**3GPP TSG RAN WG1 #108-e R1-22xxxxx**

**e-Meeting, February 21st – March 3rd, 2022**

**Agenda Item: 8.8.1.3**

**Source: Moderator (China Telecom)**

**Title: [108-e-R17-CovEnh-03] Summary of email discussion on joint channel estimation for PUSCH**

**Document for: Discussion**

1. Introduction

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

The detailed objectives are as follows.

* *Specification of PUSCH enhancements [RAN1, RAN4]*
  + *Specify the following mechanisms for enhancements on PUSCH repetition type A [RAN1]*
    - *Increasing the maximum number of repetitions up to a number to be determined during the course of the work.*
    - *The number of repetitions counted on the basis of available UL slots.*
  + *Specify mechanism(s) to support TB processing over multi-slot PUSCH [RAN1]*
    - *TBS determined based on multiple slots and transmitted over multiple slots.*
  + *Specify mechanism(s) to enable joint channel estimation [RAN1, RAN4]*
    - *Mechanism(s) to enable joint channel estimation over multiple PUSCH transmissions, based on the conditions to keep power consistency and phase continuity to be investigated and specified if necessary by RAN4 [RAN1, RAN4]*
      * *Potential optimization of DMRS location/granularity in time domain is not precluded*
    - *Inter-slot frequency hopping with inter-slot bundling to enable joint channel estimation [RAN1]*
* *Specification of PUCCH enhancements [RAN1, RAN4]*
  + *Specify signaling mechanism to support dynamic PUCCH repetition factor indication [RAN1]*
  + *Specify mechanism to support DMRS bundling across PUCCH repetitions [RAN1, RAN4]*
    - *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]*

Editors’ CRs on introduction of coverage enhancements have been approved in RAN#94e [3]. This contribution is a summary of the following email discussion.

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

* 1st check point: February 25
* Final check point: March 3

1. Background

## 2.1 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.

RAN1 has 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, 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) |
| Not support  (4b) | Not support  (4b) | Not support  (4b) |
| 5: PUSCH transmissions across non-consecutive slots | Not support | Not support | Not support | Not support |

## 2.2 The maximum duration

In the LS [4][5][7] and agreed way forward [6] in RAN4, RAN4 provided answers to the related questions about the maximum duration.

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| --- | --- |
| **RAN1’s questions** | **RAN4’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 [4].  Depend on the outcome of “What factors determine the maximum duration”. Note: 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 [6].  Values RAN4 being considered are 5, 8, 16 or 32 slots [7]. |
| 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 [4].  Phase and power tolerance within the duration [6]. |
| Whether the maximum duration should be the same for different cases for both PUSCH and PUCCH? | Yes [4]. |
| 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 [4].  No. Note: It has been agreed to only focus on the modulation orders not higher than QPSK [6]. |
| Whether the maximum duration is dependent on UL waveform (DFT-s-OFDM vs. OFDM)? | No [4]. |
| Whether the maximum duration is band specific? | The length of maximum duration is [6]:   * Option 1: Band specific * Option 2: FR specific   UE reports the single value per band [7]. |
| 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 [4].  Down select among the following options once we have the results of the simulations [6]:   * Option 1: Subject to a single maximum duration value.   + The value is defined for a given set of factors which are depends on the conclusion for the other issues under discussion. * Option 2: Subject to multiple maximum duration value and UE could report the supported value(s).   UE reports the single value per band from a set of up to 4 values, and RAN4 does not consider the value more than 32 slots for the capability for maximum duration. Values RAN4 being considered are 5, 8, 16 or 32 slots [7]. |

1. Summary of contributions in RAN1#107bis-e

## 3.1 Time domain window

#### Issue #1: Events that violate power consistency and phase continuity

##### Issue #1-1: Events for HD-FDD RedCap UE

Based on the contributions, companies’ views on the events for HD-FDD RedCap UE are summarized as follows:

* For HD-FDD RedCap UEs configured with DMRS bundling, an event is constituted for a case where a dropping or cancellation of a PUSCH transmission according dropping rules in [17.2, TS 38.213].

**Support:** Huawei, HiSilicon, LG, Spreadtrum

* For HD-FDD RedCap UEs configured with DMRS bundling, an event is constituted for a case where the gap between two consecutive PUSCH transmissions overlaps with any symbol of downlink reception or downlink monitoring even if neither of the repetitions overlaps with it.

**Support:** Huawei, HiSilicon, Nokia, NSB, CATT, Spreadtrum, Intel, TCL, LG, Ericsson, CMCC (?)

**CMCC**: Remove “even if neither of the repetitions overlaps with it”.

**Panasonic, vivo**: Replace “downlink reception or downlink monitoring” with “an SS/PBCH block provided by ssb-PositionInBurst”.

**Huawei** proposes to adopt the following 2 TPs**:**

**TP #1**

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| **3GPP TS 38.214**  **6.1.7 UE procedure for determining time domain windows for bundling DM-RS**  \*\*\* Unchanged text is omitted \*\*\*  - For PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B or TB processing over multiple slots, a dropping or cancellation of a PUSCH transmission according to clause 9, clause 11.1, clause 11.2A and clause 17.2 of [6, TS 38.213].  - For PUCCH transmissions of PUCCH repetition, a dropping or cancellation of a PUCCH transmission according to clause 9, clause 9.2.6, clause 11.1 and clause 17.2 of [6, TS 38.213].  \*\*\* Unchanged text is omitted \*\*\* |

**TP #2**

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| --- |
| **3GPP TS 38.214**  **6.1.7 UE procedure for determining time domain windows for bundling DM-RS**  \*\*\* Unchanged text is omitted \*\*\*  Events which cause power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or PUCCH transmissions of PUCCH repetition, within the nominal TDW, are:  - For PUSCH transmissions of PUSCH repetition type A or TB processing over multiple slots, the gap between two consecutive PUSCH transmissions, overlaps with any symbol of downlink reception or downlink monitoring even if neither of the repetitions overlaps with it.  - For PUCCH transmissions of PUCCH repetition, the gap between two consecutive PUCCH repetitions overlaps with any symbol of downlink reception or downlink monitoring even if neither of the repetitions overlaps with it.  \*\*\* Unchanged text is omitted \*\*\* |

**Spreadtrum** proposes to adopt the following TP**:**

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| **6.1.7 UE procedure for determining time domain windows for bundling DM-RS**  < Unchanged part is omitted >  Events which cause power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or PUCCH transmissions of PUCCH repetition, within the nominal TDW, are:  < Unchanged part is omitted >  - For PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B or TB processing over multiple slots, a dropping or cancellation of a PUSCH transmission according to clause 9, clause 11.1, clause 11.2A and clause 17.2 of [6, TS 38.213].  - For PUCCH transmissions of PUCCH repetition, a dropping or cancellation of a PUCCH transmission according to clause 9.2.6, clause 11.1 and clause 17.2 of [6, TS 38.213].  < Unchanged part is omitted > |

**Nokia** proposes to adopt the following TP**:**

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| **6.1.7 UE procedure for determining time domain windows for bundling DM-RS**  <<omitted text>>  Events which cause power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or PUCCH transmissions of PUCCH repetition, within the nominal TDW, are:   * A downlink slot or downlink reception or downlink monitoring based on *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* for unpaired spectrum. * A downlink reception or downlink monitoring for the case of reduced capability half-duplex UE in paired spectrum and SUL band.   <<omitted text>> |

**CATT** proposes to adopt the following TP**:**

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| **6.1.7 UE procedure for determining time domain windows for bundling DM-RS**  << unchanged text is omitted >>  Events which cause power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots,or PUCCH transmissions of PUCCH repetition, within the nominal TDW, are:  - A downlink slot or downlink reception or downlink monitoring ~~based on~~ *~~tdd-UL-DL-ConfigurationCommon~~* ~~and~~*~~tdd-UL-DL-ConfigurationDedicated~~* for unpaired spectrum.  - A downlink reception or downlink monitoring for reduced capability half-duplex UE for paired spectrum.  << unchanged text is omitted >> |

**Intel** proposes to adopt the following TP**:**

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| **------------------------------ TP#2: TS 38.214-----------------------------------**  **6.1.7 UE procedure for determining time domain windows for bundling DM-RS**  **< Unchanged text omitted >**  Events which cause power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or PUCCH transmissions of PUCCH repetition, within the nominal TDW, are:  - A downlink slot or downlink reception or downlink monitoring based on tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated for unpaired spectrum.  - For the case of reduced capability half-duplex UE, a downlink reception or downlink monitoring.  - The gap between any two consecutive PUSCH transmissions, or the gap between any two consecutive PUCCH transmissions, exceeds 13 symbols.  **< Unchanged text omitted >** |

##### Issue #1-2: Dynamic & semi-static events

In RAN1 #107bis-e meeting, the following two cases were discussed:

* Case 1: A semi-static event is triggered after one or multiple dynamic events. Whether a new actual TDW is created after the semi-static event?
* Case 2: A semi-static event overlaps with a dynamic event. Whether a new actual TDW is created after the semi-static event?

 

Fig. Illustration of case 1 Fig. Illustration of case 2

When UE is capable of restarting DMRS bundling, it’s clear that an actual TDW is created after either semi-static event or dynamic event for the above cases. When UE is not capable of restarting DMRS bundling, it seems the behavior of actual TDW generation is not clear.

Based on the contributions, when UE is not capable of restarting DMRS bundling, majority companies think that a new actual TDW is created after a semi-static event no matter whether there are dynamic events before the semi-static event or dynamic events overlaps with the semi-static event since UE can know semi-static events beforehand, while some companies think that DMRS bundling stops until the end of nominal TDW when dynamic events occur. Detailed companies’ views are summarized as follows.

* **Case 1:** If a semi-static event is triggered after one or multiple dynamic events
* Option 1-1: a new actual TDW is created after the triggered semi-static event.

**Support**: vivo, NTT DOCOMO, Nokia, NSB, CATT, CTC, Spreadtrum, CMCC, Samsung, TCL

* Option 1-2: a new actual TDW is not created after the triggered semi-static event.

**Support**: InterDigital, LG, Ericsson

* **Case 2**: If a semi-static event overlaps with a dynamic event
* Option 2-1: a new actual TDW is created after the triggered semi-static event.

**Support**: InterDigital, Nokia, NSB, CATT, CTC, Spreadtrum, CMCC, Samsung, TCL

* Option 2-2: a new actual TDW is not created after the triggered semi-static event.

**Support**: LG, Ericsson

**Nokia**: The confirmed working assumption in RAN1#107-e should be read in the context that UE capability of restarting DM-RS bundling is applied for dynamic events only, i.e., “if UE is not capable of restarting DM-RS bundling in response to dynamic events, no new actual TDW is created in response to dynamic events until the end of the configured TDW”.

**Samsung**: Additional RRC parameter description should be discussed to capture the corresponding agreement (if any) in the UE feature.

##### Issue #1-3: Invalid symbol pattern for PUSCH repetition type B

**Vivo** proposes that for PUSCH repetition type B, invalid symbol pattern which creates a gap more than 13 OFDM symbols should be considered as a semi-static event. This issue was discussed in the last meeting and companies’ views are summarized as follows.

Companies (**Qualcomm, ZTE, Panasonic, Apple, LG, Xiaomi**) think no additional clarification is needed.

Companies (**Nokia, Samsung, Sharp, Spreadtrum**) are fine with vivo’s proposal.

##### Issue #1-4: Events for multi-TRP operations

In RAN1 #107bis-e meeting, the following agreement was achieved in AI 8.8.2.

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| Agreement  PUCCH repetitions with different sets of power control parameters in multi-TRP operation should be regarded as a [semi-static] event that causes power consistency and phase continuity not to be maintained across PUCCH repetitions. |

**Intel** proposes thatPUSCH repetitions with different sets of power control parameters in multi-TRP operation should also be regarded as a semi-static event and proposes to adopt the following TP for PUSCH repetitions with different sets of power control parameters for multi-TRP operation**:**

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| **----------------------------------- TP#1: TS 38.214 -----------------------------------**  **6.1.7 UE procedure for determining time domain windows for bundling DM-RS**  **< Unchanged text omitted >**  - For PUCCH transmissions of PUCCH repetition, a dropping or cancellation of a PUCCH transmission according to clause 9, clause 9.2.6 and clause 11.1 of [6, TS 38.213].  - For any two consecutive PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, and when two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'noncodebook' or first and second sets of power control parameters are configured as described in [10, TS 38.321] and in clause 7.1.1 of [6, TS 38.213], a different SRS resource set association ~~is~~ or different power control parameters are used for the two PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, according to Clause 6.1.2.1.  - For any two consecutive PUCCH transmissions of PUCCH repetition, and when a PUCCH resource used for repetitions of a PUCCH transmission by a UE includes first and second spatial relations or first and second sets of power control parameters, as described in [10, TS 38.321] and in clause 7.2.1 of [6, TS 38.213], different spatial relations or different power control parameters are used for the two PUCCH transmissions of PUCCH repetition, according to Clause 9.2.6 of [6, TS 38.213].  **< Unchanged text omitted >**  The UE shall maintain power consistency and phase continuity within an actual TDW, across PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or across PUCCH transmissions of PUCCH repetition, in case the actual TDW is created in response to frequency hopping, or in response to the use of a different SRS resource set association or different power control parameters for the two PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, ~~[~~or in response to the use of different spatial relations for the two PUCCH transmissions of PUCCH repetition,~~]~~ or in response to any event not triggered by DCI or MAC-CE. The UE maintains power consistency and phase continuity within an actual TDW, across PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or across PUCCH transmissions of PUCCH repetition, in case the actual TDW is created in response to an event triggered by DCI other than frequency hopping or by MAC-CE, subject to UE capability.  **< Unchanged text omitted >** |

## 3.2 TPC command

#### Issue #2: Clarification of the Rel-15/16 legacy power control procedure

In RAN1 #107bis-e meeting, the following observations were discussed on the Rel-15/16 legacy power control procedure.

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| **Observations:**   * Clarification on whether absolute TPC command is supported for group common TPC with DCI format 2\_2 for Rel-15/16 is needed.   + If supported, whether the timeline of absolute TPC command follows the accumulate TPC command. * Clarification on the interpretation of the definition of for DG-PUSCH in TS 38.214 for Rel-15/16 is needed.   + Interpretation 1: is defined as the number of OFDM symbols after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUSCH transmission occasion i. With this interpretation, value of for a PUSCH transmission occasion is different from the one for another PUSCH transmission occasion among the same set of PUSCH repetitions for a TB.   + Interpretation 2: is defined as the number of OFDM symbols after a last symbol of a corresponding PDCCH reception and before a first symbol of the first PUSCH repetition for a TB. With this interpretation, value of for all PUSCH transmission occasions are the same for the TB. |

For the 1st observation, the majority companies think absolute TPC command is supported for group common TPC with DCI format 2\_2 and the timeline of absolute TPC command follow the accumulate TPC command, while some company doesn’t think so. For the 2nd observation, companies have different understandings on the interpretation of the definition of K\_PUSCH (i) for DG-PUSCH.

In RAN1 #107bis-e meeting, companies think it is necessary to clarify the UE behaviour in Rel-15 CR session. In RAN1 #108-e meeting, relevant contributions are submitted to Rel-15 CR session in AI 7.1. As per Chair’s guidance, this is handled in [108-e-NR-CRs-03].

#### Issue #3: TPC command

##### Issue #3-1: About the working assumption for group common TPC commands with format 2\_2

In RAN1 #107e, the following working assumption was achieved for TPC commands.

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| **Working assumption:**   * The action of group common TPC commands with format 2\_2 does not constitute an event that violates power consistency and phase continuity.   + If UE is configured to accumulate TPC commands,     - 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. TPC commands take effect after the current configured TDW.   + If UE is not configured to accumulate TPC commands     - 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. |

The majority companies (**Huawei, HiSilicon, Nokia, NSB, vivo, ZTE, OPPO, Sharp, CTC, Intel, Xiaomi, Samsung, TCL**) support to confirm the WA. Some companies (**Panasonic, Spreadtrum, Interdigital, LG, Ericsson**) propose only to confirm the main bullet and 1st sub-bullet, while **Apple** proposes only to confirm the main bullet. **LG** proposes to remove the 2nd sub-bullet.

Companies’ further views on the above WA are summarized as follows:

* Remove the FFS bullet.
  + **Support**: Huawei, HiSilicon, vivo, ZTE, Panasonic, CTC, Xiaomi, Samsung, TCL, CMCC
  + **Not Support**: Intel
* Replace all the “configured TDW” to “actual TDW”.
  + **Support**: Huawei, HiSilicon, CMCC

**CMCC** proposes the following modification:

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| **Working assumption:**   * The action of group common TPC commands with format 2\_2 does not constitute an event that violates power consistency and phase continuity.   + If UE is configured to accumulate TPC commands,     - If UE receives TPC commands that would take into effect during a ~~configured~~actual TDW, UE accumulates TPC commands without taking effect during the current ~~configured~~ actual TDW. TPC commands take effect after the current ~~configured~~ actual TDW.   + If UE is not configured to accumulate TPC commands     - T~~t~~he last TPC command that would take effect within a ~~configured~~actual 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~~actual TDW.       * ~~FFS: no more than 1 TPC command is expected to take effect during a configured TDW.~~ |

##### Issue #3-2: How to capture the working assumption in Issue #3-1

During the discussion in RAN1 #107bis-e meeting, three options are discussed on how to capture the working assumption in Issue #3-1 into the spec. Based on companies’ contributions, there can be two ways to go in RAN1#108-e.

* Alt.1: Down select one of Option 0 ~ 3.
  + **Option 0:** For DG PUSCH or PUCCH associated with a DCI, Keep Rel-15/16 legacy power control procedure.

**Support:** ZTE, NTT DOCOMO

* + **Option 1:** Legacy definition of is preserved for PUSCH transmissions without DM-RS bundling. Redefine for PUSCH transmissions within a nominal TDW in case of DM-RS bundling. e.g., is a number of symbols from *K* symbols before the start of the nominal time domain window including the transmission occasion *i* and before a first symbol of the transmission occasion *i*.

FFS: the value of K, e.g., K is “*a number of symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by k2 in PUSCH-ConfigCommon for active UL BWP of carrier of serving cell* ”.

**Support:** Nokia, NSB

* + **Option 2:** Modify the TPC command value set , e.g. if transmission occasion *i* is not the first transmission occasion within a nominal time domain window, then any TPC command values received via DCI format 2\_2 contained in the set are deleted and added to the set where *j* is a transmission occasion occurring after the end of the nominal time domain window.

**Support:** Qualcomm

* + **Option 3:** For group common TPC commands with format 2\_2, if UE is configured to accumulate TPC commands,
    - For a transmission occasion occurs within a nominal time domain window, , where transmission occasion is a first transmission occasion within the nominal time domain window.
    - For the first transmission occasion occurring after the nominal time domain window, , where is all the TPC command values that would take effect for the transmission occasions occurring after transmission occasion and no later than transmission occasion (i.e. including occasion *k* itself).

**Support at least the spirit**: CATT, Samsung, ZTE, Ericsson, Huawei, HiSilicon, vivo, Sharp, Intel, LG (?)

* Alt.2: It’s up to Editor how to capture TPC enhancement to support DMRS bundling into the specification.

**Apple:** For the absolute power control, in working assumption the last TPC command is applied by the UE after the current configured TDW, the received last TPC command could be smaller than the UE processing time, which could not be applied to the current configured TDW.

