3GPP TSG-RAN WG2 Meeting #127bis draft R2-2409221

Hefei, China, Oct 14th – 18th, 2024

**Agenda item: 7.20.2**

**Source: Samsung**

**Title: Report of [AT127bis][201][MIMOevo] PHR related aspects**

**WID/SID: NR\_MIMO\_evo\_DL\_UL-Core**

**Document for: Discussion and Decision**

# Introduction

This document records inputs and outcome for the following offline discussion.

* [AT127bis][201][MIMOevo] Proposals for PHR related aspects (Samsung)

Scope: Discuss proposals in R2-2408748, R2-2409024, R2-2409092, R2-2409141

Intended outcome: Summary/Proposals in R2-2409221 for CB.

Deadline: before CB.

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| --- | --- | --- |
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|  |  |  |

# Discussion

## 2.1 Issue 1: Whether to generate R17 or R18 PHR MAC CE

Multi-entry PHR MAC CE is used for PHR in DC/CA. In this case, one of the two MAC entities generates and transmits the multi-entry PHR MAC CE which can include information of PH, Pcmax, MPE of serving cells from both MAC entities.

For MIMO, two PHR mode is supported for R17 feature mTRP PUSCH repetition and R18 feature STx2P multi-panel scheme.

For STx2P multi-panel scheme, if a MAC entity is configured with *twoPHRmode*, for a serving cell configured with STx2P multi-panel scheme and belonging to this MAC entity, two Type 1 PH, two Pcmax values and two MPEs are calculated at PHY, i.e., one Type 1 PH and the corresponding Pcmax, MPE is reported per TCI state.

For mTRP PUSCH repetition, if the MAC entity is configured with *twoPHRmode*, for a serving cell configured with mTRP PUSCH repetition and belonging to this MAC entity, two Type 1 PH, one Pcmax and one MPE are calculated at PHY.

In DC case, it is possible one gNB supports only Rel-17 feature and the other gNB supports Rel-18 feature. The following table gives a list of possible configurations, and the corresponding PHR MAC CE according to the current specification.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| case | MAC1  (Sender) | Activated cells  of MAC1 | MAC2 | Activated cells  of MAC2 | MAC CE | PH | Pcmax | MPE |
| 1 | twoPHR | At least one cell  with multi-panel | whichever configuration | | R18 | 2 Type 1 | 2 values | 2 values |
| 2 | twoPHR | At least one cell  PUSCH repetition  No cell with  multi-panel | twoPHR | At least one cell with Multi-panel | R17 | 2 Type 1 | 1 value | 1 value |
| 3 | twoPHR | At least one cell  PUSCH repetition  No cell with  multi-panel | other cases than case 2 | | R17 | 2 Type 1 | 1 value | 1 value |

As listed above, case 1 can be specified by the following if condition, and case 2+3 can be specified by the following else if condition.

* If the MAC entity generating and transmitting the PHR MAC CE (i.e., MAC1) is configured with R18 feature multi-panel scheme (i.e., twoPHRmode and at least one serving cell belong to this MAC entity is configured with multi-panel scheme):
  + R18 multi-entry PHR MAC CE for STx2P is generated;
  + Up to 2 Type 1 PH, 2 Pcmax, and 2 MPE can be reported for each serving cell belonging to this MAC entity or the other MAC entity.
* Else if the MAC entity generating and transmitting the PHR MAC CE (i.e., MAC1) is configured with R17 feature mTRP PUSCH repetition (i.e., twoPHRmode and at least one serving cell belong to this MAC entity is configured with mTRP PUSCH repetition):
  + R17 multi-entry PHR MAC CE for mTRP is generated;
  + Up to 2 Type 1 PH, 1 Pcmax, and 1 MPE can be reported for each serving cell belonging to this MAC entity or the other MAC entity.

The following figure shows one case of decoding failure when R18 PHR MAC CE is generated and transmitting to a R17 gNB.



Figure 1. Example of PHR MAC CE on Rel-17 MAC entity

**Q1: Do you agree the above “if-elseif” block?**

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| **Company** | **Y/N** | **Reason/Comment** |
| LGE | Y |  |
| Huawei, Hisilicon | Y |  |
|  |  |  |
|  |  |  |

Rapp: there is no other comment received

* **agreeable**

**Q2: If Q1 is agreed, do you think the following TP is needed for clause 5.4.6 (as proposed by R2-2409092) to clarify the conditions of generating R17/18 multi-entry PHR MAC CE?**

|  |
| --- |
| *…unnecessary part…*  3> else if this MAC entity is configured with *twoPHRMode* and at least one Serving Cell belonging to this MAC entity is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:  4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Multiple Entry PHR for multiple TRP STx2P MAC CE as defined in clause 6.1.3.82 based on the values reported by the physical layer.  3> else if this MAC entity is configured with *twoPHRMode* and at least one Serving Cell belonging to this MAC entity is configured with multiple TRP PUSCH repetition:  4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Multiple Entry PHR for multiple TRP MAC CE as defined in clause 6.1.3.51 based on the values reported by the physical layer.  *…unnecessary part…* |

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| **Company** | **Y/N** | **Reason/Comment** |
| LGE | Y |  |
| Huawei, Hisilicon | Y, but | “at least one” is okay. But we see no difference between “”associated” and “belonging to this MAC entity”. Not strong view on the wording, can follow majority |
| Ericsson |  | Okay to keep original, no strong view |
| ZTE |  | Some concern with second >3, whether it is aligned with R17 MAC procedure needs further discussion. |

Rapp: For ZTE’s comment, do not see difference to R17 MAC procedure.

