window length *L* is configured per UL BWP
* The start of the first configured TDW is the first PUSCH transmission
	+ FFS: The first available slot/symbol, or the first physical slot/symbol for the first PUSCH transmission.
* The start of other configured TDWs can be implicitly determined prior to first repetition.
	+ FFS: The configured TDWs are consecutive for paired spectrum/SUL band
	+ FFS: The start of the configured TDWs for unpaired spectrum is implicitly determined based on semi-static DL/UL configuration.
* The end of the last configured TDW is the end of the last PUSCH transmission.
	+ FFS: The end of the configured TDW is the last available slot/symbol, or the last physical slot/symbol for the last PUSCH transmission.
* Within one configured TDW, one or multiple actual TDWs can be implicitly determined:
	+ The start of the first actual TDW is the first PUSCH transmission within the configured TDW.
		- FFS: The first available slot/symbol, or the first physical slot/symbol for the first PUSCH transmission.
	+ After one actual TDW starts, UE is expected to maintain the power consistency and phase continuity until one of the following conditions is met, then the actual TDW is ended.
		- The actual TDW reaches the end of the last PUSCH transmission within the configured TDW.
			* FFS: The end of the actual TDW is the last available slot/symbol, or the last physical slot/symbol for the last PUSCH transmission.
		- An event occurs that violates power consistency and phase continuity
			* FFS: The events may include e.g., a DL slot based on DL/UL configuration for unpaired spectrum, the actual TDW reaches the maximum duration, DL reception/monitoring occasion for unpaired spectrum, high priority transmission, frequency hopping, precoder cycling.
			* FFS: The end of the actual TDW is the last available slot/symbol of the PUSCH transmission right before an event such that the power consistency and phase continuity are violated.
	+ If the power consistency and phase continuity are violated due to an event, whether a new actual TDW is created is subject to UE capability of supporting restarting DMRS bundling.
		- If UE is capable of restarting DM-RS bundling, one new actual TDW is created after the event,
			* FFS: The start of the new actual TDW is the first available slot/symbol for PUSCH transmission after the event.
		- If UE is not capable of restarting DM-RS bundling, no new actual TDW is created until the end of the configured TDW.
		- FFS: UE capability of restarting DMRS bundling is applied only to dynamic event or not

Note 1: A ‘configured TDW’ refers to a time domain window whose length can be configured to ‘L’ and whose start and end is determined as described above.

Note 2: An ‘actual TDW’ refers to a time domain window during whose entire duration the DM-RS bundling is actually applied. An ‘actual TDW’ duration is always less than or equal to the ‘configure TDW’ duration.

Note 3: Whether the terms ‘configured TDW’ and ‘actual TDW’ are revised to other terms and if such terminology is used in specifications is to be further discussed.

1. Agreements at RAN1#105-e

Agreement**:**

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

Agreement:

* Definition of **the maximum duration**: a maximum time duration during which **UE is able to** maintain power consistency and phase continuity subject to power consistency and phase continuity requirements.
* FFS whether or not such a definition is necessary for RAN1 specifications.
	+ Note: whether such a definition is to be specified in RAN4 specifications is up to RAN4.
* FFS the maximum duration may be reported by UE.
* Note: it is understood that for a UE, the maximum duration is no less than the time domain window duration

Agreement: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 UL waveform (DFT-s-OFDM vs. OFDM)?
	+ Whether the maximum duration is band specific?
	+ Besides the factors listed above, whether or not the maximum duration is further dependent on UE capabilities (e.g., multiple possible values for a given set of factor(s)), and if so, whether the UE should report such a duration

Agreement:

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

Agreement:

* 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 with consecutive slots
		- 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.

**Working assumption:**

* For non-back-to-back PUSCH transmissions (at least for the case of the same TB) 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
	+ 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
	+ Subject to UE capability with details FFS (e.g., separate vs. joint capability for type A & type B, w.r.t. OFF power requirements, etc.)
* FFS: Joint channel estimation over non-back-to-back PUSCH transmissions with other uplink transmissions between the two successive PUSCH transmissions across consecutive slot.

Agreement:

* Joint channel estimation for PUSCH transmissions is enabled or disabled via RRC configuration for a UE
	+ FFS: whether additional dynamic signaling is needed to enable/disable joint channel estimation for PUSCH transmissions
	+ Note: the enabling of such a feature is subject to certain prerequisites
	+ FFS RRC parameter details (including explicit vs. implicit configuration)
* FFS For joint channel estimation for PUSCH, the time domain window is not explicitly enabled or disabled separately from joint channel estimation.

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.

Agreement:

For joint channel estimation for PUSCH repetition type A of PUSCH repetitions of the same TB, down select one of the following alternatives for the time domain window.