**CTC** has the following observation.

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| * All the three options on the TPC enhancement to support DMRS bundling can work properly for CG-PUSCH and DG-PUSCH. * For Option 1,   + The timeline is same for CG-PUSCH and DG-PUSCH.   + UE behavior for DG-PUSCH is different from legacy UE behavior. * For Option 2 and Option 3,   + The timeline is different for CG-PUSCH and DG-PUSCH.   + Legacy UE behavior for DG-PUSCH is kept. * Option 2 and Option 3 have the same effect on TPC commands. |

**CATT** has the following proposal.

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| For group common TPC commands with format 2\_2 for CG-PUSCH, if UE is configured to accumulate TPC commands,   * For a transmission occasion occurs within a nominal time domain window, , where transmission occasion is a first transmission occasion within the nominal time domain window. * For the first transmission occasion occuring after the nominal time domain window, , where is all the TPC command values that would take effect from symbols before the transmission occasions to symbols before the transmission occasion . |

**Samsung and ZTE** have the following proposal.

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| --- |
| If the UE is provided PUSCH-DMRS-bundling = ‘enable’, and for processing TPC command values provided by DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI,   * For a transmission occasion occurs within a nominal time domain window, , where transmission occasion is a first transmission occasion within the nominal time domain window. * For the first transmission occasion occuring after the nominal time domain window, , where is all the TPC command values that would take effect for the transmission occasions occurring after transmission occasion and no later than transmission occasion (i.e. including occasion k itself) |

**Qualcomm** proposes to capture the agreement on deferring TPC updates to the end of nominal TDWs using the following TP in 38.213, Section 7.1.1:

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| --- |
| “If the UE is provided *PUSCH-DMRS-Bundling* = ‘enabled’, and transmission occasion is not the last transmission occasion within a nominal time domain window, then any TPC command values received via DCI format 2\_2 contained in the set are deleted and added to the set where is a transmission occasion occurring after the end of the nominal time domain window.” |

**Ericsson** proposes that the Rel-15/16 (slot based) transmission occasion definitions are used to specify power control operation for DCI format 2\_2 and DMRS bundling and adopt the following TP for accumulated TPC operation.

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| If the UE is provided *PUSCH-DMRS-Bundling* = ‘enabled’, and for processing TPC command values provided by DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, if a transmission occasion containing a PUSCH transmission configured by *ConfiguredGrantConfig* occurs within a nominal time domain window determined as described in [6, TS 38.214], then , where transmission occasion is a first transmission occasion within the nominal time domain window. For a first transmission occasion after the transmission nominal time domain window, , with as defined above. |

**Huawei** proposes to adopt the following 2 TPs**:**

**TP#1** for case with accumulation of TPC commands (TS 38.213).

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| **7 Uplink Power control**  **7.1 Physical uplink shared channel**  **7.1.1 UE behaviour**  < Unchanged parts are omitted >  -  is the PUSCH power control adjustment state  for active UL BWP  of carrier  of serving cell  and PUSCH transmission occasion  if the UE is not provided *tpc-Accumulation*, where  - The  values are given in Table 7.1.1-1  -  is a sum of TPC command values in a set  of TPC command values with cardinality  that the UE receives between  symbols before PUSCH transmission occasion  and  symbols before PUSCH transmission occasion  on active UL BWP  of carrier  of serving cell  for PUSCH power control adjustment state , where  is the smallest integer for which  symbols before PUSCH transmission occasion  is earlier than  symbols before PUSCH transmission occasion   * If the UE is provided *PUSCH-DMRS-Bundling* =‘enabled’, and for processing TPC command values provided by DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, * , where = * If the transmission occasion is the first transmission occasion within an actual time domain window determined as described in[6, TS 38.214], or if the transmission occasion is a transmission occasion that is not within an actual time domain window, then , otherwise where the transmission occasion is the first transmission occasion within the same actual time domain window as the transmission occasion .   < Unchanged parts are omitted > |

**TP#2** for case without accumulation of TPC commands configured (TS 38.213).

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| **7 Uplink Power control**  **7.1 Physical uplink shared channel**  **7.1.1 UE behaviour**  < Unchanged parts are omitted >  -  is the PUSCH power control adjustment state for active UL BWP  of carrier  of serving cell  and PUSCH transmission occasion  if the UE is provided *tpc-Accumulation*, where  -  absolute values are given in Table 7.1.1-1   * If the UE is provided *PUSCH-DMRS-Bundling* =‘enabled’, and for processing TPC command values provided by DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, * , where = * If the transmission occasion is the first transmission occasion within an actual time domain window determined as described in[6, TS 38.214], or if the transmission occasion is a transmission occasion that is not within an actual time domain window, then , otherwise where the transmission occasion is the first transmission occasion within the same actual time domain window as the transmission occasion .   < Unchanged parts are omitted > |

**Nokia** proposes to adopt the following TP (TS 38.213):

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| **\*\*\*Unchanged text is omitted \*\*\***  **7.1.1 UE behaviour**  **\*\*\*Unchanged text is omitted \*\*\***  - is the PUSCH power control adjustment state for active UL BWP of carrier of serving cell and PUSCH transmission occasion if the UE is not provided *tpc-Accumulation*, where  - The values are given in Table 7.1.1-1  - is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUSCH transmission occasion and symbols before PUSCH transmission occasion on active UL BWP of carrier of serving cell for PUSCH power control adjustment state , where is the smallest integer for which symbols before PUSCH transmission occasion is earlier than symbols before PUSCH transmission occasion  - If the UE is provided *PUSCH-DMRS-Bundling* = ‘enabled’, is a number of symbols for active UL BWP of carrier of serving cell from K symbols before the first symbol of the nominal time domain window including the transmission occasion *i* and before a first symbol of the transmission occasion *i*, where the nominal time domain window is determined as described in[6, TS 38.214] and K is a number of symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP of carrier of serving cell .  - If the UE is not provided *PUSCH-DMRS-Bundling* = ‘enabled’,  - If a PUSCH transmission is scheduled by a DCI format, is a number of symbols for active UL BWP of carrier of serving cell after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUSCH transmission  - If a PUSCH transmission is configured by *ConfiguredGrantConfig*, is a number of symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP of carrier of serving cell  - If the UE has reached maximum power for active UL BWP of carrier of serving cell at PUSCH transmission occasion and , then  - If UE has reached minimum power for active UL BWP of carrier of serving cell at PUSCH transmission occasion and , then  - A UE resets accumulation of a PUSCH power control adjustment state for active UL BWP of carrier of serving cell to  - If a configuration for a corresponding value is provided by higher layers  - If a configuration for a corresponding value is provided by higher layers  where is determined from the value of as  - If and the UE is provided higher *SRI-PUSCH-PowerControl*, is the *sri-PUSCH-ClosedLoopIndex* value(s) configured in any *SRI-PUSCH-PowerControl* with the *sri-P0-PUSCH-AlphaSetId* value corresponding to  - If and the UE is not provided *SRI-PUSCH-PowerControl* or ,  - If , is provided by the value of *powerControlLoopToUse*  - If the UE is provided *PUSCH-DMRS-Bundling* = ‘enabled’ and *tpc-Accumulation,* is the PUSCH power control adjustment state *l* for active UL BWP *b* of carrier *f* of serving cell *c* and PUSCH transmission occasion *i*, which is identical for all transmission occasions belonging to a nominal TDW, and equal to the absolute value carried by the last TPC command before the first symbol of the nominal TDW including transmission occasion *i,* and provided by DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI  - If the UE is not provided *PUSCH-DMRS-Bundling* = ‘enabled’, is the PUSCH power control adjustment state for active UL BWP of carrier of serving cell and PUSCH transmission occasion  if the UE is provided *tpc-Accumulation*, where  - absolute values are given in Table 7.1.1-1  **\*\*\*Unchanged text is omitted \*\*\***  **7.2.1 UE behaviour**  **\*\*\*Unchanged text is omitted \*\*\***  - For the PUCCH power control adjustment state  for active UL BWP  of carrier  of primary cell  and PUCCH transmission occasion  -  is a TPC command value included in a DCI format scheduling a PDSCH reception for active UL BWP  of carrier  of the primary cell  that the UE detects for PUCCH transmission occasion , or is jointly coded with other TPC commands in a DCI format 2\_2 with CRC scrambled by TPC-PUCCH-RNTI [5, TS 38.212], as described in clause 11.3  -  if the UE is provided *twoPUCCH-PC-AdjustmentStates* and *PUCCH-SpatialRelationInfo* and  if the UE is not provided *twoPUCCH-PC-AdjustmentStates* or *PUCCH-SpatialRelationInfo*  - If the UE obtains a TPC command value from a DCI format scheduling a PDSCH reception and if the UE is provided *PUCCH-SpatialRelationInfo*, the UE obtains a mapping, by an index provided by *p0-PUCCH-Id*, between a set of *pucch-SpatialRelationInfoId* values and a set of values for *closedLoopIndex* that provide the  value(s). If the UE receives an activation command indicating a value of *pucch-SpatialRelationInfoId*, the UE determines the value *closedLoopIndex* that provides the value of  through the link to a corresponding *p0-PUCCH-Id* index  - If the UE obtains one TPC command from a DCI format 2\_2 with CRC scrambled by a TPC-PUCCH-RNTI, the  value is provided by the closed loop indicator field in DCI format 2\_2  -  is the current PUCCH power control adjustment state  for active UL BWP  of carrier  of primary cell  and PUCCH transmission occasion , where  - The  values are given in Table 7.1.2-1  -  is a sum of TPC command values in a set  of TPC command values with cardinality  that the UE receives between  symbols before PUCCH transmission occasion  and  symbols before PUCCH transmission occasion  on active UL BWP  of carrier  of primary cell  for PUCCH power control adjustment state, where  is the smallest integer for which  symbols before PUCCH transmission occasion  is earlier than  symbols before PUCCH transmission occasion  - If the UE is provided *PUCCH-DMRS-Bundling* = ‘enabled’, is a number of symbols for active UL BWP of carrier of serving cell from K symbols before the first symbol of the time domain window including the transmission occasion to the first symbol of the transmission occasion , where the time domain window is determined as described in[6, TS 38.214] and *K* is a number of  symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP  of carrier  of primary cell .  - If the UE is not provided *PUCCH-DMRS-Bundling* = ‘enabled’,  - If the PUCCH transmission is in response to a detection by the UE of a DCI format,  is a number of symbols for active UL BWP  of carrier  of primary cell  after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUCCH transmission  - If the PUCCH transmission is not in response to a detection by the UE of a DCI format,  is a number of  symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP  of carrier  of primary cell  - If the UE has reached maximum power for active UL BWP  of carrier  of primary cell  at PUCCH transmission occasion  and , then  - If UE has reached minimum power for active UL BWP  of carrier  of primary cell  at PUCCH transmission occasion  and , then  **\*\*\*Unchanged text is omitted \*\*\*** |

**Vivo** proposes to adopt the following TP:

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| ------------------------------------------------Start of TP#1 for section 7.1.1 of 38.213 V17.0.0----------------------------------  **7.1.1 UE behaviour**  If a UE transmits a PUSCH on active UL BWP of carrier of serving cell using parameter set configuration with index and PUSCH power control adjustment state with index , the UE determines the PUSCH transmission power in PUSCH transmission occasion as  [dBm]  where,  - is the UE configured maximum output power defined in [8-1, TS 38.101-1], [8-2, TS38.101-2] and [8-3, TS38.101-3] for carrier of serving cell in PUSCH transmission occasion .  <<unchanged text omitted>>  - is the PUSCH power control adjustment state for active UL BWP of carrier of serving cell and PUSCH transmission occasion if the UE is not provided *tpc-Accumulation*, where  - The values are given in Table 7.1.1-1  - is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUSCH transmission occasion and symbols before PUSCH transmission occasion on active UL BWP of carrier of serving cell for PUSCH power control adjustment state , where is the smallest integer for which symbols before PUSCH transmission occasion is earlier than symbols before PUSCH transmission occasion  - If the UE is provided PUSCH-DMRS-Bundling = ‘enabled’ and not provided *tpc-Accumulation*,,  - for a transmission occasion occurs within a nominal time domain window determined as described in [6, TS 38.214], , where transmission occasion is a first transmission occasion within the nominal time domain window;  - for the first transmission occasion occurs after the previous nominal time domain window, , where is all the TPC command values that would take effect between the first symbol of the previous nominal time domain window and the first symbol of the current nominal time domain window.  - If a PUSCH transmission is scheduled by a DCI format, is a number of symbols for active UL BWP of carrier of serving cell after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUSCH transmission  - If a PUSCH transmission is configured by *ConfiguredGrantConfig*, is a number of symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP of carrier of serving cell  - If the UE has reached maximum power for active UL BWP of carrier of serving cell at PUSCH transmission occasion and , then  - If UE has reached minimum power for active UL BWP of carrier of serving cell at PUSCH transmission occasion and , then  - A UE resets accumulation of a PUSCH power control adjustment state for active UL BWP of carrier of serving cell to  - If a configuration for a corresponding value is provided by higher layers  - If a configuration for a corresponding value is provided by higher layers  where is determined from the value of as  - If and the UE is provided higher *SRI-PUSCH-PowerControl*, is the *sri-PUSCH-ClosedLoopIndex* value(s) configured in any *SRI-PUSCH-PowerControl* with the *sri-P0-PUSCH-AlphaSetId* value corresponding to  - If and the UE is not provided *SRI-PUSCH-PowerControl* or ,  - If , is provided by the value of *powerControlLoopToUse*  - is the PUSCH power control adjustment state for active UL BWP of carrier of serving cell and PUSCH transmission occasion  if the UE is provided *tpc-Accumulation*, where  - absolute values are given in Table 7.1.1-1  - If the UE is provided PUSCH-DMRS-Bundling = ‘enabled’ and provided *tpc-Accumulation*,  - for a transmission occasion occurs within a nominal time domain window determined as described in [6, TS 38.214], then , where transmission occasion is a first transmission occasion within the nominal time domain window,  - for the first transmission occasion occurs after the previous nominal time domain window, , where is the last TPC command value that would take effect before the first symbol of the current nominal time domain window.  If the UE transmits a PUSCH associated with the first RS resource index , the UE applies the first value, the first value, and for determining . If the UE transmits a PUSCH associated with the second RS resource index , the UE applies the second value, the second value, and or if *twoPUSCH-PC-AdjustmentStates* is provided or not provided, respectively, for determining .  <<unchanged text omitted>>  ------------------------------------------------End of TP#1 for section 7.1.1 of 38.213 V17.0.0----------------------------------  ------------------------------------------------Start of TP#2 for section 7.2.1 of 38.213 V17.0.0----------------------------------  **7.2.1 UE behaviour**  If a UE transmits a PUCCH on active UL BWP of carrier in the primary cell using PUCCH power control adjustment state with index , the UE determines the PUCCH transmission power in PUCCH transmission occasion as  [dBm]  where  - is the UE configured maximum output power defined in [8-1, TS 38.101-1], [8-2, TS38.101-2] and [8-3, TS38.101-3] for carrier of primary cell in PUCCH transmission occasion  <<unchanged text omitted>>  - is the current PUCCH power control adjustment state for active UL BWP of carrier of primary cell and PUCCH transmission occasion , where  - The values are given in Table 7.1.2-1  - is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUCCH transmission occasion and  symbols before PUCCH transmission occasion on active UL BWP of carrier of primary cell for PUCCH power control adjustment state, where is the smallest integer for which symbols before PUCCH transmission occasion is earlier than symbols before PUCCH transmission occasion  - If the UE is provided PUCCH-DMRS-Bundling = ‘enabled’,  - for a transmission occasion occurs within a nominal time domain window determined as described in [6, TS 38.214], , where transmission occasion is a first transmission occasion within the nominal time domain window;  - for the first transmission occasion occurs after the previous nominal time domain window, , where is all the TPC command values that would take effect between the first symbol of the previous nominal time domain window and the first symbol of the current nominal time domain window.  - If the PUCCH transmission is in response to a detection by the UE of a DCI format, is a number of symbols for active UL BWP of carrier of primary cell after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUCCH transmission  <<unchanged text omitted>>  ------------------------------------------------End of TP#2 for section 7.2.1 of 38.213 V17.0.0---------------------------------- |

**OPPO** proposes to adopt the following TP (TS 38213-h00):

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| \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*Start of the TP\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  **7.1 Physical uplink shared channel**  <text omitted>  is the PUSCH power control adjustment state for active UL BWP of carrier of serving cell and PUSCH transmission occasion if the UE is not provided *tpc-Accumulation*, where  - The values are given in Table 7.1.1-1  - For PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2, PUSCH repetition Type A with a configured grant, PUSCH repetition Type B and TB processing over multiple slots, when PUSCH-DMRS-Bundling is enabled, if TPC command is received in DCI format 2\_2 and the TPC command would take into effect during a nominal TDW, as defined in clause 6.1.7 of [6, TS 38.214], the TPC commands is not applied during the nominal TDW and would be applied after the nominal TDW.  - is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUSCH transmission occasion and symbols before PUSCH transmission occasion on active UL BWP of carrier of serving cell for PUSCH power control adjustment state , where is the smallest integer for which symbols before PUSCH transmission occasion is earlier than symbols before PUSCH transmission occasion  - If a PUSCH transmission is scheduled by a DCI format, is a number of symbols for active UL BWP of carrier of serving cell after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUSCH transmission  - If a PUSCH transmission is configured by *ConfiguredGrantConfig*, is a number of symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP of carrier of serving cell  - If the UE has reached maximum power for active UL BWP of carrier of serving cell at PUSCH transmission occasion and , then  - If UE has reached minimum power for active UL BWP of carrier of serving cell at PUSCH transmission occasion and , then  - A UE resets accumulation of a PUSCH power control adjustment state for active UL BWP of carrier of serving cell to  - If a configuration for a corresponding value is provided by higher layers  - If a configuration for a corresponding value is provided by higher layers  where is determined from the value of as  - If and the UE is provided higher *SRI-PUSCH-PowerControl*, is the *sri-PUSCH-ClosedLoopIndex* value(s) configured in any *SRI-PUSCH-PowerControl* with the *sri-P0-PUSCH-AlphaSetId* value corresponding to  - If and the UE is not provided *SRI-PUSCH-PowerControl* or ,  - If , is provided by the value of *powerControlLoopToUse*  - is the PUSCH power control adjustment state for active UL BWP of carrier of serving cell and PUSCH transmission occasion  if the UE is provided *tpc-Accumulation*, where  - absolute values are given in Table 7.1.1-1  - For PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2, PUSCH repetition Type A with a configured grant, PUSCH repetition Type B and TB processing over multiple slots, when PUSCH-DMRS-Bundling is enabled, if TPC command(s) is received in DCI format 2\_2 , and if one or more TPC command(s) that would take effect in a nominal TDW, as defined in clause 6.1.7 of [6, TS 38.214], are received, only the last TPC command is applied after the nominal TDW while the others are omitted.  <text omitted>  \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*End of the TP\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* |

