**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** |
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**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** |
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##### 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** |
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**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** |
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**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** |
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##### 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** |
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##### 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** |
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## 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** |
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##### 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.

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| **Company** | **Comments** |
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**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.

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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). |

Companies are encouraged to provide comments on the above proposal.

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| **Company** | **Comments** |
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**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** |
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## 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.

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| **Company** | **Comments** |
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## 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** |
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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.**

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| **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”

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

**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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