* Alt 1: All the repetitions are covered by one single time domain window
	+ The start of the window is the first PUSCH transmission
	+ FFS: how to handle non-consecutive physical slots for UL transmission, e.g., due to DL/UL configuration for unpaired spectrum
	+ FFS: frequency hopping and precoder cycling
* Alt 2: All the repetitions are covered by one or multiple time domain windows
	+ For the start of each window,
		- The start of the first window is the first PUSCH transmission.
		- FFS: how to determine the start of other windows, e.g., whether multiple windows are consecutive or non-consecutive, whether the start of the window depends on DL/UL configuration for unpaired spectrum
	+ For the length of each window,
		- FFS Each window consists of at least two adjacent physical slots for UL transmission.
		- The length of each window is no longer than the maximum duration.
		- FFS: how to determine the length of each window
		- FFS: whether the length of each window depends on DL/UL configuration for unpaired spectrum
	+ FFS: how to handle non-consecutive physical slots for UL transmission, e.g., due to DL/UL configuration for unpaired spectrum.
	+ FFS: frequency hopping and precoder cycling
* Other alternatives are not precluded.
1. Agreements at 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.
	+ FFS how the time domain window is determined (e.g., via explicit configuration and/or implicitly derived) and whether or not to have the possibility of enabling/disabling the time domain window
	+ FFS the units the time domain window (e.g. repetitions, slots, and/or symbols)
		- FFS : association between the potential use case(s) and units of the time window
	+ FFS: single or multiple time domain windows
* FFS: relation with UE capability
* FFS: whether the term "time domain window" is used in the specification or replaced by other technical terms
* FFS whether or not to further consider impacting of timing advance

**Agreements:**

* A new DMRS pattern equally spaced among PUSCH transmissions is not considered for joint channel estimation in Rel-17.

**Agreements:**

* For inter-slot frequency hopping with inter-slot bundling, down select on the following two options:
	+ Option 1: The bundle size (time domain hopping interval) equals to the time domain window size.
	+ Option 2: The bundle size (time domain hopping interval) can be different from the time domain window size.
		- 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

**Conclusion:**

* For optimization of DMRS granularity in time domain with joint channel estimation, the proponents are encouraged to provide more simulation results in next meeting

**Agreements:**

* For the time domain window for joint channel estimation, down select on the following two options:
	+ 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, if agreed
		- TBoMS, if agreed
		- Different TB, if agreed
	+ 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, if agreed
		- TBoMS, if agreed
		- Different TB, if agreed

**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.
		- 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 back-to-back PUSCH transmissions with different TBs
1. Agreements at RAN1#104e

**Agreements**:

* Following potential use cases are considered for joint channel estimation for PUSCH:
	+ Use case 1: back-to-back PUSCH transmissions within one slot.
	+ Use case 2: non-back-to-back PUSCH transmissions within one slot.
	+ Use case 3: back-to-back PUSCH transmissions across consecutive slots.
	+ Use case 4: non-back-to-back PUSCH transmissions across consecutive slots.
	+ Use case 5: PUSCH transmissions across non-consecutive slots.

Note: RAN1 assumes “back-to-back PUSCH transmission” has zero gap in-between adjacent PUSCH transmissions.

Agreements:

* 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 at least for the following case:
	+ Over back-to-back PUSCH transmissions (of the same TB) for repetition type A scheduled by dynamic grant or configured grant
	+ FFS details (including possible other cases)

Agreements:

* For joint channel estimation, ~~define~~ a time domain window is introduced to facilitate further discussion, during which UE is expected to maintain power consistency and phase continuity among PUSCH transmissions subject to power consistency and phase continuity requirements.
	+ FFS: whether the window should be specified
	+ FFS: the length of the time domain window is defined by a set of repetitions/slots/symbols
	+ FFS: single or multiple time domain windows
* FFS: relation with UE capability
* FFS: the time domain window may or may not be configured ~~or specified~~.
* FFS: whether the term "time domain window" is used in the specification or replaced by other technical terms
* FFS: Whether the window is determined by the power consistency and phase continuity requirements and/or by other factors is to be decided.

Agreements:

* Companies are encouraged to study optimization of DMRS granularity in time domain with joint channel estimation, including:
	+ Use cases
	+ Simulations results
	+ Enhanced schemes, e.g.,
		- Different DMRS density for different PUSCH transmissions
		- No DMRS for some PUSCH transmissions
	+ If applicable, impact of dynamic changes, e.g., cancellation of a repetition and companies report the evaluation method.
* Companies are encouraged to study optimization of DMRS location in time domain with joint channel estimation, including:
	+ Use cases
	+ Simulations results
	+ Enhanced schemes, e.g.,
		- DMRS equally spaced among PUSCH transmissions
		- DMRS located in special slots
		- Orphan symbol上 used for DMRS
	+ If applicable, impact of dynamic changes, e.g., cancellation of a repetition and companies report the evaluation method.
* Note: the simulation assumptions for DM-RS in TR 38.830 are used as baseline for performance evaluation on optimization of DMRS location/granularity in time domain.
	+ Take into account impairments such as frequency offset, and report corresponding parametrization together with the results. Further discuss impairment details.

**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

Agreements:

* For joint channel estimation.
	+ Take into account the residual frequency error, e.g., +/- 0.1 ppm as upper bound.
	+ Companies can report other values and frequency error model.
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17. R1-2111029 Remaining issues on joint channel estimation for PUSCH vivo
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19. R1-2111205 Discussion on joint channel estimation for PUSCH TCL Communication Ltd.
20. R1-2111273 Discussion on joint channel estimation for PUSCH CATT
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