**Intel** proposes to adopt the following TP**:**

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| **-----------------------------------TP#3: TS 38.213-----------------------------------** **7.1.1 UE behaviour** **< Unchanged text omitted >**  - is the PUSCH power control adjustment state for active UL BWP of carrier of serving cell and PUSCH transmission occasion if the UE is not provided *tpc-Accumulation*, where  - The values are given in Table 7.1.1-1  - is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUSCH transmission occasion and symbols before PUSCH transmission occasion on active UL BWP of carrier of serving cell for PUSCH power control adjustment state , where is the smallest integer for which symbols before PUSCH transmission occasion is earlier than symbols before PUSCH transmission occasion  - If the UE is provided *PUSCH-DMRS-bundling* = ‘enable’, and for processing TPC command values provided by DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, where is the first transmission occasion within a nominal time domain window determined as described in [6, TS 38.214] and is a transmission occasion within the nominal time domain window after .  - If a PUSCH transmission is scheduled by a DCI format, is a number of symbols for active UL BWP of carrier of serving cell after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUSCH transmission  - If a PUSCH transmission is configured by *ConfiguredGrantConfig*, is a number of symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP of carrier of serving cell  - If the UE has reached maximum power for active UL BWP of carrier of serving cell at PUSCH transmission occasion and , then  - If UE has reached minimum power for active UL BWP of carrier of serving cell at PUSCH transmission occasion and , then  - A UE resets accumulation of a PUSCH power control adjustment state for active UL BWP of carrier of serving cell to  - If a configuration for a corresponding value is provided by higher layers  - If a configuration for a corresponding value is provided by higher layers  where is determined from the value of as  - If and the UE is provided higher *SRI-PUSCH-PowerControl*, is the *sri-PUSCH-ClosedLoopIndex* value(s) configured in any *SRI-PUSCH-PowerControl* with the *sri-P0-PUSCH-AlphaSetId* value corresponding to  - If and the UE is not provided *SRI-PUSCH-PowerControl* or ,  - If , is provided by the value of *powerControlLoopToUse*  - is the PUSCH power control adjustment state for active UL BWP of carrier of serving cell and PUSCH transmission occasion  if the UE is provided *tpc-Accumulation*, where  - absolute values are given in Table 7.1.1-1  - If the UE is provided *PUSCH-DMRS-bundling* = ‘enable’, and for processing TPC command values provided by DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, where is the first transmission occasion within a nominal time domain window determined as described in [6, TS 38.214] and is a transmission occasion within the nominal time domain window after .  **< Unchanged text omitted >** |

**Sharp** proposes to adopt the following TP**:**

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| **7.1.1 UE behaviour**  <Unchanged parts are omitted>  - is the PUSCH power control adjustment state for active UL BWP of carrier of serving cell and PUSCH transmission occasion if the UE is not provided *tpc-Accumulation*, where  - The values are given in Table 7.1.1-1  - is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUSCH transmission occasion and symbols before PUSCH transmission occasion on active UL BWP of carrier of serving cell for PUSCH power control adjustment state , where is the smallest integer for which symbols before PUSCH transmission occasion is earlier than symbols before PUSCH transmission occasion   * If the UE is provided *PUSCH-DMRS-Bundling* = ‘enabled’, and for processing TPC command values provided by DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, ), where is determined such that PUSCH transmission occasion is the first PUSCH transmission occasion within the nominal TDW if PUSCH transmission occasion is within the nominal TDW and not the first PUSCH transmission occasion within the nominal TDW.   - If a PUSCH transmission is scheduled by a DCI format, is a number of symbols for active UL BWP of carrier of serving cell after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUSCH transmission  <Unchanged parts are omitted> |

**LG** proposes that Only TPC commands expected to be applied within nominal TDW when joint channel estimation is not enabled should be accumulated and are updated in units of nominal TDW and proposes to adopt the following TP:

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| ================== Start of Text Proposal for TS38.213 ==================  **7.1.1 UE behaviour**  <--------------------------------------Other parts are omitted-------------------------------------->  - is the PUSCH power control adjustment state for active UL BWP of carrier of serving cell and PUSCH transmission occasion if the UE is not provided *tpc-Accumulation*, where  - The values are given in Table 7.1.1-1  - When *PUSCH-DMRS-Bundling* is enabled and if transmission occasion is within the first nominal TDW, is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUSCH transmission occasion and symbols before PUSCH transmission occasion on active UL BWP of carrier of serving cell for PUSCH power control adjustment state , where is the largest integer that transmission occasion and transmission occasion are within same nominal TDW and is the smallest integer for which symbols before PUSCH transmission occasion is earlier than symbols before PUSCH transmission occasion  - When *PUSCH-DMRS-Bundling* is enabled and if transmission occasion is not within the first nominal TDW, is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUSCH transmission occasion and symbols before PUSCH transmission occasion on active UL BWP of carrier of serving cell for PUSCH power control adjustment state , where is the largest integer that transmission occasion and transmission occasion are within same nominal TDW and is the largest integer that transmission occasion is within the previous nominal TDW, for which symbols before PUSCH transmission occasion is earlier than symbols before PUSCH transmission occasion  - When *PUSCH-DMRS-Bundling* is not enabled, is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUSCH transmission occasion and symbols before PUSCH transmission occasion on active UL BWP of carrier of serving cell for PUSCH power control adjustment state , where is the smallest integer for which symbols before PUSCH transmission occasion is earlier than symbols before PUSCH transmission occasion  - If a PUSCH transmission is scheduled by a DCI format, is a number of symbols for active UL BWP of carrier of serving cell after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUSCH transmission  <--------------------------------------Other parts are omitted-------------------------------------->  - is the current PUCCH power control adjustment state for active UL BWP of carrier of primary cell and PUCCH transmission occasion , where  - The values are given in Table 7.1.2-1  - When *PUCCH-DMRS-Bundling* is enabled, is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUCCH transmission occasion and symbols before PUCCH transmission occasion on active UL BWP of carrier of primary cell for PUCCH power control adjustment state, where is the smallest integer for which symbols before PUCCH transmission occasion is earlier than symbols before PUCCH transmission occasion  - is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUCCH transmission occasion and symbols before PUCCH transmission occasion on active UL BWP of carrier of primary cell for PUCCH power control adjustment state, where is the smallest integer for which symbols before PUCCH transmission occasion is earlier than symbols before PUCCH transmission occasion  - is a sum of TPC command values in a set of TPC command values with cardinality that the UE receives between symbols before PUCCH transmission occasion and  symbols before PUCCH transmission occasion on active UL BWP of carrier of primary cell for PUCCH power control adjustment state, where is the smallest integer for which symbols before PUCCH transmission occasion is earlier than symbols before PUCCH transmission occasion  <--------------------------------------Other parts are omitted-------------------------------------->  ================== End of Text Proposal for TS38.213 ================== |

## 3.3 RRC parameters

**Nokia, Panasonic**: The value range for both *PUSCH-TimeDomainWindowLength* and *PUCCH-TimeDomainWindow Length* is INTEGER (2, ..., 32).

**ZTE:**

* *The value range of PUSCH-TimeDomainWindowLength is INTEGER (2..32).*
* *The value range of PUCCH-TimeDomainWindowLength is INTEGER (2..8).*

**Ericsson:** Inform RAN4 that the minimum value that can be reported as a maximum duration for DMRS bundling at least for TDD should be no less than 8, and is preferably larger from a RAN1 perspective.

## 3.4 Others

**The start of configured TDW for CG PUSCH**

The issue was discussed during RAN1 #107bis-e meeting. According to the discussion, it seems the majority think the current spec is clear, which is aligned with the agreements and the Interpretation 2 illustrated in the following figure. **Samsung** proposes for CG-PUSCH, the start of first nominal TDW should be the first allocated slot in a configured grant periodicity.



**High power UE**

**Vivo:** For high power UE, if DMRS bundling is enabled, the power class for Tx power setting should be determined prior to the first PUSCH transmission within one configured TDW.If the percentage of uplink symbols transmitted in a certain evaluation period would exceed the duty cycle in the upcoming configured TDW, UE should reduce transmission power from the first repetition and adopt the same transmission power for all repetitions in the configured TDW.



**Figure 1. Example of power change at UE due to high duty cycle**

**Precoding cycling**

**Panasonic**: Specify that a UE expects to perform the same precoder of precoding cycling within an actual TDW.

**PT-RS**

**InterDigital:** Support enabling PT-RS during DM-RS bundling

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

**CA/DC:**

**MediaTek:** JCE is not supported for CA/DC cases in R-17.

**Applicability of DMRS Bundling**

**Qualcomm**: Restrict DMRS bundling for PUSCH to only MCS values that correspond to QPSK or lower modulation orders.

**Autonomous UE Tx power changes**

**MediaTek:** JCE may be affected by UE autonomous Tx power changes due to PL changes and P-MPR changes satisfying SAR requirements. Our preference would be for RAN4 to not restrict the UE’s ability to perform those functions during JCE. Proposal: No restriction on UE autonomous power adjustments (e.g., due to PL changes or P-MPR changes) for JCE.

**OPPO** proposes to adopt the following TP for clarification on describing first PUSCH transmission, available slot and downlink monitoring (TS 38.214-h00)**:**

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| \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*Start of the TP\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  **6.1.7 UE procedure for determining time domain windows for bundling DM-RS**  <text omitted>  - For PUSCH transmission of a PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2 and PUSCH repetition Type A with a configured grant, when *AvailableSlotCounting* is enabled, and for TB processing over multiple slots:  - The start of the first nominal TDW is the first slot determined for the first PUSCH transmission.  - The end of the last nominal TDW is the last slot determined for the last PUSCH transmission.  - The start of any other nominal TDWs is the first slot determined for PUSCH transmission after the last slot determined for PUSCH transmission of a previous nominal TDW.  - For PUSCH transmissions of a PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2 and PUSCH repetition Type A with a configured grant, when the UE is not configured with *AvailableSlotCounting* or when *AvailableSlotCounting* is disabled, and for PUSCH repetition type B:  - The start of the first nominal TDW is the first slot scheduled for the first PUSCH transmission.  - The end of the last nominal TDW is the last slot scheduled for the last PUSCH transmission.  - The start of any other nominal TDWs is the first slot after the last slot of a previous nominal TDW.  - For PUCCH transmissions of a PUCCH repetition:  - The start of the first nominal TDW is the first slot determined for the first PUCCH transmission.  - The end of the last nominal TDW is the last slot determined for the last PUCCH transmission.  - The start of any other nominal TDWs is the first slot determined for PUCCH transmission after the last slot determined for PUCCH transmission of a previous nominal TDW.  For PUSCH transmissions of a PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2, PUSCH repetition Type A with a configured grant, PUSCH repetition Type B and TB processing over multiple slots, a nominal TDW consists of one or multiple actual TDWs. The UE determines the actual TDWs as follows:  - The start of the first actual TDW is the first symbol of the first PUSCH transmission in a slot determined for PUSCH transmission of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots within the nominal TDW.  - The end of an actual TDW is  - The last symbol of the last PUSCH transmission in a slot determined for PUSCH transmission of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots within the nominal TDW, if the actual TDW reaches the end of the last PUSCH transmission within the nominal TDW.  - The last symbol of a PUSCH transmission before the event, if an event occurs which causes power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots within the nominal TDW, and the PUSCH transmission is in a slot determined for PUSCH transmission of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A ~~wth~~ with a configured grant, or PUSCH repetition type B or TB processing over multiple slots.  -<text omitted>  Events which cause power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or PUCCH transmissions of PUCCH repetition, within the nominal TDW, are:  - A downlink slot or downlink reception ~~or downlink monitoring~~ based on *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* for unpaired spectrum. Or, downlink RS or PDCCH monitoring as descried in clause 5, clause 6 and clause 11 of [6, TS 38.213].  - The gap between any two consecutive PUSCH transmissions, or the gap between any two consecutive PUCCH transmissions, exceeds 13 symbols.  <text omitted>  \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*End of the TP\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* |

1. Email discussion (1st round)

## 4.1 Time domain window

#### Issue #1: Events that violate power consistency and phase continuity

##### Issue #1-1: Events for HD-FDD RedCap UE

**Proposal 1a:**

* For HD-FDD RedCap UEs configured with DMRS bundling, an event is constituted for a case where a dropping or cancellation of a PUSCH transmission according dropping rules in [17.2, TS 38.213].

Companies are encouraged to provide comments on the above proposal.

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| **Company** | **Comments** |
| Huawei, HiSilicon | Support. |
| ZTE | Fine with the proposal. |
| QC | Support |
| vivo | Support. |
| Panasonic | For proposals 1a and 1b, it is not clear whether "an event is constituted for a case " is a dynamic event or semi-static event as it is not described in the texts. We would like to clarify the intention of FL for the proposals 1a and 1b shown as follows?   * Firstly, just to agree it as an event in either proposal 1a or proposal 1b * Secondly, depending on whether it is triggered by dynamic or semi-static manner, the event is further categorized as a dynamic event or semi-static event   @FL, please share your intention/view if we missed anything. Thanks. |
| InterDigital | Support |
| NTT DOCOMO | Support the proposal. |
| Intel | We are fine with the proposal. |
| LG | Fine with the proposal. |
| Ericsson | OK |
| CATT | Support. |
| Samsung | We don’t think there is a need for an agreement or a conclusion. Whether it is a HD-FDD RedCap UE or non-RedCap UE, if the UE can’t transmit in a slot, DMRS bundling would be interrupted. |
| Xiaomi | Support |
| Sharp | Support |
| Spreadtrum | Support |
| Apple | OK |
| CMCC | Support |

**Proposal 1b:**

* For HD-FDD RedCap UEs configured with DMRS bundling, an event is constituted for a case where the gap between two consecutive PUSCH transmissions overlaps with any symbol of downlink reception or downlink monitoring even if neither of the repetitions overlaps with it.

Companies are encouraged to provide comments on the above proposal.

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| **Company** | **Comments** |
| Nokia/NSB | Support the proposal |
| Huawei, HiSilicon | Support. |
| ZTE | The event could be simplified as downlink reception or downlink for HD-FDD. |
| QC | Support |
| vivo | Support the proposal in principle. |
| Panasonic | Same comment as the above for the proposal 1a |
| InterDigital | Support |
| NTT DOCOMO | Support the proposal. |
| Intel | We are fine with the proposal 1b in principle. We suggest to update this as follows.  **Proposal 1b:**   * For HD-FDD RedCap UEs configured with DMRS bundling, an event is constituted for a case where the gap between two consecutive PUSCH transmissions overlaps with any symbol of downlink reception or downlink monitoring ~~even if neither of the repetitions overlaps with it~~.   It is up to editor to capture this in the spec. |
| LG | Fine with the proposal. |
| Ericsson | Support |
| CATT | Support. |
| Samsung | Support. |
| Xiaomi | Support |
| Sharp | Support |
| Spreadtrum | Support |
| Apple | OK |
| CMCC | Support |
| CMCC | Support |

##### Issue #1-2: Dynamic & semi-static events

**FL comments:** This issue was raised in RAN1#107b-e and many contributions discuss this issue in RAN1#108-e. Companies have different understandings on the current spec and agreements. Clarification is needed.

**Proposed observation:**

Clarification on the following two cases is needed.

* Case 1: A semi-static event is triggered after one or multiple dynamic events. Whether a new actual TDW is created after the semi-static event?
* Case 2: A semi-static event overlaps with a dynamic event. Whether a new actual TDW is created after the semi-static event?

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| **Company** | **Comments** |
| Nokia/NSB | Yes, in our view and based on current specification wording, a new actual TDW is always created after a semi-static event even if the semi-static event is triggered after one or multiple dynamic events or overlaps with a dynamic event. While discussing the UE capability of restarting DM-RS bundling in response to dynamic event, it was argued by the proponents that the main reason for introducing UE capability of restarting DM-RS bundling in response to dynamic events is that some UEs may not have capability of quickly reacting to dynamic events and hence cannot be prepared beforehand for maintaining power consistency and phase continuity. This difficulty does not exist for semi-static events, which are known beforehand by RRC configuration, even if they end up overlapping or being after dynamic events. Therefore, regardless of whether dynamic events happen before a semi-static event or not, the UE should always be able to prepare a new actual TDW after the semi-static event. |
| ZTE | We agree more discussion is needed.  In the following figure, the semi-static event is after the dynamic grant in slot 2. The UE should be able to re-start the TDW from slot 3 as it has enough preparation time for the semi-static time. For the dynamic event at the beginning of slot 4, it may or may not trigger a new TDW based on the UE capability.    Figure 1  Similarly, if the semi-static event is before or overlaps with the dynamic event, The UE should also be able to trigger a new TDW at the beginning of slot 3.   * For slot 2 in Figure 1, if the dynamic event is at the end of the slot (or saying at the beginning of slot 3), it is the case that semi-static event is before the dynamic event. * For slot 2 in Figure 1, if the semi-static event is also at the beginning of event, e.g., the first symbol is a semi-static DL symbol, it is the case that two events overlap with each other.   Overall, our understanding is: 1) A new TDW shall be always created if it is triggered by a semi-static event, no matter it is before or after or overlapping with a dynamic event. 2) A new TDW is not created if it is only triggered by a dynamic event and the UE has no capability of re-starting DMRS bundling. |
| QC | We assume this is in the context of a UE that has not indicated a capability to resume bundling after a dynamic event. For such a UE, we should not assume any further capability after a dynamic event has occurred.  This is already quite clear from previous agreements. No further discussion is needed. |
| vivo | Support a new actual TDW is created for Case 1 and Case 2. |
| Panasonic | Yes for both cases 1 and 2 because UE is mandatory to support restarting DM-RS bundling due to semi-static event as shown in the following agreement.   |  | | --- | | **Agreement:**   * 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.   + An event is regarded as a dynamic event if it is triggered by a DCI or MAC-CE, otherwise it is regarded as a semi-static event.   + Note: At least frequency hopping event is considered as semi-static event. | |
| InterDigital | In our understanding, a UE not capable of restarting bundling after a dynamic event, does not restart bundling before the end of the configured TDW. This seemed to be the intention of the confirmed WA of RAN1#107-e (“If UE is not capable of restarting DM-RS bundling, no new actual TDW is created until the end of the configured TDW.”). This seems simpler from UE (and possibly NW) implementation perspective and testing.  We are fine to apply this principle to both Case 1 and Case 2, i.e. UE does not restart in that Case 2 either. |
| NTT DOCOMO | Agree with the proposed observations. It is better to clarify the two scenarios. |
| Intel | Case 1: based on the existing agreement, it is clear that if a semi-static event is triggered after one or multiple dynamic events, UE will not restart the DMRS bundling if UE does not support restarting of DMRS bundling after dynamic events.  Case 2: our view is that this could be considered as a corner case. It is not clear to us why we need to consider simultaneous semi-static and dynamic events for DMRS bundling. |
| LG | We would like to point out an agreement made in the previous meeting before discussion.  **Agreement:**  Update the description of the RRC parameters *PUSCH-Window-Restart* and *PUCCH-Window-Restart* as follows*.*   * UE bundles PUSCH DM-RS remaining in a nominal time domain window after ~~dynamic~~ event(s) triggered by DCI or MAC-CE that violate power consistency and phase continuity requirements * UE bundles PUCCH DM-RS remaining in a nominal time domain window after ~~dynamic~~ event(s) triggered by DCI or MAC-CE that violate power consistency and phase continuity requirements   Note: Events ~~should be excluded,~~ which are triggered by DCI or MAC CE, but regarded as semi-static events, e.g. frequency hopping, UL beam switching for multi-TRP operation, or other if defined, are excluded.  It is our understanding that only for the UE with capability, actual TDW is created after the dynamic event according to the description of UE with capability. Since the description of capability depends on the dynamic event only, whether it is overlapped with semi-static event or not does not matter. Therefore for both of cases, a new actual TDW is created for UE with capability only following previous agreement. |
| Ericsson | Similar understanding as Qualcomm regarding if a UE does not support restarting DMRS bundling: as soon as a dynamic event occurs, bundling stops until the end of the current nominal TDW, regardless of the presence of a semi-static event.  If a UE does support restarting DMRS bundling, the symbols excluded from bundling are the union of the symbols of all events, regardless of the types of the events.  Therefore, the current definition of events in 38.214 seems clear with respect to the interaction of dynamic and semi-static events. |
| CATT | We share similar understanding with Nokia and ZTE. For both cases, we think a new actual TDW should be restarted. |
| Samsung | We don’t think there is a need to agree to these observations. Proposal 2 seems to be sufficient. |
| Xiaomi | Support a new actual TDW is created for Case 1 and Case 2. |
| Sharp | We are fine with the observation. |
| Spreadtrum | Share similar view as Nokia/NSB. Yes to both cases. |
| CMCC | Support a new TDW is created for both Case 1 and Case 2. |

**FL comments:** Based on companies’ contributions, the majority support a new actual TDW is created after a semi-static event no matter whether there are dynamic events before the semi-static event or dynamic events overlaps with the semi-static event since UE can know semi-static events beforehand.

**Proposal 2:**

For UEs not capable of restarting DM-RS bundling,

* If a semi-static event is triggered after one or multiple dynamic events, a new actual TDW is created after the triggered semi-static event.
* If a semi-static event overlaps with a dynamic event, a new actual TDW is created after the triggered semi-static event.
* Note: No specification impact is expected.

Companies are encouraged to provide comments on the above proposal.

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| **Company** | **Comments** |
| Nokia/NSB | Support the proposal |
| ZTE | As discussed above, we think adopting the following conclusion seems more accurate.   1. A new TDW shall be always created if it is triggered by a semi-static event, no matter it is before or after or overlapping with a dynamic event. 2. A new TDW is not created if it is only triggered by a dynamic event and the UE has no capability of re-starting DMRS bundling. |
| QC | Do not support. This is not in line with previous agreements. Please also see response to the observation above. |
| vivo | Support the proposal. Current spec is clear and confirms to the majority understanding. |
| Panasonic | Support the proposal 2. |
| InterDigital | Do not support, based on explanation above. |
| NTT DOCOMO | Support the proposal. |
| Intel | We do not see the need for the first sub-bullet. As mentioned above, our understanding is that if a semi-static event is triggered after one or multiple dynamic events, UE will not restart the DMRS bundling based on existing agreement if UE does not support restarting of DMRS bundling after dynamic events.  For the second bullet, we are fine to make the procedure clear, although we think this is the corner case and no need to optimize it in maintenance phase. |
| LG | As commented in previous observation, we think the previous agreement regarding RRC parameter *PUSCH-Window-Restart* and *PUCCH-Window-Restart* should be revised to support this proposal. |
| Ericsson | Do not support, given the reasons above. |
| CATT | Support. |
| Samsung | Fine with the proposal.  A description needs to be added in the corresponding UE feature - we suggest to add Note2 as follow:  **Proposal 2-v1:**  For UEs not capable of restarting DM-RS bundling,   * If a semi-static event is triggered after one or multiple dynamic events, a new actual TDW is created after the triggered semi-static event. * If a semi-static event overlaps with a dynamic event, a new actual TDW is created after the triggered semi-static event. * Note1: No specification impact is expected. * Note2: Additional RRC parameter description should be discussed to capture this agreement in the UE feature. |
| Xiaomi | Support |
| Sharp | Support |
| Spreadtrum | Support the proposal |
| CMCC | Fine with the 1st two bullets. But considering though based on current TP companies still have different understanding, we are not sure if the there won’t be any specification impact. |

**FL comments:** Companies not supporting the above Proposal 2 are encouraged to provide comments on how to understand the following agreement if there are dynamic events in the first hop within the nominal TDW.



**Agreement:**

* DMRS bundling shall be restarted at the beginning of each frequency hop.

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| **Company** | **Comments** |
| QC | No, such a UE will not be capable of restarting bundling in subsequent hops. That’s precisely what the UE capability is trying to convey. Not sure what the confusion here is.  This UE is designed to be incapable to reprogramming its RF after the dynamic event to continue supporting bundling in the remaining duration. We don’t see why we should impose any further restrictions on such a UE. |
| InterDigital | The UE does not restart DMRS bundling in this case. The quoted agreement is actually a portion (sub-bullet) of a larger agreement made to define interaction between inter-slot frequency hopping and DMRS bundling for PUCCH/PUSCH repetitions, within PUCCH AI in RAN1#107e. It does not concern the issue of whether to restart or not after dynamic event. |
| Intel | Our understanding is that frequency hopping is neither considered as semi-static nor dynamic event. UE would restart the DMRS bundling if frequency hopping occurs. This may not be related to the above proposals. |
| LG | Since it was agreed that frequency hopping is “considered as semi-static event” and captured in TS 38.214 as following, it is our understanding that actual TDW is created for every hop with and without capability. We do not see any controversial point here.  <TS38.214>  The UE maintains power consistency and phase continuity within an actual TDW, across PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or across PUCCH transmissions of PUCCH repetition, in case the actual TDW is created in response to an event triggered by DCI other than frequency hopping or by MAC-CE, subject to UE capability. |
| Ericsson | From RAN1#107, we have the following agreed. We think the behavior should be clear for a UE not capable of restarting DM-RS bundling (for dynamic events).   * + 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 |

##### Issue #1-3: Invalid symbol pattern for PUSCH repetition type B

**Vivo** proposes that for PUSCH repetition type B, invalid symbol pattern which creates a gap more than 13 OFDM symbols should be considered as a semi-static event.

Companies are encouraged to continue the discussion on the above proposal by vivo.

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| **Company** | **Comments** |
| Huawei, HiSilicon | Whether the invalid symbol pattern is applied or not still depends on the indicated value of a DCI field. Suggest proponents to clarify why it is a semi-static event.  TS 38.212  Invalid symbol pattern indicator – 0 bit if higher layer parameter *invalidSymbolPatternIndicatorDCI-0-1* is not configured; otherwise 1 bit as defined in Clause 6.1.2.1 in [6, TS 38.214].  TS 38.214, S6.1.2.1  - if the PUSCH is scheduled by DCI format 0\_1, or corresponds to a Type 2 configured grant activated by DCI format 0\_1, and if *invalidSymbolPatternIndicatorDCI-0-1* is configured,   * - if invalid symbol pattern indicator field is set 1, the UE applies the invalid symbol pattern; * - otherwise, the UE does not apply the invalid symbol pattern; |
| ZTE | There are two kinds of invalid symbols. The first one is configured by *numberOfInvalidSymbolsForDL-UL-Switching*, it should be regarded as a semi-static event. Another is configured by *invalidSymbolPattern*, which may or may not be enabled by DCI depending on whether *invalidSymbolPatternIndicatorDCI-0-1 or invalidSymbolPatternIndicatorDCI-0-2* is configured. So, it can be regarded as a semi-static event if not enabled by DCI or a dynamic event if can be enabled by DCI. Anyway, an event causing by a gap with more than 13 symbols is already captured in the specification, and whether it is a semi-static or dynamic event is also clear according to current specification. We don’t see any spec impact here. |
| vivo | The motivation is to clarify this is a semi-static event.  If invalid symbol pattern for PUSCH repetition type B is configured via *invalidSymbolPatternIndicatorDCI-0-1* or *invalidSymbolPatternIndicatorDCI-0-2*, invalid symbol pattern can be enabled by setting ‘invalid symbol pattern indicator’ field to 1 in DCI.  Frequency hopping, which is configured by RRC but triggered by the hopping flag field in DCI, is considered as the semi-static event as well. The reason to consider the frequency hopping as semi static event is the ‘frequency hopping flag’ is indicated together with the UL grant, which is known prior to the first PUSCH repetition. Hence, the event indicated by the same scheduling DCI can be considered as semi-static events.  Following the same logic, the invalid symbols pattern indicated by scheduling DCI for type B PUSCH repetition should also be considered as a semi-static event. |
| InterDigital | Prefer to still consider this a dynamic event. |
| NTT DOCOMO | We are fine with the proposal. However, it is against the agreement that the DMRS bundling mechanism is not optimized for PUSCH repetition type B. Hence, we prefer to deprioritize this issue if the consensus is not reached quickly. |
| Intel | We do not support the proposal. |
| LG | Just quick clarification. Isn’t it included in the following event? (captured from the list of events in TS 38.214)  - The gap between any two consecutive PUSCH transmissions, or the gap between any two consecutive PUCCH transmissions, exceeds 13 symbols. |
| Ericsson | The agreement to support repetition Type B was that it reuse only those mechanisms defined for repetition Type A. We do not think the proposal is in line with that agreement. |
| CATT | Taking invalid symbol pattern as an event is already captured in current spec, as pointed out by LG.  Whether it is dynamic or semi-static even is clearly defined by current spec, as point out by HW and ZTE. The reason we agree to consider inter-slot hopping as semi-static is to guarantee the JCE performance, since FH is widely use. Invalid symbol pattern seems not comparable to FH in this regard. |
| Xiaomi | Taking invalid symbol pattern as an event is already captured in current spec, as pointed out by LG. |
| Sharp | It is already specified as one of the events that “the gap between any two consecutive PUSCH transmissions exceeds 13 symbols”. |
| Spreadtrum | Prefer to regard this as a dynamic event. |
| Apple | We also consider this was covered by existing event, i.e., larger than 13 symbols, as pointed out by LG. |
| CMCC | Share similar view with LG, it should be covered by the gap in-between two transmissions. |
| FL | It seems most companies do no support this proposal. Suggest no further discussion in this meeting. |

##### Issue #1-4: Events for multi-TRP operations

**Intel** proposes thatPUSCH repetitions with different sets of power control parameters in multi-TRP operation should also be regarded as a semi-static event

Companies are encouraged to provide comments on the above proposal by Intel.

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| **Company** | **Comments** |
| Nokia/NSB | Support |
| vivo | In our understanding, for PUSCH repetition for multiple TRP operation, the power control parameter for different TRP is automatically changed since associated SRS resource are changed. Hence, current spec already covers this case. From the TPs provided by Intel, we do not recognize the intention to regard that as a semi-static event. |
| Panasonic | Support |
| Intel | Support |
| LG | Fine with the proposal. |
| Ericsson | Support |
| CATT | Support. |
| Samsung | Support |
| Xiaomi | Support |
| Sharp | Support |
| Spreadtrum | Support |
| Apple | Just want to clarify the relationship between the proposal and the below agreements. To us, the proposal seems already covered by the agreements. Configuring different set of power control parameter itself doesn’t change the UE behaviour, only UE switches the transmission to another TRP with another set of power control parameter could break the power consistency, thus, it’s an event.  Agreement  If DMRS bundling and UL beam switching for multi-TRP operation are configured simultaneously, UL beam switching for multi-TRP operation is regarded as a semi-static event. |
| CMCC | support |

## 4.2 TPC command

#### Issue #3: TPC command

##### Issue #3-1: About the working assumption for group common TPC commands with format 2\_2

**FL comments:** Since whether absolute TPC command is supported for group common TPC with DCI format 2\_2 is under discussion in [108-e-NR-CRs-03]. Let’s confirm accumulate TPC command first.

@Huawei, CMCC, regarding the comment “replace configured TDW with actual TDW”, from FL perspective, we have devoted great efforts and worked out this working assumption as a compromise in RAN1#107-e, I don’t think companies are willing to re-open the discussion.

@CMCC, Regarding the comment on absolute TPC command, I would like to check if there are other companies supporting the revision.

**Proposal 3:** For the following working assumption,

* Confirm the main bullet
* Confirm the 1st sub-bullet for accumulate TPC commands
* Keep the 2nd sub-bullet for absolute TPC commands as working assumption and remove FFS sub-bullet.

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| **Working assumption:**   * The action of group common TPC commands with format 2\_2 does not constitute an event that violates power consistency and phase continuity.   + If UE is configured to accumulate TPC commands,     - 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. TPC commands take effect after the current configured TDW.   + If UE is not configured to accumulate TPC commands     - 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. |

Companies are encouraged to provide comments on the above proposal.

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| **Company** | **Comments** |
| Nokia/NSB | Support FL proposal |
| Huawei, HiSilicon | Thanks for FL’s reply.  We understand that the current Working Assumption was a compromise. However, how the WA can be in line with the existing agreement is more important.   |  | | --- | | Agreement   * 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. |   According to the agreement above, the DG PUSCH transmission or URLLC transmission in Case 2 and Case 3 and Case 4 constitutes an event that violates power consistency and phase continuity for DMRS bundling for CG PUSCHs or eMBB PUSCHs, where Case 2 - 4 are,   * Case 2: CG PUSCH transmissions and DG PUSCH transmission(s) are interlaced. * Case 3: CG PUSCH transmissions are cancelled by DG PUSCH transmission(s). * Case 4: eMBB PUSCH transmissions are cancelled by URLLC transmission(s) via UL CI.   **Replacing the “configured TDW” to “actual TDW” can align the Working Assumption with the agreement.** Otherwise, since the closed-loop PC state has been changed by the agreed event for “the other uplink transmission”, during the second actual TDW (after the event) of the configured TDW the UE **cannot** restore the previous closed-loop PC state that has been applied in the first actual TDW because of the limited number of closed-loop PC state.  For example, slot#0 and slot#1 are a configured TDW where a first PUSCH with two repetitions is scheduled in the first 7 symbols of each slot, with +1 dB PC state. A second PUSCH is scheduled at the gap between two repetitions of the first PUSCH, so that the configured TDW is split into two actual TDW. The closed-loop PC state for the second PUSCH is changed to +3 dB by its own TPC command. The UE cannot transmit the second half of the first PUSCH with +1 dB PC state anymore because its memory of PC has been refreshed into +3 dB by the event.  Therefore, we have the following proposal.  **Proposal 3-1:** For the following working assumption,   * Confirm the main bullet * Confirm the 1st sub-bullet for accumulate TPC commands with “configured TDW” replaced by “actual TDW” * Keep the 2nd sub-bullet for absolute TPC commands as working assumption and remove FFS sub-bullet. |
| ZTE | Fine with the proposal. |
| QC | It might be best to NOT confirm even the main bullet. In the absence of a consensus on how TPC commands are to be handled across PUSCH repetitions, it might be best to treat TPC commands as events and move on.  Lets wait for more progress from 108-e-NR-CRs-03. |
| vivo | Support the proposal. |
| Panasonic | We support the proposal 3. |
| InterDigital | Support FL proposal |
| NTT DOCOMO | Support the proposal. |
| Intel | We are fine with to confirm the working assumption. But we think the last FFS should be confirmed:   * no more than 1 TPC command is expected to take effect during a configured TDW   For the last FFS, our view is that for coverage enhancement, it is expected that UE would typically already apply maximum transmit power for PUSCH/PUCCH repetition We do not think this is typical scenario that gNB sends more than one TPC command during configured TDW window. |
| LG | Support the proposal for the progress. |
| Ericsson | OK to confirm the first main bullet and first subbullet. Prefer to not make any change to the status or content of the second main bullet, pending further discussion in 108-e-NR-CRs-03 and in this agenda item.  Also OK to wait a little to see if 108-e-NR-CRs-03 can shed light on both main bullets. |
| CATT | We feel hesitant to support. As point out by many companies (also in Issue#-2), Interpretation 1 is correct on current DG-PUSCH power control. Therefore, for DG-PUSCH, the power among DG-PUSCH repetitions does not change by nature (Option 0), regardless JCE is configured or not, and regardless group common TPC is configured or not.  Furthermore, legacy behaviour of DG-PUSCH power control (Option 0) seems even more stringent than the WA, since all repetitions must keep the same power. It seems unnecessary to confirm this WA for DG-PUSCH case.  Is it aim to cover CG-PUSCH case only? |
| Samsung | Support FL proposal. |
| Xiaomi | Support FL’s proposal |
| Sharp | Support the proposal in principle, but we are not sure if we can make the confirmation on “TPC commands take effect after the current configured TDW” in the 1st sub-bullet before concluding the Rel-15 CR discussion between interpretations 1 and 2. This is related to our comment for Issue#3-2. |
| Spreadtrum | Support FL proposals. |
| Apple | We are ok to confirm the main bullet.  For the first bullet, the majoritiy agreed with interpretation 1 on Kpusch, so the transmission power will not adjust during the repetition. In this case, the timeline to apply the TPC command is not clear if TPC commands take effect after the current configured TDW for DG PUSCH repetition. |
| CMCC | Thanks for FL’s reply and sorry for the late response. Our proposal is as below.  The sub-bullet of the non-accumulated TPC command could be updated as below,   * 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. |

##### Issue #3-2: How to capture the working assumption in Issue #3-1

CTC observes that for DG-PUSCH with interpretation 1, the effect of Option 2 and Option 3 is equivalent to Option 0 and legacy UE behavior is kept.

Companies are encouraged to provide comments on the above observation.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Keeping legacy UE behavior for DG-PUSCH would not be compliant with the WA.  **Working assumption:**   * The action of group common TPC commands with format 2\_2 does not constitute an event that violates power consistency and phase continuity.   + If UE is configured to accumulate TPC commands,     - 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. TPC commands take effect after the current configured TDW.   The red part of the WA would indeed not be satisfied with legacy behavior of DG-PUSCH, since all repetitions would be characterized by the same power even if multiple nominal TDW are created within the set of repetitions. |
| Huawei, HiSilicon | The observation seems based on incorrect assumption that interpretation 1 would be correct.  According to interpretation 1 for DG-PUSCH, a UE is required to keep unchanged transmission power for all repetitions in all cases, which the UE is incapable of. |
| ZTE | For DG-PUSCH with interpretation 1, Option 2 is equivalent to Option 0/legacy behavior if the TPC command values received via DCI format 2\_2 contained in the set is not modified, i.e., based on legacy rules with interpretation 1.  For DG-PUSCH with interpretation 1, Option 3 is equivalent to Option 0/legacy behavior, assuming ‘would take effect’ in Option 3 follows the same rules as legacy with interpretation 1. |
| QC | I think we will need resolution in 108-e-NR-CRs-03 to be able to make any progress. If interpretation 1 prevails, then yes Option 0 might suffice for DG-PUSCH. |
| vivo | In our understanding, the observation is reasonable and we support the Interpretation 1. |
| InterDigital | Option 0 does not seem equivalent to Option 2 or Option 3 if the configured TDW does not span the whole set of repetitions.  @Huawei: Interpretation 1 does not imply this in our understanding? It may imply that the same TPC adjustment is applied to all repetitions. |
| Intel | It may be good to wait for the progress in the email discussion for Rel-15/16 behaviour for TPC command |
| LG | We are not sure how legacy UE behaviour can support any options since the configured TDW is a new concept. |
| Ericsson | Agree with CTC’s observation and support Interpretation 1. |
| CATT | Fine with the observation. And, if Interpretation 1 is valid (which is likely to be), Option 0 is sufficient to DG-PUSCH. Option 0 seems even more stringent than the Option 1~3 since it mandates the same power for all repetitions. |
| Samsung | Proposal 3 (if agreed) is sufficient. Then next step is to discuss the options that FL summarizes below. |
| Xiaomi | Support interpretation 1 |
| Sharp | Even if Interpretation 1 is correct, the effect of Option 2 and Option 3 is not equivalent to Option 0. This is because all the accumulated TPC commands take effect after whole duration of all the repetitions in the legacy procedure while the accumulated TPC commands take effect after the configured TDW (which may be shorter than the whole duration of all the repetitions) in Option 2 and 3. |
| Spreadtrum | Share similar view as Intel. We can wait the progress of Rel-15/16 behaviour for TPC command. |
| Apple | Agree with CTC’s observation. |

**FL comments:** It seems the current situation is a bit complicated. On one hand, clarification on absolute TPC command and the definition of for DG-PUSCH is under discussion in [108-e-NR-CRs-03]. On the other hand, companies have different understandings on how to capture the working assumption into the specification while it somehow depends on the outcome of discussion in [108-e-NR-CRs-03]. From FL understanding, there can be two ways to go in RAN1#108-e as listed in section 3.2.

**Proposal 4:**

* If interpretation 1 is the correct understanding on the definition of for DG-PUSCH in TS 38.214 for Rel-15/16,
  + Down select one of Option 1 ~ 3 for CG-PUSCH in RAN1#108-e.
  + Down select one of Option 0 ~ 3 for DG-PUSCH in RAN1#108-e.
* If interpretation 2 is the correct understanding on the definition of for DG-PUSCH in TS 38.214 for Rel-15/16, down select one of Option 1 ~ 3 for both CG-PUSCH and DG-PUSCH in RAN1#108-e.
* If no consensus on the above down selection can be reached in RAN1#108-e, it’s up to Editor how to capture TPC enhancement to support DMRS bundling into the specification.

|  |
| --- |
| * **Option 0:** For DG PUSCH or PUCCH associated with a DCI, Keep Rel-15/16 legacy power control procedure. * **Option 1:** Legacy definition of is preserved for PUSCH transmissions without DM-RS bundling. Redefine for PUSCH transmissions within a nominal TDW in case of DM-RS bundling. e.g., is a number of symbols from *K* symbols before the start of the nominal time domain window including the transmission occasion *i* and before a first symbol of the transmission occasion *i*.   + - FFS: the value of K, e.g., K is “a number of symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by k2 in PUSCH-ConfigCommon for active UL BWP of carrier of serving cell ”. * **Option 2:** Modify the TPC command value set , e.g. if transmission occasion *i* is not the first transmission occasion within a nominal time domain window, then any TPC command values received via DCI format 2\_2 contained in the set are deleted and added to the set where *j* is a transmission occasion occurring after the end of the nominal time domain window. * **Option 3:** For group common TPC commands with format 2\_2, if UE is configured to accumulate TPC commands,   + - For a transmission occasion occurs within a nominal time domain window, , where transmission occasion is a first transmission occasion within the nominal time domain window.     - For the first transmission occasion occurring after the nominal time domain window, , where is all the TPC command values that would take effect for the transmission occasions occurring after transmission occasion and no later than transmission occasion (i.e. including occasion *k* itself). |

Companies are encouraged to provide comments on the above proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Before down-selecting between the listed options, a clarification on the role of TPC commands received through DCI format 0\_1 scheduling a different PUSCH than the active one with DMRS bundling is necessary.  Let us take the following example:    where PUSCH1~PUSCH4 are PUSCH repetitions belonging to a same nominal TDW (red dashed box) and is the TPC command carried by a DCI format 0\_1 scheduling a DG-PUSCH (PUSCH5) outside the current nominal TDW. Let us also note that this could be a very relevant case during network operation, for a gNB to avoid breaking of phase continuity within the nominal TDW. In addition, reception of a TPC command in format 0\_1 within a nominal TDW is not listed in the list of (dynamic) events causing phase and power consistency not to be maintained, meaning that neither of PUSCH2, PUSCH3 and PUSCH4 will account for in setting their transmission power. Assuming this is common understanding, defining K\_PUSCH(i) to start at the start of the nominal TDW (Option 1) does not create any disadvantage and allows a UE to keep phase continuity and power consistency even if a TPC command in DCI 0\_1 is received within the nominal TDW. On the other hand, in such a scenario it would become redundant to define two sets of (one for format 2\_2 and one for format 0\_1) since RAN1 has not agreed that reception of a TPC command in DCI 0\_1 constitutes an event that breaks power consistency, and hence its application would anyway have to be postponed at least until the start of the actual PUSCH5 transmission. However, if this is not common understanding, we would appreciate if feature lead could trigger a corresponding discussion. |
| ZTE | It’s better to explicitly clarify what is interpretation 1 and 2 in the proposal.  If no consensus can be made, it could be simply treat TPC as an event and there would be no spec impacts on TS 38213. |
| QC | For sure, we should not leave to Editor’s judgement. Don’t support the third bullet.  Seems okay otherwise, although, we think both interpretations may not work if we are to support CG-DG interlacing. Okay to take TPC as an event as an alternative.  We are okay to wait until the second week assuming some additional guidance emerges from the CR thread.  @Nokia, the action time of a TPC command received via DCI format 0\_1 needs additional clarification. Its not clear whether it will take effect before PUSCH2/PUSCH3/PUSCH4 --- the current description doesn’t seem to preclude this. |
| vivo | Support the proposal in principle. We can continue to discuss this issue until the outcome of discussion in [108-e-NR-CRs-03]. |
| InterDigital | Regardless of which of Interpretation 1 or 2 is correct, we would prefer down-selecting to same Option for both CG and DG. |
| NTT DOCOMO | We are generally fine with the proposal's motivation. However, Option 1 is different from Option 0, 2 and 3 in a sense that the definition of *K* is the symbol from the start of nominal time domain window instead of the first transmission occasion. This difference could change the time duration monitoring TPC commands, as the unit of nominal time domain windows is a slot while that of transmission occasions is a symbol.    Therefore, we suggest modifying Option 1 into the following approach.   * **Option 1:** Legacy definition of is preserved for PUSCH transmissions without DM-RS bundling. Redefine for PUSCH transmissions within a nominal TDW in case of DM-RS bundling. e.g., is a number of symbols from *K* symbols before the start of the first repetition within the nominal time domain window including the transmission occasion *i* and before a first symbol of the transmission occasion *i*.   FFS: the value of K, e.g., K is “a number of symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by k2 in PUSCH-ConfigCommon for active UL BWP of carrier of serving cell ”. |
| Intel | It may be good to wait for the progress in the email discussion for Rel-15/16 behaviour for TPC command |
| Ericsson | Ok with the first two bullets for discussion now, but prefer not to have the third at least at this stage. Agree with ZTE it would be more clear to elaborate on what Interpretations 1 and 2 are (maybe reference the FL summary) if we go for a formal agreement. |
| CATT | We have the same understanding with Nokia that the in the TPC command in DCI 0\_1 would not be accumulated in neither of PUSCH2, PUSCH3 and PUSCH4. According to the following highlighted description in TS38.213, only the in the scheduling DCI for the PUSCH transmissions is included in the set of accumulated TPC command as well as other group common TPC commands. Since there is no scheduling DCI for CG-PUSCH repetitions, only TPC commands in DCI format 2\_2 should be considered.   |  | | --- | | - For the PUSCH power control adjustment state for active UL BWP of carrier of serving cell in PUSCH transmission occasion  - is a TPC command value included in a DCI format that schedules the PUSCH transmission occasion on active UL BWP of carrier of serving cell or jointly coded with other TPC commands in a DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, as described in clause 11.3 |   Hence we think it is necessary to introduce the advance for the start of the configured TDW (details in R1-2201375).  Also we echo ZTE and QC’s view that if no consensus can be made, it could be simply list TPC as an event, so no spec changes on power control in 38.213. |
| Samsung | We don’t think there is a need for any agreement on the interpretation of the current specifications, and/or consider different options for CG-PUSCH and DG-PUSCH.  Option 3 seems to capture the WA. |
| Sharp | If interpretation 1 is correct, Option 0 should be supported. This is because it is unnecessary restriction that accumulated TPC commands are applied at every configured TDW while the accumulated TPC commands are applied after end of repetition in the legacy procedure and the configured TDW is equal to or smaller than duration of all the repetitions. |
| Apple | Ok with first two proposal. if no consensus could be reached, considering the TPC as event seems still problematic, when to apply the TPC command is still debatable, i.e., timeline. |

**Proposal 5:** Agree in principle to the following in order to capture the working assumption on group common TPC commands with format 2\_2.

* For group common TPC commands with format 2\_2, if UE is configured to accumulate TPC commands,
  + - For a transmission occasion occurs within a nominal time domain window, , where transmission occasion is a first transmission occasion within the nominal time domain window.
    - For the first transmission occasion occurring after the nominal time domain window, , where is all the TPC command values that would take effect for the transmission occasions occurring after transmission occasion and no later than transmission occasion (i.e. including occasion k itself).

Companies are encouraged to provide comments on the above proposal.

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| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Do not support for the reasons stated above |
| Huawei, HiSilicon | As commented above, replacing the “configured TDW” to “actual TDW” can align the Working Assumption with the existing agreement. Therefore, we suggest  **Proposal 5-rev:** Agree in principle to the following in order to capture the working assumption on group common TPC commands with format 2\_2.   * For group common TPC commands with format 2\_2, if UE is configured to accumulate TPC commands,   + - For a transmission occasion occurs within a [nominal] time domain window, , where transmission occasion is a first transmission occasion within the nominal time domain window.     - For the first transmission occasion occurring after the [nominal] time domain window, , where is all the TPC command values that would take effect for the transmission occasions occurring after transmission occasion and no later than transmission occasion (i.e. including occasion k itself).     - FFS: how to accommodate the case where a sequence of CG PUSCH repetitions is interrupted by a DG-PUSCH, e.g. whether or not “nominal” TDW above should be replaced with actual TDW |
| ZTE | Fine with the proposal. |
| QC | The second sub-bullet may or may not line up with legacy behavior. Lets wait for more clarity. |
| vivo | Support the proposal. |
| Intel | We are fine with the proposal 5. |
| Ericsson | OK with the proposal |
| CATT | The proposal needs update.  As commented above, we think the start and the end time period of TPC accumulation for should be slightly modified, i.e. advanced.  In addition, we hope to figure out whether this is only applied to CG-PUSCH. |
| Samsung | Support Proposal 5. |
| Xiaomi | Fine with the proposal |
| Sharp | Support the proposal |
| Spreadtrum | Support |
| Apple | Sharing the similar view as CATT, the timeline to determine is still not clear for DG PUSCH. |
|  |  |

## 4.3 RRC parameters

**FL comments:** As per Chair’s guidance, RAN1 will send the updated RRC parameters to RAN2 at the end of Week 1, which means that we have to finalize all relevant issues in Week 1. There are remaining issues: value range for *PUSCH-TimeDomainWindowLength* and *PUCCH-TimeDomainWindowLength*, and default value for *PUCCH-TimeDomainWindowLength*. For the value range, since it depends on RAN4, the discussion will be open after the progress in RAN4. As per Chair’s guidance, another LS will be sent to RAN2 at the end of Week 2 including this issue.

For *PUSCH-TimeDomainWindowLength*, the default value is as follows.

* For PUSCH repetition type A/B, if *PUSCH-TimeDomainWindowLength* is not configured, the default value of *PUSCH-TimeDomainWindowLength* is the minimum value in the unit of consecutive slots of the time duration for the transmission of K repetition and the maximum duration defined in TS38.101-1/2.
* For TBoMS, if *PUSCH-TimeDomainWindowLength* is not configured, the default value of *PUSCH-TimeDomainWindowLength* is the minimum value in the unit of consecutive slots of the duration of TBoMS transmission (including repetition of TBoMS) and the maximum duration defined in TS38.101-1/2.

It seems the default value for *PUCCH-TimeDomainWindowLength* is missing.

**Proposal 6:**

* For PUCCH repetition, if *PUCCH-TimeDomainWindowLength* is not configured, the default value of *PUCCH-TimeDomainWindowLength* is the minimum value in the unit of consecutive slots of the time duration for the transmission of K repetition and the maximum duration defined in TS38.101-1/2.

Companies are encouraged to provide comments on the above proposal.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Our understanding is that this is already captured in TS 38.214. We would appreciate if FL could elaborate more on the need of this proposal. |
| vivo | Support. |
| Panasonic | We do not understand motivation for a need of the proposal 6. This is because it repeats the same thing that we agreed in the 2nd bullet of the below agreement.   |  | | --- | | **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) | |
| NTT DOCOMO | Support the proposal. |
| Intel | Share similar view as Nokia. |
| LG | Same view with Nokia/NSB and Intel. |
| Ericsson | Same view/question as Nokia. |
| CATT | Understand the intension but seems Nokia is correct. In latest 214:   |  | | --- | | - For PUCCH transmissions of PUCCH repetition, the duration of each nominal TDW except the last nominal TDW, in number of consecutive slots, is:  - Given by *PUCCH-TimeDomainWindowLength*, if configured.  - Computed as min ([maxDMRS-BundlingDuration], *M*), if *PUCCH-TimeDomainWindowLength* is not configured, where *M* is the time duration in consecutive slots from the first slot determined for PUCCH transmissions of PUCCH repetition to the last slot determined for PUCCH transmissions of PUCCH repetition according to clause 9.2.6 of [6, TS 38.213]. | |
| Samsung | OK |
| Xiaomi | support |
| Spreadtrum | Support |

## 4.4 Others

**FL comments:** Regarding the issues summarized in section 3.4. These issues seem not so critical or they have already been discussed in previous meetings.

Any comments on the issues summarized in section 3.4?

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| --- | --- |
| **Companies** | **Comments** |
| Samsung | Regarding “**Panasonic**: Specify that a UE expects to perform the same precoder of precoding cycling within an actual TDW” – the use of same precoder within the actual TDW seems reasonable. Given we are in maintenance phase, it is worth further considering this proposal only if consensus can be reached quickly. |
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|  |  |

1. Email discussion (2nd round)

## 5.1 Time domain window

#### Issue #1: Events that violate power consistency and phase continuity

##### Issue #1-1: Events for HD-FDD RedCap UE

**FL comment:** It seems the majority support proposal 1a.

@ Panasonic, from FL perspective, the categorization of semi-static event and dynamic event is clearly captured in the spec, if there is no additional clarification issue, we can just go with the spec. Thus, just to agree it as an event is enough.

@Samsung, if DMRS bundling is interrupted by events, the events should be defined, otherwise gNB and UE may not be aligned.

**Proposal 1a:**

* For HD-FDD RedCap UEs configured with DMRS bundling, an event is constituted for a case where a dropping or cancellation of a PUSCH transmission according dropping rules in [17.2, TS 38.213].

**Support**: Huawei, HiSilicon, ZTE, Qualcomm, vivo, InterDigital, NTT DOCOMO, Intel, LG, Ericsson, CATT, Xiaomi, Sharp, Spreadtrum, Apple, CMCC

**Not needed**: Samsung

Any further comments on the above proposal?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Panasonic | Support |
| vivo | Support |
| Intel | Support |
| NTT DOCOMO | Support |
| Samsung | Regardless of whether it is HD-FDD Redcap UEs or not, the dropping rules will be an event. If PUSCH dropping rules are reflected in spec, then the agreement made in the previous meeting is sufficient.  However, it’s not a critical issue, we are okay to compromise it. |
| Ericsson | Support |
| CMCC | Support.  Technically the proposal 1a is right. And we should also make conclusions for HD-FDD Redcap UEs. Though we share a similar view as Samsung, it is covered by current TP. |
| LG | Support. |
| Sharp | Support |
| Apple | Support. |
| ZTE | Support |
| FL | Proposal 1a is stable. Thanks Samsung for flexibility. |

**FL comment:** It seems the majority support proposal 1b.

@ Intel, it seems there is no need to mention “It is up to editor to capture this in the spec”. Anyway, it up to editor, right? Regarding “even if neither of the repetitions overlaps with it”, if there is no harm, let’s keep it.

**Proposal 1b:**

* For HD-FDD RedCap UEs configured with DMRS bundling, an event is constituted for a case where the gap between two consecutive PUSCH transmissions overlaps with any symbol of downlink reception or downlink monitoring even if neither of the repetitions overlaps with it.

**Support**: Nokia, NSB, Huawei, HiSilicon, ZTE, Qualcomm, vivo, InterDigital, NTT DOCOMO, LG, Ericsson, CATT, Samsung, Xiaomi, Sharp, Spreadtrum, Apple, CMCC

Any further comments on the above proposal?

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| --- | --- |
| **Company** | **Comments** |
| Panasonic | Support |
| vivo | Support |
| Intel | We still prefer to remove the last part. “even if neither of the repetitions overlaps with it”. In our view, this is for the gap between two PUSCH transmissions, why do we need to mention “even if neither of the repetitions overlaps with it”. |
| NTT DOCOMO | Support |
| Samsung | Support |
| Ericsson | Support |
| CMCC | Support. |
| LG | Support |
| Sharp | Support |
| Apple | Support. |
| Xiaomi | Support |

##### Issue #1-2: Dynamic & semi-static events

**FL comments:** Looking at companies’ comments, from FL perspective, regardless of whether a new actual TDW is created for the two cases, clarification is definitely needed. I’m not sure why some companies think no clarification or discussion is needed. Before proceeding, I suggest we focus on the observation first.

**Proposed observation:**

Clarification on the following two cases is needed.

* Case 1: A semi-static event is triggered after one or multiple dynamic events. Whether a new actual TDW is created after the semi-static event?
* Case 2: A semi-static event overlaps with a dynamic event. Whether a new actual TDW is created after the semi-static event?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Panasonic | Same comment as previous round, i.e., yes for both cases 1 and 2 because UE is mandatory to support restarting DM-RS bundling due to semi-static event. |
| CATT | It will be good to clarify. Even for now, different views arise when interpreting the current spec. If the spec is not clear enough, we’d better fix it as soon as possible. |
| vivo | The answer is yes for both Case 1 and Case 2. |
| Nokia/NSB | Yes, for both Case 1 and Case 2.  The agreement reads:   * 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   This agreement was made before mandatory capability of restarting DMRS bundling after a semi-static event was agreed. In this context, and assuming a UE would not be able to restart DMRS bundling after **any** event, the second bullet (If UE is not capable of restarting DM-RS bundling, no new actual TDW is created until the end of the configured TDW) would need to be literally read as no actual TDW is created after **any** event until the end of the nominal TDW. However, since it was later agreed that a UE is mandated to restart DMRS bundling after a semi-static event, the second bullet loses significance and contrasts with the statement in the first bullet. Because of this, we believe a UE is mandated to always restart DMRS bundling after a semi-static event, regardless of when it occurs, and in alignment with the first bullet of the agreement.  In other words, the two bullets mean:   * If UE is capable of restarting DM-RS bundling, one new actual TDW is created after the event,   + This applies when the event is either semi-static or it is dynamic and the UE supports DMRS bundling restarting capability in case of dynamic events, regardless of when the event occurs. * If UE is not capable of restarting DM-RS bundling, no new actual TDW is created until the end of the configured TDW.   + This applies when only dynamic events occur inside the configured TDW and the UE does not support DMRS bundling restarting capability in case of dynamic events. |
| Intel | Thanks FL’s clarification on the agreement for treating frequency hopping as semi-static event. For Case 1: Our view is that except these special events without UE capability, e.g., frequency hopping, and UL beam switching, UE would not need to restart the DMRS bundling based on the existing agreement as mentioned by Nokia. In this case, UE would not restart the DMRS bundling after the dynamic events when UE is not capable of restarting DM-RS bundling   * + If UE is not capable of restarting DM-RS bundling, no new actual TDW is created until the end of the configured TDW.   For case 2: as mentioned previously, we are fine to clarify this, but our understanding is this may not be typical case. |
| InterDigital | We assume that the clarification is needed only for the UE not capable of restarting DMRS bundling.  For such a UE, our understanding is no new actual TDW is created until the end of the configured TDW after a dynamic event occurs, irrespective of any overlapping or subsequent semi-static event (Case 1 and Case 2).  The rationale is that such “non-capable” UE would typically schedule in advance changes in powers/phases over the configured TDW (considering semi-static events). When a dynamic event occurs, this process is broken and UE falls back to non-bundling mode. The occurrence of a subsequent semi-static event does not allow or help this UE to “restart” the DMRS bundling. |
| Samsung | In our point of view, the capability of restarting DM-RS bundling has been introduced to take into account the case that the UE can’t create a new actual TDW right after dynamic event because the UE needs preparation time. Following with the above intention, we are not sure whether the UE not capable of restarting DM-RS bundling can always create a new actual TDW in the above cases. It seems the capability of restarting a window is meaningless. |
| Ericsson | We think the answer is ‘no’ for both case 1 or 2 in a UE that does not support restarting DMRS bundling  As InterDigital points out, if the UE not capable of restart schedules its phase/power changes in advance, then a dynamic interruption to this schedule would mean it can’t restart prior to the end of the nominal TDW.  This is in line with the agreement cited by Intel. |
| CMCC | Yes to both Case 1 and Case 2. We share the same view that UE is mandate to restart a actual TDW after semi-static events. |
| LG | We also think it needs to be clarified since the interpretation can be divided. And as pointed out in previous round, new actual TDW is created for both of cases when UE have capability to restart DMRS bundling according to the agreement captured below.  **Agreement:**  Update the description of the RRC parameters *PUSCH-Window-Restart* and *PUCCH-Window-Restart* as follows*.*   * UE bundles PUSCH DM-RS remaining in a nominal time domain window after ~~dynamic~~ event(s) triggered by DCI or MAC-CE that violate power consistency and phase continuity requirements * UE bundles PUCCH DM-RS remaining in a nominal time domain window after ~~dynamic~~ event(s) triggered by DCI or MAC-CE that violate power consistency and phase continuity requirements   Note: Events ~~should be excluded,~~ which are triggered by DCI or MAC CE, but regarded as semi-static events, e.g. frequency hopping, UL beam switching for multi-TRP operation, or other if defined, are excluded. |
| QC | We think the answer is no for both cases for a UE that does not support restarting DMRS bundling.  This is the sub-bullet in the agreement:   * + If UE is not capable of restarting DM-RS bundling, no new actual TDW is created until the end of the configured TDW.   We don’t know why there is any ambiguity here.  Also, from a practical standpoint, we think that a UE that can support both of the listed cases is very highly likely to declare itself to be capable of supporting restarting. The overhead at that point is not much.  We feel the current description offers a clear demarcation of UE capability and no further refining is required. |
| Xiaomi | Yes to both case 1 and case 2. |

**FL comments:**

@Intel, according to the highlighted part in the following agreement, frequency hopping is a semi-static event

**Agreement:**

* 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.
  + An event is regarded as a dynamic event if it is triggered by a DCI or MAC-CE, otherwise it is regarded as a semi-static event.
  + Note: At least frequency hopping event is considered as semi-static event.

@Companies not supporting Proposal 2 in section 4.1, if DMRS bundling is not restarted for the second hop, do you think it would be a big detrimental to frequency hopping?



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| **Company** | **Comments** |
| Ericsson | It depends on the frequency of the dynamic event, how many UEs are configured with at least 4 repetitions, and how many UEs do not support dynamic events. Gains from frequency hopping would remain. |
| LG | It is our understanding that frequency hopping is “considered as semi-static event” which is different from the semi-static event. Therefore it does not conflict with the agreement that “DMRS bundling shall be restarted at the beginning of each frequency hop”. And it seems well captured in spec that only dynamic event is defined as following. We do not see any controversial point here.  <TS38.214>  The UE maintains power consistency and phase continuity within an actual TDW, across PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1 or 0\_2, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or across PUCCH transmissions of PUCCH repetition, in case the actual TDW is created in response to an event triggered by DCI other than frequency hopping or by MAC-CE, subject to UE capability. |
| QC | It’s a less capable UE. gNB knows this and yet it is indicated to support a dynamic event. We prefer to let the gNB have the benefit of the doubt on whether it was worthwhile to let that dynamic event occur or not.  We seem to be asking the wrong questions here. We should focus on the dynamic event and try to figure out if it was indeed necessary or not. |

##### Issue #1-4: Events for multi-TRP operations

**FL comments:** It seems the majority support the following proposal 7.

**Proposal 7:**

* PUSCH repetitions with different sets of power control parameters in multi-TRP operation is regarded as a semi-static event.

**Support**: Nokia, NSB, Panasonic, Intel, LG, Ericsson, CATT, Samsung, Xiaomi, Sharp, Spreadtrum, CMCC

**Already covered by spec/agreement**: vivo, Apple

The proponents are encouraged to provide reply on the comments by vivo and Apple.

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| **Company** | **Comments** |
| Intel | Our understanding is that different set of power control parameters are also applied for mTRP operation. Here is agreement in RAN1#104-e meeting.  **Agreement**  For single-DCI based M-TRP PUSCH repetition schemes, up to two power control parameter sets (using *SRI-PUSCH-PowerControl*) can be applied when SRS resources from two SRS resource sets indicated in DCI format 0\_1/0\_2.   * FFS1: Details on linking SRI fields to two power control parameters,   + Alt. 1: Add second *sri-PUSCH-MappingToAddModList*, and select two *SRI-PUSCH-PowerControl* from two *sri-PUSCH-MappingToAddModList*   + Alt. 2: Add SRS resource set ID in *SRI-PUSCH-PowerControl*, and select *SRI-PUSCH-PowerControl* from *sri-PUSCH-MappingToAddModList* considering the SRS resource set ID   + Alt. 3: Let RAN2 handle this   + Alt.4: Add second *sri-PUSCH-PathlossReferenceRS-Id*/*sri-P0-PUSCH-AlphaSetId*/*sri-PUSCH-ClosedLoopIndex* in *SRI-PUSCH-PowerControl*. * FFS2: Enhancements on open-loop power control parameter set indication * FFS3: Consideration on *srs-PowerControlAdjustmentStates* * FFS4: Impact of multi-TRP PUSCH repetition on PHR reporting * FFS5: Enhancement on power control parameters per TRP when SRI(s) indication of two SRS resource sets is absent. |
| Samsung | @ vivo, Apple: We also think that it seems to be related to the previous agreement made in RAN1#107bis-e. However, to clarify and align with the below agreement for PUCCH repetition, it can be considered.  **Agreement**  PUCCH repetitions with different sets of power control parameters in multi-TRP operation should be regarded as a [semi-static] event that causes power consistency and phase continuity not to be maintained across PUCCH repetitions. |
| Apple | We consider if two set of power control parameters are configured for m-TRP PUSCH repetition, one parameter set associated with one TRP. When UE perform beam switching from one TRP to another, related power control parameter will be applied. In another word, the power control parameter must associate with one TRP, it’s not an independent exist. Beam switching event already covers the potential power control parameter event. In addition, if we agree the Proposal 7, how to apply this semi-static event? Is it the same beam switching event triggered by scheduling DCI? |

## 5.2 TPC command

#### Issue #3: TPC command

##### Issue #3-1: About the working assumption for group common TPC commands with format 2\_2

**FL comments:** It seems difficult to confirm the WA or part of the WA, considering the tight relationship with [108-e-NR-CRs-03]. Let’s wait for the progress in [108-e-NR-CRs-03].

##### Issue #3-2: How to capture the working assumption in Issue #3-1

**FL comments:** My original thinking was that in this email thread we can discuss the following options based on both interpretation 1 and interpretation 2. Then, after the progress of [108-e-NR-CRs-03], we can simply go for one of them. However, since we shall wait for the outcome of [108-e-NR-CRs-03] for issue #3-1, we may have to wait for issue #3-2 as well. But I still encourage companies to further discuss the following options.

Before discussing the options, I would like to first align companies understanding on the following points:

**Point 1:**

In the Working assumption, it says:

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| * + If UE is configured to accumulate TPC commands,     - 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. TPC commands take effect after the current configured TDW. |

For DG-PUSCH with interpretation 1 as illustrated in the following figure:

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| : PUSCH transmission occasion *i*;  : Transmission power control state for ;  : TPC command value of ;  : A set of TPC command values that should be accumulated for ;  T(*i*): Time period for TPC accumulation for . |

**FL understanding:** For DG-PUSCH with interpretation 1, based on current timeline and TPC procedure, , it can be seen that and will not be added in any TPC command value set, they would not take effect. In the working assumption, it says “If UE receives TPC commands that would take into effectduring a configured TDW …TPC commands take effect after the current configured TDW”, since and would not take effect during a configured TDW, it aligns with the WA that and also don’t take effect after the current configured TDW.

Q1: Do you agree the above FL understanding? If not, please provide your reasons.

Please do not comment like “interpretation 1” is not the correct understanding, please focus on the question itself.

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| **Company** | **Comments** |
| NTT DOCOMO | We think and take effect after the current configured TDW. Let’s assume that the after the configured TDW and is transmitted symbols before the transmission occasion. In this scenario, . It is exactly aligned with the WA. |
| CATT | To our understanding, in interpretation 1, if no DMRS bundling, and will not take effect until the end of all PUSCH repetitions. They take effect when another PUSCH transmission is scheduled by a new DCI.  With DMRS bundling, when combined with the ‘would take into effect…’ in WA, it lead to the same consequence, i.e. no power change takes into effect in all configured TDWs (within the repetitions). ‘TPC commands take effect after the current configured TDW’ would mean TPC commands take effect in the next PUSCH scheduled by another DCI. |
| vivo | We do not agree with FL understanding. In our understanding, the motivation of the WA is to delay the application time of TPC commands in previous configured TDW until the next configured TDW to maintain phase continuity and power consistency. Thus, and should take effect after the current configured TDW, which requires the solution to capture the WA into spec. |
| Nokia/NSB | We thank FL for the observation and agree, at least partly, with FL understanding. It is correct that for DG-PUSCH neither nor would take into effect into any configured TDW based on legacy behavior. However, this is not related to the configured TDW, but rather to the duration of the PUSCH repetitions. Indeed, and would take effect for the first PUSCH scheduled after the set of repetitions, regardless of the number of TDWs that cover the set of repetitions. |
| Intel | For DG-PUSCH with interpretation 1, we tend to agree with FL that if we strictly follow the working assumption, and would not take into effect into a configured TDW and they are not considered for the next step. In this case, and will not take effect after the current configured TDW. |
| InterDigital | Agree with FL that with Interpretation 1, the and would anyway not take effect until the end of the repetitions. The WA would not necessitate spec change if only this case existed (and if Interpretation 1 is correct). |
| Samsung | This was discussed/clarified before agreeing to the WA. TPC commands received within the window are not applied (hence transmit power is constant within the window) but they are accumulated and applied when the window changes. |
| Ericsson | Agree with Nokia. |
| CMCC | We have the same understanding as FL, under interpretation 1, the and would not take effect in the nominal TDW. But we do not think this will impact the target or the intention of the quoted part from working assumption in point 1. |
| LG | Focusing on the question itself, we agree with FL’s understanding with interpretation 1. However, as other companies commented, it does not account for the configured TDW, so even with interpretation 1, we think enhancement is necessary to achieve UE behaviour described in WA. |
| Sharp | It is our understanding that WA is automatically not applied to DG-PUSCH with interpretation 1 (i.e., Option 0 in issue#3-2 is applied to DG-PUSCH with Interpretation 1) because the duration of all the repetitions is equal to or larger than the configured TDW and the condition that “if UE receives TPC commands that would take into effect during a configured TDW” is always false. Consequently, there is no TPC command taking effect after the current configured TDW. Its understanding is aligned with FL understanding.  However, since other companies still have different understandings, we suggest keeping it to be WA for now. |
| QC | Yes, we agree. We think that if we go with Interpretation 1, we may not have much to do here.  Our views are aligned with Nokia’s. |
| Apple | According to interpretation 1, the transmission power will not change during the repetitions. The working assumption will change the transmission power during the repetition as TPC command will apply to next TDW. So during the repetition, the legacy power control procedure is changed by WA. |
| Huawei, HiSilicon | With interpretation 1, all repetitions scheduled by one DCI are transmitted with the same transmission power. TPC and cannot change the Tx power for these repetitions but can change the Tx power for other scheduled/configured PUSCH transmission even when they are interlaced. |

**Point 2:**

Based on companies’ comments, it seems necessary to align companies understanding about TPC behaviour of DCI 0\_1 during the nominal TDW.



As illustrated in the above figure provided by Nokia, where PUSCH1~PUSCH4 are PUSCH repetitions belonging to a same nominal TDW (red dashed box) and is the TPC command carried by a DCI format 0\_1 scheduling a DG-PUSCH (PUSCH5) outside the current nominal TDW, companies are encouraged to answer the following questions:

Q1: Will PUSCH2, PUSCH3 and PUSCH4 account for in setting their transmission power?

Q2: What’s the UE behaviour to deal with ?

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| **Company** | **Comments** |
| NTT DOCOMO | Q1. No. PUSCH power control adjustment state should be constant during nominal TDW.  Q2. PUSCH5 will account for in setting its transmission power. |
| CATT | Q1. No  Q2. determines the power of PUSCH5. |
| vivo | When DMRS bundling is not enabled,  Q1: It depends on whether the same close-loop state is used for both PUSCH5 and PUSCH2, PUSCH3 and PUSCH4. If yes, PUSCH2, PUSCH3 and PUSCH4 would account for in setting their transmission power. If different close-loop state, PUSCH2, PUSCH3 and PUSCH4 would not account for in setting their transmission power.  Q2: PUSCH5 would apply or accumulate .  When DMRS bundling is enabled (based on the WA),  Q1: PUSCH2, PUSCH3 and PUSCH4 would not account for in setting their transmission power.  Q2: PUSCH5 would account for in setting its transmission power. |
| Nokia/NSB | Q1: No, will only impact the transmission power of PUSCH5, which is the PUSCH scheduled by the DCI carrying .  Q2: would only apply to the scheduled PUSCH5, regardless of when PUSCH5 occurs and would not be applied to other PUSCH2, PUSCH3 and PUSCH4. This implies that the reception of a DCI would never constitute an event for FDD, regardless of its content. Then, if the scheduled PUSCH falls within the TDW, the event will occur at the moment of the PUSCH transmission either because the PUSCH transmission cancels one repetition of a set of repetitions or occurs in between two repetitions. |
| Intel | Q1: No.  Q2: is only applied for the scheduled PUSCH5. |
| InterDigital | Same understanding as NTT DOCOMO, CATT, Nokia, Intel. |
| Samsung | Q1: Transmissions within the window are with same power. TPC command cannot be applied to PUSCH2~4.  Q2: This is not related to DM-RS bundling. The UE applies the TPC command only for PUSCH5. |
| Ericsson | Q1: No.  Q2: Regardless of if DMRS bundling is configured, with interpretation 1 and DG PUSCH triggered repetitions, applies only to PUSCH 5. If DMRS bundling is configured, then the WA also requires the same power. |
| CMCC | Under the legacy behaviour without considering Rel-17 DMRS bundling features.  Q1: No. the TPC command in scheduling DCI will only take effect in the scheduled PUSCH.  Q2: The TPC command in scheduling DCI will only take effect in the scheduled PUSCH. It will not impact the power of PUSCH 2,3,4. |
| LG | Q1: No, since it is not group common TPC command.  Q2: is only applied for the scheduled PUSCH5, as other companies commented. |
| Sharp | Q1: No  Q2: is only applied for the scheduled PUSCH5. |
| QC | Q1: Even without DMRS bundling, its not clear if the TPC command carried in the uplink grant would apply to the CG PUSCH. If we are to follow the legacy spec literally, it might be required to apply it to CG-PUSCH as well. But we are not sure if this is the right behaviour.  Q2: We prefer that it not take effect until DG-PUSCH, but this may need to be formally clarified. |
| ZTE | Q1/2: In case of no DMRS bundling, our understanding is it is still under discussion in [108-e-NR-CRs-03]. |
| Xiaomi | Q1. No  Q2. determines the power of PUSCH5. |
| Huawei, HiSilicon | Q1: Yes if DMRS bundling is disabled and PUSCHx share the same closed-loop state, otherwise No.  Q2: According to the following spec excerpt, as long as is received earlier enough, it should be taken into account for PUSCH2.   |  | | --- | | -  is the PUSCH power control adjustment state  for active UL BWP  of carrier  of serving cell  and PUSCH transmission occasion  if the UE is not provided *tpc-Accumulation*, where  - The  values are given in Table 7.1.1-1  -  is a sum of TPC command values in a set  of TPC command values with cardinality  that the UE receives between  symbols before PUSCH transmission occasion  and  symbols before PUSCH transmission occasion  on active UL BWP  of carrier  of serving cell  for PUSCH power control adjustment state , where  is the smallest integer for which  symbols before PUSCH transmission occasion  is earlier than  symbols before PUSCH transmission occasion  - If a PUSCH transmission is scheduled by a DCI format 0\_0 or DCI format 0\_1,  is a number of symbols for active UL BWP  of carrier  of serving cell  after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUSCH transmission  - If a PUSCH transmission is configured by *ConfiguredGrantConfig*,  is a number of  symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP  of carrier  of serving cell | |

@ Nokia, as pointed out by CATT, only the in the scheduling DCI for the PUSCH transmissions is included in the set of accumulated TPC command as well as other group common TPC commands. Does this solve your concern?

@ CATT, do you mean to make the following update for Option 3: “where is all the TPC command values that would take effect from symbols before the transmission occasions to symbols before the transmission occasion ”? If so, FL thinks it indicates the same timeline as current version, the timeline of Figure 3 in you Tdoc seems not correctly capture Option 3, because the timeline of Option 3 is described as “ would take effect for the transmission occasion…”. Taking CG-PUSCH as an example, FL thinks the timeline of current Opiton 3 is illustrated as in the following figure.



@ Proponents for Option 1, please check NTT DOCOMO’s modification for Option 1: “ is a number of symbols from *K* symbols before the start of the first repetition within the nominal time domain window including the transmission occasion *i* and before a first symbol of the transmission occasion *i*.”

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| * **Option 0:** For DG PUSCH or PUCCH associated with a DCI, Keep Rel-15/16 legacy power control procedure. * **Option 1:** Legacy definition of is preserved for PUSCH transmissions without DM-RS bundling. Redefine for PUSCH transmissions within a nominal TDW in case of DM-RS bundling. e.g., is a number of symbols from *K* symbols before the start of the nominal time domain window including the transmission occasion *i* and before a first symbol of the transmission occasion *i*.   + - FFS: the value of K, e.g., K is “a number of symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by k2 in PUSCH-ConfigCommon for active UL BWP of carrier of serving cell ”. * **Option 2:** Modify the TPC command value set , e.g. if transmission occasion *i* is not the first transmission occasion within a nominal time domain window, then any TPC command values received via DCI format 2\_2 contained in the set are deleted and added to the set where *j* is a transmission occasion occurring after the end of the nominal time domain window. * **Option 3:** For group common TPC commands with format 2\_2, if UE is configured to accumulate TPC commands,   + - For a transmission occasion occurs within a nominal time domain window, , where transmission occasion is a first transmission occasion within the nominal time domain window.     - For the first transmission occasion occurring after the nominal time domain window, , where is all the TPC command values that would take effect for the transmission occasions occurring after transmission occasion and no later than transmission occasion (i.e. including occasion *k* itself). |

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| **Company** | **Comments** |
| CATT | We really appreciate @FL’s explanation. By literally interpreting the word ‘take effect’, if *T(i)* already covers *KPUSCH(i-1)*, we agree with you, and would be fine with original Option 3. |
| vivo | Support to adopt Option3 to capture the WA. Option 3 is clear and simple. |
| Nokia/NSB | @FL, yes if CATT explanation is common understanding, it does solve our concern. This means that if another PUSCH is scheduled in between a set of repetitions, the TPC command in the scheduling DCI will only apply to such scheduled PUSCH.  @FL: NTT DOCOMO brought a very good point. Option 1 should be modified to account for NTT DOCOMO’s suggestion.  Regarding the options to capture the WA in the specifications, we support Option 1 with the modifications suggested by NTT DOCOMO, and believe that Option 3 has at least the following drawback.  Along the lines of the discussion on TPC behaviour of DCI 0\_1 during the nominal TDW, let us take as an example the scenario below. Therein, a TPC command carrying is received via DCI 0\_1 scheduling PUSCH5, and received in between a set of repetitions within the same cTDW, and where and are group common TPC commands carried in DCI 2\_2.    Before proceeding, please note that the order of arrival of the three considered DCIs is irrelevant for the purpose of this example. Indeed, could be received before or after with no change to the logic of our example. Now, based on the description of Option 3, and on the understanding that applies only to the scheduled PUSCH5, we have that , where . This however would not be aligned with legacy operation in case PUSCH1~PUSCH4 would not belong to a configured TDW, for which the power of PUSCH5 would be , effectively different than the power of PUSCH5 when the CG-PUSCHs are within a nominal TDW. In addition, any PUSCH6 that would come after PUSCH5 would have a transmission power that includes twice. In other words, Option 3 changes how legacy power control for DG-PUSCH without DM-RS bundling works depending on whether DM-RS bundling is enabled or not for other PUSCH transmissions. This impact is far from being trivial since it literally shows a non-backward compatible impact on legacy operations. Overall, this demonstrates that not only Option 3 is not simpler, but also has backward compatibility issues.  Interestingly, this problem does not exist for the case of Option 1, as shown in Figure below:    In this case, PUSCH5 is transmitted with same power as if PUSCH1~PUSCH4 were not within a nominal TDW. PUSCH6 would then compensate for , which is not accounted in PUSCH5, as in legacy operation. In other words, Option 1 preserves how legacy power control for DG-PUSCH without DM-RS bundling works, regardless of whether DM-RS bundling is enabled or not for other PUSCH transmissions. Therefore, it is not only simpler but also fully backward compatible.  At this stage, we are not even sure this is the only case in which such non-backward compatibility issues would occur in Option 3, given that the scenario above could very well be only one of the many not obvious but relevant scenarios in which Option 3 may not work properly, and so we strongly encourage companies to think further about their support to the above options. It is really not just about preferring this or that solution, but rather ensuring that what we agree on offers consistent behaviour, which does not impact how legacy operations works. Changing the power control algorithm that was agreed in Rel-15/16 after lots of discussions, and in consideration of many possible scenarios, should not be the preferred way to capture the WA into the specifications when another possibility as Option 1 exists and has lower impact on the algorithm and the specifications.  In addition, and assuming Interpretation 1 for DG-PUSCH is confirmed, Option 1 would harmonize the UE behavior for determination of transmit power for DG and CG PUSCH. |
| Intel | We are fine with Option 3. |
| InterDigital | Option 1, 2 and 3 seem equivalent. Option 1 may be easier to integrate into the existing framework of 38.213. We slightly prefer Option 1. |
| NTT DOCOMO | We support Option 1 and share the same view with Nokia. Option 1 is similar behaviour to Interpretation 1 and backword compatible. The main reason to support Option 3 is the simplicity, which is subjective perspective. Also, the Option 3 has non backword compatible issue as Nokia brought up. |
| Samsung | Support Option 3 |
| Ericsson | Support option 3 in principle. We think it could be more clear to use the notation in 38.213 for the cardinality, e.g.:  For a first transmission occasion after the transmission nominal time domain window, , with as defined in 38.213 subclause 7.1.1.  @Nokia: Thanks for the careful analysis. However, for us , where is actually the better behavior, since all the TPC commands are taken into account, and each TPC command meets a timeline for a PUSCH transmission. There is no legacy behavior to compare to for where TPC commands are deferred, and so that does not seem to be directly relevant. |
| CMCC | Option 3 is preferred, which is more straightforward and has less impact to the legacy specification and most close to the WS. |
| LG | Just quick clarification. All of the options above is the enhancement based on the nominal TDW length which is irrelevant to the conventional UE behaviour without joint channel estimation. We do not think any of the options impact on legacy UE behaviour. |
| QC | With these options, what is the underlying assumption on interlaced transmissions?  We are okay to go with any option that does not require a power control state reversal. This is rather explicit in Option 2. But are not sure with the other two options.  If its clarified that a UE need not expect interlaced transmissions, then its possible that there is not much of a different across the three options. |
| Apple | One clarification question on Option 3, for DG PUSCH repetition, what is the timeline for to be accumulated before the transmission occasion k? Kpusch(k)=Kpusch(1) for interpretation 1? Kpusch (1) is the first transmission of the repetition. |
| ZTE | Support Option 3 |
| Xiaomi | Support Option 3 |
| Huawei, HiSilicon | Support Option 3.  @Nokia, Thank you very much for your nice figures and analysis. We feel Option 3 is in a good form for all transmission occasions of a TB. But it seems not good enough in case of two TBs as illustrated by your figure. To address your concerns, we suggest some small revision to Option 3   * **Option 3a:** For group common TPC commands with format 2\_2, if UE is configured to accumulate TPC commands,   + - For a transmission occasion occurs within a nominal time domain window, , where transmission occasion is a first transmission occasion within the nominal time domain window.     - For the first transmission occasion occurring after the nominal time domain window, , where is all the TPC command values that ~~would take effect for the transmission occasions occurring after~~ are received between symbols before transmission occasion and ~~no later than~~ symbols before transmission occasion ~~(i.e. including occasion~~ *~~k~~* ~~itself)~~.   For example, with Option 3a in the following figure, , . |

**FL comments:** As we need to find way out in this meeting, I would like to check companies’ preference if we cannot achieve consensus on the down selection on the above options in this meeting.

* Alt 1: If no consensus on how to capture the working assumption can be reached in RAN1#108-e, it’s up to Editor how to capture it into the specification.
* Alt 2: If no consensus on how to capture the working assumption can be reached in RAN1#108-e, the action of group common TPC commands with format 2\_2 is regarded as an event.

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| **Company** | **Comments** |
| NTT DOCOMO | We prefer Alt1. Joint channel estimation cannot bring coverage enhancement gains with too many kinds of events. |
| CATT | Alt 2. Just to point out that (1) If the gNB would like to achieve JCE gain, it can just avoid sending group common TPC to a specific UE. (2) Increasing power by 3 dB is even higher than JCE gain, per SI outcome. It is justified to choose higher power gain than JCE gain. |
| vivo | Support Alt1 in principle. If no consensus can be reached, a note seems necessary for Editor to clarify the motivation of the WA. |
| Nokia/NSB | We do not support any of the two alternatives at this stage |
| Intel | Alt. 2. If no consensus is reached, it is good to treat the action of group common TPC commands as an event. This could be helpful for the progress and complete the feature, especially considering that RAN1 may not even reach consensus on the interpretation of legacy behaviour for TPC command during PUSCH/PUCCH repetition in Rel-15/16. Otherwise, this lengthy discussion seems never ended. |
| InterDigital | Support Alt. 1 which is the usual way of working in RAN1. |
| Samsung | Alt 1 |
| Ericsson | Alt 2. Agree with CATT’s comments. Also, the UE will generally not be continuously transmitting PUSCH, so there will be opportunities to transmit DCI 2\_2 without losing JCE gain. Type 2 configured grant can also be used with lower PDCCH overhead. |
| CMCC | Neither is best choice for the current stage. From our observation, option 3 has the majority support. |
| LG | We do not think any decisions should be made by editor, so unfortunately, Alt 2 would be the only option if no consensus is reached. |
| Sharp | We prefer Alt 1. |
| QC | Alt 2. There is too much ambiguity with any other option. Its not the Editor’s job to complete RAN1 design work. |
| Apple | Maybe we go another way. We propose the followings for consideration.  *if no consensus could be reached on the WA, then UE assume no group common TPC will be received during the repetition if DMRS bunding is configured.*  So, it leaves the choice to gNB. If gNB intends to change the UE transmission power with the cost of TDW broken, it can do so. Otherwise, if consider the DMRS bundling is important, no TPC from DCI 2\_2 will send. In this case, we don’t need to clarify legacy power control is intending to interpretation 1 or interpretation 2. |
| ZTE | Alt 2. If we cannot reach consensus here, it expects we cannot reach consensus about the editor CR as we cannot ensure the CR would be clear and preferable for all companies. We also agree with CATT that TPC can be prioritized over JCE. |
| Xiaomi | Neither is fine in current stage. |
| Huawei, HiSilicon | Both alternatives cannot solve anything.  For Alt1, companies happened to be uncomfortable with editor CR on the WA. It would happen again and get stuck if we go with Alt 1.  For Alt2, after so much efforts in the past meetings, the benefits of WA have been well recognized. We really don’t want to revert the WA and start from scratch only because how to capture it in spec is difficult. Even if Alt 2 is adopted, no effort can be saved because all TPC timelines being discussed now have to be discussed anyway in order to figure out when the event starts to take effect. For example, whether the event takes effect from PUSCH2 or PUSCH5 in the following figure requires discussions.    Therefore, we don’t feel either Alt 1 or Alt 2 are useful. |

## 5.3 RRC parameters

**FL comments:** The motivation of proposal 6 is that the default value of *PUCCH-TimeDomainWindowLength* is missing in R1-2200699. If companies think it is straight forward, we can directly fill the default value of *PUCCH-TimeDomainWindowLength* in the EXCEL sheet. Then the agreement on proposal 6 is not needed.

**Proposal 6:**

* For PUCCH repetition, if *PUCCH-TimeDomainWindowLength* is not configured, the default value of *PUCCH-TimeDomainWindowLength* is the minimum value in the unit of consecutive slots of the time duration for the transmission of K repetition and the maximum duration defined in TS38.101-1/2.

Any further comments?

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| **Company** | **Comments** |
| CATT | OK if the intention is to complete the excel. (though already captured in spec) |
| Samsung | Support FL proposal |
| Ericsson | Same comment as CATT |
| LG | Support. |
| Xiaomi | Support |
| FL | Thanks everyone! It will be incorporated into the RRC EXCEL sheet. No explicit agreement is needed. |

1. Email discussion (3rd round)

## 6.1 Time domain window

#### Issue #1: Events that violate power consistency and phase continuity

##### Issue #1-1: Events for HD-FDD RedCap UE

**FL comment:** I would like to check if there is any concern by removing “even if neither of the repetitions overlaps with it”. If there is, I hope Intel can live with proposal 1b.

**Proposal 1b:**

* For HD-FDD RedCap UEs configured with DMRS bundling, an event is constituted for a case where the gap between two consecutive PUSCH transmissions overlaps with any symbol of downlink reception or downlink monitoring even if neither of the repetitions overlaps with it.

**Support**: Nokia, NSB, Huawei, HiSilicon, ZTE, Qualcomm, vivo, InterDigital, NTT DOCOMO, LG, Ericsson, CATT, Samsung, Xiaomi, Sharp, Spreadtrum, Apple, CMCC

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| **Company** | **Comments** |
| CATT | We are fine with the proposal, with or without removing ‘even if …. it’. Seems such removal does not change the result.  Anyway, editor will come up with a way to capture the meaning properly. |
| Intel | If we are the only company that feels the last part “even if neither of the repetitions overlaps with it” is really redundant, we can be okay to move forward for the sake of progress. But we do think this is not needed. It is weird to mention this given that Gap is gap, and there is no repetition during the gap. |
| Ericsson | We think the proposal is a bit more clear with ‘even if…’, but is unambiguous without it. If there are strong views to drop ‘even if…’, we won’t object. |

##### Issue #1-2: Dynamic & semi-static events

**FL comments:** It’s unfortunate that some companies still think it’s not necessary to clarify the following two cases, even it is apparent that companies have different understandings on the specification and agreements.

**Proposed observation:**

Clarification on the following two cases is needed for UE not capable of restarting DMRS bundling.

* Case 1: A semi-static event is triggered after one or multiple dynamic events. Whether a new actual TDW is created after the semi-static event?

**Yes:** Panasonic, vivo, Nokia, NSB, CMCC, ZTE, CATT, Xiaomi, Spreadtrum

**No:** Intel, InterDigital, Ericsson, Qualcomm

* Case 2: A semi-static event overlaps with a dynamic event. Whether a new actual TDW is created after the semi-static event?

**Yes:** Panasonic, vivo, Nokia, NSB, CMCC, ZTE, CATT, Xiaomi, Spreadtrum

**No:** InterDigital, Ericsson, Qualcomm

**FL comments:** I would like to ask companies not willing to clarify the above two cases what the consequence is if gNB and UE have different understandings?

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| **Company** | **Comments** |
| CATT | In this case, in the duration between ‘the semi-static event’ and ‘the end of current nominal TDW’, whether phase/power condition can be met will be uncertain to the gNB. |
| Nokia/NSB | Agree with CATT. gNB may be bundling DMRS subject to different channel conditions, finally degrading performance. |
| InterDigital | If the gNB assumes that the UE restarts bundling but the UE does not restart bundling, there may be performance loss.  If the gNB assumes that the UE does not restart bundling but the UE restarts bundling, the network may send TPC command to UE and expect that UE raises power, while the UE actually would not (pending confirmation of WA on TPC). This can also creates some issues. |
| Samsung | If gNB and UE have different understandings, then DMRS bundling can’t be applied after the above cases. It leads to degrade the performance of DMRS bundling. We think it’s better to further clarify for the better performance of DMRS bundling. |
| Intel | We understand that there should have clarification on the UE behaviour for these two cases, otherwise it would lead to degraded performance for PUSCH/PUCCH decoding. |
| QC | We don’t think there is any room for misunderstanding here. gNB should work under the assumption that UE is not capable of restarting bundling if a dynamic event occurs. This is clear based on the agreements made.  If on the other hand, UE misses the DCI/MAC-CE and continues to bundle, then again, no harm is done. gNB assumes no bundling, but UE continues to bundle until end of the nominal TDW. |
| Ericsson | A gNB could conservatively assume that all slots after the dynamic event until the end of the window are not bundled, in which case there would be no potential for channel estimation losses from incorrect bundling. This would lose the gain of the DMRS bundling in the slots that are available for an aTDW. Alternatively, the gNB could more optimistically assume that the UE could restart after the semi-static event, in which case it could get the bundling gain but risk channel estimation losses when the UE isn’t actually bundling.  The extent of cases where the bundling gain is not these losses depends on how often the dynamic event occurs that is followed by or overlaps with a semi-static event, and how many slots remain after the bundling restart.  So overall we think that there will be conditions where the bundling gain is not available, but we suspect they may not be very frequent. We are open to further discussion to ensure that the spec is clear, however. |

##### Issue #1-4: Events for multi-TRP operations

**FL comments:** It seems only one company has concerns.

**Proposal 7:**

* PUSCH repetitions with different sets of power control parameters in multi-TRP operation is regarded as a semi-static event.

**Support**: Nokia, NSB, Panasonic, Intel, LG, Ericsson, CATT, Samsung, Xiaomi, Sharp, Spreadtrum, CMCC

**Have concerns**: Apple

The proponents are encouraged to provide reply on the comments by Apple.

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| **Company** | **Comments** |
| CATT | For the event violating JCE due to mTRP, current 214 states:   |  | | --- | | - For any two consecutive PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, and when two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook’ or ‘noncodebook’, a different SRS resource set association is used for the two PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, according to Clause 6.1.2.1. |   Seems Apple is right, since in our understanding, Tx power calculation depends on the reference RS resource. If the current spec (different SRS resource set association is used) already includes the power condition implicitly, this proposal may be a little redundant.  Nevertheless, this proposal is technically correct and no harm to the mechanism. So we are fine with it. Even if it is agreed, it can be up to the editor on how to capture. Possibly editor thinks current description is enough and clarifies that no update is needed, it will also be fine to us. |
| NTT DOCOMO | We share both the motivation of this proposal and the same concern as Apple. The current draft CR works well without capturing this proposal, because the power control parameter switching is accompanied by UL beam switching. So, how about making the conclusion instead of agreement? |
| Samsung | Share similar view as CATT. |
| Intel | Our understanding is that we already agree to support different power control parameters for PUCCH repetitions for mTRP operation. In addition, we agree to strive for a common design for DMRS bundling for PUSCH and PUCCH repetitions. Following this design principle, it is clear that different power control parameters should be considered as event for PUSCH repetitions/transmission. Otherwise, we should revert the agreement for PUCCH. |
| Ericsson | We see Apple and CATT’s point, and DOCOMO’s solution seems reasonable. |

## 6.2 TPC command

#### Issue #3: TPC command

**FL comments:** Looking at the progress in [108-e-NR-CRs-03], it seems not optimistic. I would like to ask the following question:

Question: If companies’ understandings cannot be aligned for Rel-15/16 TPC procedure in [108-e-NR-CRs-03], what can we do for the following working assumption?

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| **Working assumption:**   * The action of group common TPC commands with format 2\_2 does not constitute an event that violates power consistency and phase continuity.   + If UE is configured to accumulate TPC commands,     - 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. TPC commands take effect after the current configured TDW.   + If UE is not configured to accumulate TPC commands     - 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. |

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| **Company** | **Comments** |
| CATT | We suggest discussion case by case, and focus on what we have with common understanding. For the controversial part, it will not be confirmed, just as usual business in RAN1. |
| NTT DOCOMO | Confirm the working assumption without FFS sub-bullet.  Since it is not likely to reach the consensus about how UE behaves to TPC command in Rel-15/16, we prefer to discuss TPC command behaviour at least when DMRS bundling is enabled, and leave Rel-15/16 TPC command behaviour as it is. |
| Sharp | Even if companies’ understandings cannot be aligned for Rel-15/16 TPC procedure, for Rel-17, RAN1 should adopt either Interpretation 1 or Interpretation 2. This is because TPC accumulation is mandatorily supported and repetition is important for CovEnh. Particularly, it is not possible to specify operation of DMRS bundling unless Interpretation is determined.  After that, we can confirm WA for DG-PUSCH according to the determined interpretation. |
| Nokia/NSB | Follow FL recommendation below |
| Samsung | In the 1st round, FL proposed Proposal 3 – can Proposal 3 be agreed?  **Proposal 3:** For the following working assumption,   * Confirm the main bullet * Confirm the 1st sub-bullet for accumulate TPC commands * Keep the 2nd sub-bullet for absolute TPC commands as working assumption and remove FFS sub-bullet. |
| Intel | It would be good to first decide in the FL recommendation for TPC command. |
| QC | For now, we can deprioritize absolute TPC commands and try to find common ground on accumulated TPC commands.  Worst case, we fall back to treating TPC commands as events. |
| Ericsson | Similar to CATT, we should work with the working assumption as best we can on a case by case basis. For now, we can focus on accumulated case given the lack of clarity at present for absolute TPC with DCI 2\_2 for Rel-15/16. |

**FL comments:** For Rel-15/16 TPC procedure, companies’ understandings are aligned only for accumulate TPC commands for CG-PUSCH. One way is we only focus on accumulate TPC commands for CG-PUSCH. What do you think?

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| **Company** | **Comments** | |
| CATT | This is acceptable to us. | |
| NTT DOCOMO | We are fine with this approach, though we prefer unified solution for DG and CG. | |
| Sharp | We are OK to focus on accumulation TPC commands for CG-PUSCH. WA for DG-PUSCH should be kept for now. | |
| Nokia/NSB | We are fine with FL’s proposal. |
| Samsung | We think Proposal 3 can be agreed for both cases. |
| Intel | We prefer a unified solution for DG and CG. |
| QC | Sure, lets focus on this case and try to figure out the best way forward. This does seem to be more difficult case anyway. |
| Ericsson | Agree with FL suggestion, and think it is the only real option at present. If operation for absolute TPC with DCI 2\_2 becomes clear, we can take it up in the NR Cov Enh work then. |

**FL comments:** If weonly focus on accumulate TPC commands for CG-PUSCH, we still have following three options. Looking at the previous two round discussion, it seems not optimistic either.

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| * **Option 1:** Legacy definition of is preserved for PUSCH transmissions without DM-RS bundling. Redefine for PUSCH transmissions within a nominal TDW in case of DM-RS bundling. e.g., is a number of symbols from *K* symbols before the start of the first repetition within the nominal time domain window including the transmission occasion *i* and before a first symbol of the transmission occasion *i*.   + - FFS: the value of K, e.g., K is “a number of symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by k2 in PUSCH-ConfigCommon for active UL BWP of carrier of serving cell ”.   **Support:** Nokia, Intel, NTT DOCOMO   * **Option 2:** Modify the TPC command value set , e.g. if transmission occasion *i* is not the first transmission occasion within a nominal time domain window, then any TPC command values received via DCI format 2\_2 contained in the set are deleted and added to the set where *j* is a transmission occasion occurring after the end of the nominal time domain window.   **Support:** Qualcomm   * **Option 3:** For group common TPC commands with format 2\_2, if UE is configured to accumulate TPC commands,   + - For a transmission occasion occurs within a nominal time domain window, , where transmission occasion is a first transmission occasion within the nominal time domain window.     - For the first transmission occasion occurring after the nominal time domain window, , where is all the TPC command values that would take effect for the transmission occasions occurring after transmission occasion and no later than transmission occasion (i.e. including occasion *k* itself).   **Support:** CATT, vivo, Intel, Samsung, Ericsson, CMCC, ZTE |

**FL comment:** Thanks Nokia for the analysis, I tend to have the same understanding.

**Example 1 for CG-PUSCH:**



For Option 3, if PUSCH1~PUSCH4 are in the same configured TDW, we have:

For , , ;

For , , ;

For , , ;

For , , , ,

However,

For , , , ,

It seems is calculated twice for .

**Example 2 for CG-PUSCH:**



For Option 3, if PUSCH1~PUSCH2 are in the same configured TDW, and PUSCH4~PUSCH5 are in the same configured TDW, we have:

For , , ;

For , , , , ;

Then, what the first transmission occasion in the second configured TDW as illustrated in the above figure.

**Assumption 1**: is the first transmission occasion, we have:

For , , ;

For , , .

**Assumption 2**: is the first transmission occasion, we have:

For , , =;

For , , .

It seems is calculated twice for with Assumption 2.

**@ Huawei**, from FL’s understanding, it seems Option 3a still cannot solve the problem raised by Nokia.

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| * **Option 3a:** For group common TPC commands with format 2\_2, if UE is configured to accumulate TPC commands,   + - For a transmission occasion occurs within a nominal time domain window, , where transmission occasion is a first transmission occasion within the nominal time domain window.     - For the first transmission occasion occurring after the nominal time domain window, , where is all the TPC command values that  ~~would take effect for the transmission occasions occurring after~~ are received between  symbols before transmission occasion and  ~~no later than~~  symbols before  transmission occasion ~~(i.e. including occasion~~ *~~k~~* ~~itself)~~. |

@Apple, Option 3 doesn’t mean to change K or D. I think the timeline is clear. The timeline of current Option 3 is illustrated as in the following figure.



**FL comments:** Companies are encouraged to continue the discussion on the following aspects.

1. Which option(s) cannot work properly? Why?
2. Pros and cons for each option.
3. Check the problem raised for Option 3 by Nokia
4. Check Option 3a proposed by Huawei

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| **Company** | **Comments** |
| CATT | These options are proposed to capture the WA for CG-PUSCH, while problems arise when coupling with DG-PUSCH. While we see different interpretations on how each options behaver, we think all of them can work, since (1) power conditions are met, (2) a little higher/lower power is not disaster and adjustable, (3) gNB can avoid frequent TPC command by implementation, (4) legacy UE behaviour will never be impact. |
| NTT DOCOMO | 1&2: We prefer Option 1, which is aligned with DG-PUSCH in interpretation 1. However, all options 1, 2, and 3a result in the same procedure. The difference comes from how to describe it. Given the fact, we think which option to be selected can be up to the editor. It is not reasonable not to confirm the working assumption, because the way to capture is not company’s preference.  3&4: We think Option3 should be updated into Option 3a. |
| Sharp | Option 3 has no problem on the point raised by Nokia, and we think Option 3a is equivalent to Option 3. This is because a set D(j) includes TPC commands received between KPUSCH(i1) symbols before TO(i1) and KPUSCH(k) symbols before TO(k) (i.e., Option 3a). In Example 1, . A set D for PUSCH5 includes TPC commands received between KPUSCH(1) symbols before the start of PUSCH1 and KPUSCH(5) symbols before the start of PUSCH5. We prefer Option 3a that is clearer than Option 3, in terms of what “would take effect” means. |
| FL | Let’s focus the discussion on CG-PUSCH.  If companies don’t provide answers and reasons for question 1, I would assume companies think all options can work properly. |
| Nokia/NSB | We agree that RAN1 should strive to capture the WA in the specification, as long as the agreed Option does not impact the transmission power of a generic PUSCH transmission not subject to DMRS bundling compared to legacy behaviour. In this sense we would like to thank Huawei for the great effort to address part of our concerns and confirm that at least for Example 1 Option 3a would work. However, and for the sake of completeness, what would be the behaviour of Option 3a in a scenario like the one in Example 2, where K\_PUSCH(k) is earlier than K\_PUSCH(i1)? More generically, we find that Option 3/3a causes non backward compatibility problems in all the cases where the power control state for a generic transmission occasion (regardless of when it occurs) depends on a transmission occasion within a nominal TDW, simply because the K\_PUSCH(i) are not adjusted accordingly and just ignored. For reference, see yet another example below.    As we stated previously, plenty of such examples can be found when sufficient analyses of Option 3/Option 3a are carried out, whereas the same does not hold for Option 1.  Having said this, and to avoid any misunderstandings, if these issues could be easily addressed by simple twists to Option 3a, that would be very fine by us. Our goal is to ensure what RAN1 agree on is solid and does not have backward compatibility issue (we think it is paramount). However, if Option 3 starts becoming too cumbersome and convoluted to address this issue and provide full backward compatibility, and plenty of notes/exceptions/special cases must be added to achieve this goal, we will not be able to agree to Option 3, since Option 1 does not seem to have issues and it can be easily integrated in the specifications and is fully backward compatible. We respectfully ask all companies and FL to consider this when assessing which Option should be chosen. It is not a matter of preference at this stage, but rather ensuring that enabling/disabling DM-RS bundling for a given set of PUSCH repetitions **does not have any impact on power control of other PUSCH transmissions.**  Nokia has always adopted a very collaborative attitude and we are striving to find a solution agreeable to everyone and backward compatible. We would appreciate if the same open mind was shown towards other alternatives like Option 1, which is simpler and fully backward compatible. The discussion should not be about preferences but about technical facts. What we observe is that very few companies are actually engaging in this discussion with such an approach, which ensures that what RAN1 agrees on is technically sound, simple and fully backward compatible. This is a pity.  @CATT, we do agree that probably “a little higher/lower power is not disaster and adjustable”, but since we have a solution with Option 1 that works properly and without these problems, why not to go for it? We are not even sure why RAN1 is expressing such reluctancy to Option 1, since it would be very easily integrated in the specifications and would not create NBC issues.  @Sharp, we suggest taking a closer look at the modifications that Option 3a provides compared to Option 3. They are different in different ways. We also assume Sharp does not see any problem with Option 1? |
| Samsung | The changes proposed by Huawei in Option 3a are fine. There are no issues, and Option 3a is the simplest and most straightforward/clear way to describe the WA. We support Option 3a. |
| QC | We don’t think Option 1 and 3 work well for the case where we need to accommodate a DG-PUSCH in between CG-PUSCH repetitions (say due to CG/DG collision/prioritization):    Its not possible to keep the transmit power the same across all repetitions in such cases.  I hope companies can take a closer look at Option 2. Timeline is the point of contention. What Option 2 does is to **completely sidestep timeline issues**. It just talks about what commands are in the sets and moves them around. Doesn’t even require power to be the same across repetitions.  We don’t even have to wait for the CR outcome. It’s a very faithful interpretation of the agreement we have. |
| Ericsson | There seems to be debate in [108-e-NR-CRs-03] whether CG/DG interlacing is supported, so focussing on the CG-only case as FL suggests seems appropriate. In that scenario, presuming Options 3 and 3a are equivalent, either is fine for us in principle (again, we expect editorial changes to adapt agreements to be suitable to 213).  For us, Option 1 seems to have higher spec impact and diverge more from Rel-15 principles, since DG timing is used for CG. We don’t think its performance would be better or worse than Option 3/3a.  We don’t see the difference in the intended operation between Option 2 and 3, and think Option 3/3a is more clear. |

**FL comments:** As we need to find way out in this meeting, I would like to check companies’ preference if we cannot achieve consensus on the down selection on the above options in this meeting again. **If you are not in favour of any alternative, please provide constructive comments how to conclude this issue.**

* Alt 1: If no consensus on how to capture the working assumption can be reached in RAN1#108-e, it’s up to Editor how to capture it into the specification.

**Support:** NTT DOCOMO, vivo, InterDigital, Samsung, Sharp

* Alt 2: If no consensus on how to capture the working assumption can be reached in RAN1#108-e, the action of group common TPC commands with format 2\_2 is regarded as an event.

**Support:** CATT, Intel, Ericsson, LG, Qualcomm, ZTE

* Alt 3: If no consensus on how to capture the working assumption can be reached in RAN1#108-e, UE does not expect to receive group common TPC commands with format 2\_2 that would take effect during the actual TDWs.

**Support:** Apple

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| **Company** | **Comments** |
| CATT | Prefer Alt 2. Alt 1 does no solve the issue but leave a hole in future maintenance phase. Alt 3 seems restricting the gNB scheduling, but as we commented before, gNB should be justified to simply increase 3dB power than to achieve 1~2dB JCE gain with additional complexity. |
| NTT DOCOMO | Support Alt1.  It is not reasonable to go for Alt2 or Alt3, because the way to capture it in the spec is not company’s preference. The outcomes of Option1, 2, and 3a are the same. |
| Nokia/NSB | Sorry to repeat ourselves but we struggle understanding why a fully BC compatible and simple solution like Option 1 would pose any issue to NW or UE. Its spec impact is very small and has no impact on existing Rel-16 logics, nor on other PUSCH transmissions not subject to DM-RS bundling (as explained above). In this context, (i) if any modified Option 3a does not solve the technical concern raised above with “acceptable complications”, and (ii) if Option 1 cannot be agreed on, then the only reasonable outcome is Alt. 2.  @NTT DOCOMO: our preference is for a technically sound, simple and backward compatible solution. This solution can be Option 1 or any other Option which meets the conditions above. It is not a preference, but a rational decision motivated by well detailed and analysed concerns. We are not sure the same can be stated for any other Option on the table. |
| InterDigital | Support Alt1, agree with NTT DOCOMO. |
| Intel | Support Alt. 2. As mentioned previously, further prolonging the discussion does not help the progress, especially when considering that Rel-15/16 behaviour is not aligned among companies.  This is the last meeting for the Rel-17 maintenance. It would be great that we can close this discussion as soon as possible. |
| QC | I feel we have been debating this for too long. Alt 2 seems like a reasonable conclusion if we can’t reach consensus.  Lets not leave this to the editor. The editor should not be tasked with RAN1 design work. The responsibility is on us. |
| Ericsson | Alt 1 is aligned with RAN1 working procedure in our understanding. The group reaches consensus on the behavior, and the editor implements the agreed behavior.  Alt 2 on the other hand allows more rapid power control, which could have some benefit.  Alt 3 is also acceptable, and seems a reasonable fall back solution if Alt 2 can’t be agreed. |

1. Agreements at RAN1#107b-e

**Conclusion:**

* It is not expected to redefine transmission occasion for PUSCH/PUCCH for DMRS bundling in Rel-17.

**Agreement:**

* The value range of *PUSCH-TimeDomainWindowLength* is INTEGER (2..[32]).
* The value range of *PUCCH-TimeDomainWindowLength* is INTEGER (2..[8]).
* Note: the value shall not exceed the maximum duration.

**Agreement:**

**Adopt the following TP to TS 38.214**

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| --- |
| **6.1.7 UE procedure for determining time domain windows for bundling DM-RS** **< unchanged text omitted>**  - For PUCCH transmissions of PUCCH repetition, a dropping or cancellation of a PUCCH transmission according to clause 9, clause 9.2.6 and clause 11.1 of [6, TS 38.213].  **< unchanged text omitted>** |

**Agreement:**

Send an LS to RAN4 asking the following question

* For extended CP, is 11-symbol the maximum length for the non-zero un-scheduled gap in-between the PUSCH transmission or PUCCH repetition, when UE is required to maintain power consistency and phase continuity?

**Agreement**

Final LS [R1-2200773](file:///C:\3gpp\Meetings\TSGR1\TSGR1_107b-e\Docs\R1-2200773.zip) on DMRS bundling for PUSCH and PUCCH is endorsed.

**Agreement:**

* If DMRS bundling and UL beam switching for multi-TRP operation are configured simultaneously, UL beam switching for multi-TRP operation is regarded as a semi-static event.

**Agreement:**

Update the description of the RRC parameters *PUSCH-Window-Restart* and *PUCCH-Window-Restart* as follows*.*

* UE bundles PUSCH DM-RS remaining in a nominal time domain window after ~~dynamic~~ event(s) triggered by DCI or MAC-CE that violate power consistency and phase continuity requirements
* UE bundles PUCCH DM-RS remaining in a nominal time domain window after ~~dynamic~~ event(s) triggered by DCI or MAC-CE that violate power consistency and phase continuity requirements

Note: Events ~~should be excluded,~~ which are triggered by DCI or MAC CE, but regarded as semi-static events, e.g. frequency hopping, UL beam switching for multi-TRP operation, or other if defined, are excluded.

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)

**Agreement:**

* 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.

**Conclusion:**

* 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.

**Agreement:**

**This working Assumption is confirmed.**

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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. |

**Agreement:**

* The action of gNB indicated TA commands constitutes an event that violates power consistency and phase continuity.

**Agreement:**

* 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.
  + An event is regarded as a dynamic event if it is triggered by a DCI or MAC-CE, otherwise it is regarded as a semi-static event.
  + Note: At least frequency hopping event is considered as semi-static event.

**Working assumption:**

* The action of group common TPC commands with format 2\_2 does not constitute an event that violates power consistency and phase continuity.
  + If UE is configured to accumulate TPC commands,
    - 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. TPC commands take effect after the current configured TDW.
  + If UE is not configured to accumulate TPC commands
    - 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.

**Agreement:**

**The following working Assumption is confirmed.**

|  |
| --- |
| **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. |

**Agreement:**

* 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.

**Agreement:** The following agreement is clarified as follows.

* For PUSCH repetition type A counting based on available 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”

|  |
| --- |
| **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. |

**Agreement:**

* UE should not perform UE autonomous TA adjustment during the actual time domain window.

**Agreement:**

* The TDW determination procedure agreed for PUSCH repetition type A is reused, when applicable, for PUSCH repetition type B and TBoMS with or without repetition.
* No additional specification enhancements for PUSCH repetition type B and TBoMS.

**Agreement:**

* If DMRS bundling and UL beam switching for multi-TRP operation are configured simultaneously, UL beam switching for multi-TRP operation constitutes an event that violates power consistency and phase continuity.
  + FFS: UL beam switching for multi-TRP operation is regarded as a semi-static event.

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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5. 3GPP R4-2114991, “LS on joint channel estimation for PUSCH and PUCCH (R1-2106212, R4-2111706)”, Qualcomm, RAN4#100-e, Aug. 2021.
6. 3GPP R4-2120002, Reply LS on PUCCH and PUSCH repetition, RAN4, Qualcomm, RAN4#101-e, November 1th – 12th, 2021.
7. 3GPP R4-2120003, WF on phase continuity and power consistency for PUCCH and PUSCH transmissions, Huawei, HiSilicon, RAN4#101-e, November 1th – 12th, 2021.
8. 3GPP R4-2202368, Reply LS on Maximum duration for DMRS bundling, RAN4, Qualcomm, RAN4#101b-e, January 17th – 25th, 2022.
9. [R1-2200968](file:///D:\Work\3GPP\RAN1\Docs\R1-2200968.zip) Discussion on joint channel estimation for PUSCH Huawei, HiSilicon
10. [R1-2201014](file:///D:\Work\3GPP\RAN1\Docs\R1-2201014.zip) Joint channel estimation for PUSCH coverage enhancements Nokia, Nokia Shanghai Bell
11. [R1-2201106](file:///D:\Work\3GPP\RAN1\Docs\R1-2201106.zip) Remaining issues on joint channel estimation for PUSCH vivo
12. [R1-2201166](file:///D:\Work\3GPP\RAN1\Docs\R1-2201166.zip) Discussion on remaining issues for joint channel estimation for PUSCH ZTE
13. [R1-2201285](file:///D:\Work\3GPP\RAN1\Docs\R1-2201285.zip) Consideration on Joint channel estimation for PUSCH OPPO
14. [R1-2201375](file:///D:\Work\3GPP\RAN1\Docs\R1-2201375.zip) Remaining issues on joint channel estimation for PUSCH CATT
15. [R1-2201434](file:///D:\Work\3GPP\RAN1\Docs\R1-2201434.zip) Discussion on joint channel estimation for PUSCH Panasonic Corporation
16. [R1-2201443](file:///D:\Work\3GPP\RAN1\Docs\R1-2201443.zip) Remaining issues on joint channel estimation China Telecom
17. R1-2201444 FL Summary of joint channel estimation for PUSCH Moderator (China Telecom)
18. [R1-2201489](file:///D:\Work\3GPP\RAN1\Docs\R1-2201489.zip) Remaining issues on joint channel estimation for PUSCH NTT DOCOMO, INC.
19. [R1-2201555](file:///D:\Work\3GPP\RAN1\Docs\R1-2201555.zip) Discussion on joint channel estimation for PUSCH Spreadtrum Communications
20. [R1-2201659](file:///D:\Work\3GPP\RAN1\Docs\R1-2201659.zip) Discussion on joint channel estimation InterDigital, Inc.
21. [R1-2201710](file:///D:\Work\3GPP\RAN1\Docs\R1-2201710.zip) Remaining details on joint channel estimation for PUSCH Intel Corporation
22. [R1-2201782](file:///D:\Work\3GPP\RAN1\Docs\R1-2201782.zip) Remaining issues on cross-slot channel estimation for PUSCH Apple
23. [R1-2201870](file:///D:\Work\3GPP\RAN1\Docs\R1-2201870.zip) Remaining issues on joint channel estimation for PUSCH CMCC
24. [R1-2201912](file:///D:\Work\3GPP\RAN1\Docs\R1-2201912.zip) Remaining issues on joint channel estimation for PUSCH Xiaomi
25. [R1-2201963](file:///D:\Work\3GPP\RAN1\Docs\R1-2201963.zip) Remaining Issues for Joint Channel Estimation for PUSCH Ericsson
26. [R1-2202028](file:///D:\Work\3GPP\RAN1\Docs\R1-2202028.zip) Joint channel estimation for PUSCH Samsung
27. [R1-2202085](file:///D:\Work\3GPP\RAN1\Docs\R1-2202085.zip) Discussion on Joint channel estimation over multi-slot MediaTek Inc.
28. [R1-2202153](file:///D:\Work\3GPP\RAN1\Docs\R1-2202153.zip) Joint channel estimation for PUSCH Qualcomm Incorporated
29. [R1-2202198](file:///D:\Work\3GPP\RAN1\Docs\R1-2202198.zip) Joint channel estimation for PUSCH Sharp
30. [R1-2202237](file:///D:\Work\3GPP\RAN1\Docs\R1-2202237.zip) Discussion on joint channel estimation for PUSCH TCL Communication Ltd.
31. [R1-2202301](file:///D:\Work\3GPP\RAN1\Docs\R1-2202301.zip) Discussions on joint channel estimation for PUSCH LG Electronics
32. [R1-2201169](file:///D:\Work\3GPP\RAN1\Docs\R1-2201169.zip) Discussion on RRC parameters for coverage enhancement ZTE