* **agreeable**

## 2.2 Issue 2: Whether to report one Pcmax or two?

If Q1 is agreed, for the “if” branch (i.e., R18 PHR MAC CE is generated), how many Pcmax values to be reported for each serving cell depends on the configuration.

As explained at the beginning, for a serving cell configured with STx2P multi-panel scheme and belonging to a MAC entity configured with twoPHRmode, two Pcmax values and two MPEs are calculated at PHY. In this case, two Pcmax values and two MPEs can be accommodated in the MAC CE and reported. For a serving cell with other configurations, only one Pcmax and one MPE is calculated at PHY and thus reported by MAC CE.

**Q3: If Q1 is agreed, do you agree the following steps?**

* If the MAC entity generating and transmitting the PHR MAC CE (i.e., MAC1) is configured with R18 feature multi-panel scheme (i.e., twoPHRmode and at least one serving cell belong to this MAC entity is configured with multi-panel scheme):
  + R18 multi-entry PHR MAC CE for STx2P is generated;
  + If a serving cell is configured with STx2P multi-panel scheme and belongs to a MAC entity configured with twoPHRmode:
    - Obtain two Pcmax values and two MPEs.
  + Else:
    - Obtain one Pcmax value and one MPE.
* Else if the MAC entity generating and transmitting the PHR MAC CE (i.e., MAC1) is configured with R17 feature mTRP PUSCH repetition (i.e., twoPHRmode and at least one serving cell belong to this MAC entity is configured with mTRP PUSCH repetition):
  + R17 multi-entry PHR MAC CE for mTRP is generated;
  + Up to 2 Type 1 PH, 1 Pcmax, and 1 MPE can be reported for each serving cell belonging to this MAC entity or the other MAC entity.

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| **Company** | **Y/N** | **Reason/Comment** |
| LGE | Y |  |
| Huawei, Hisilicon | Y |  |

Rapp: there is no other comment received

* **agreeable**

**Q4: If Q3 is agreed, do you agree the following the TP for clause 5.4.6 (based on TP from R2-2409092, R2-2408748) to clarify the conditions of reporting one or two Pcmax?**

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| --- |
| *…unnecessary part…*  4> else (i.e. if this MAC entity is not configured with *phr-AssumedPUSCH-Reporting*):  5> if this MAC entity is configured with *twoPHRMode* and at least one Serving Cell belonging to this MAC entity is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:  6> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN* and the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:  7> obtain two values for the corresponding PCMAX,f,c,k fields from the physical layer.  7> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:  8> obtain two values for the corresponding MPEk fields from the physical layer.  6> else:  7> obtain the value for the corresponding PCMAX,f,c field from the physical layer.  7> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:  8> obtain the value for the corresponding MPE field from the physical layer.  5> else:  6> if this MAC entity has UL resources allocated for transmission on this Serving Cell; or  6> if the other MAC entity, if configured, has UL resources allocated for transmission on this Serving Cell and *phr-ModeOtherCG* is set to *real* by upper layers:  7> obtain the value for the corresponding PCMAX,f,c field from the physical layer.  7> if *mpe-Reporting-FR2* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:  8> obtain the value for the corresponding MPE field from the physical layer.  *…unnecessary part…* |

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| --- | --- | --- |
| **Company** | **Y/N** | **Reason/Comment** |
| LGE | Y |  |
| Huawei, Hisilicon | Y |  |

Rapp: some comments are received to reduce potential duplication. After further checking, we do not see other better way. Let’s stick with this TP for now.

**=> agreeable**

## 2.3 Issue 3: How to select one Pcmax to report in MAC when two are calculated at PHY?

If Q1 is agreed, for the “elseif” branch (i.e., R17 PHR MAC CE is generated), only one Pcmax can be accommodated in the MAC CE and reported for each serving cell, even if a serving cell configured with multi-panel scheme has two Pcmax values calculated by PHY. How to select one Pcmax to be reported from the two available Pcmax values needs to be specified.

**Q5: Do you agree the above issue needs to be solved?**

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| **Company** | **Y/N** | **Reason/Comment** |
| LGE | Y |  |
| Huawei, Hisilicon | Y |  |

Rapp: no other comment is received, this is agreeable.

* **Agreeable**

Similar to our last meeting’s discussion and decision on selecting one Type 1 PH value from two available values, the value associated to the first TCI state and/or the real PUSCH transmission can be prioritized.

**Q6: If Q1 is agreed, do you agree the following steps (proposed in R2-2409024)?**

* If the MAC entity generating and transmitting the PHR MAC CE (i.e., MAC1) is configured with R18 feature multi-panel scheme (i.e., twoPHRmode and at least one serving cell belong to this MAC entity is configured with multi-panel scheme):
  + R18 multi-entry PHR MAC CE for STx2P is generated;
  + Up to 2 Type 1 PH, 2 Pcmax, and 2 MPE can be reported for each serving cell belonging to this MAC entity or the other MAC entity.
* Else if the MAC entity generating and transmitting the PHR MAC CE (i.e., MAC1) is configured with R17 feature mTRP PUSCH repetition (i.e., twoPHRmode and at least one serving cell belong to this MAC entity is configured with mTRP PUSCH repetition):
  + R17 multi-entry PHR MAC CE for mTRP is generated;
  + If a serving cell is configured with STx2P multi-panel scheme and belonging to a MAC entity configured with twoPHRmode:
  + If the first joint/UL TCI is applied for a real PUSCH transmission or if there is no real PUSCH transmission,
    - the Pcmax associated to the PUSCH transmission for the first joint/UL TCI is obtained,
    - the corresponding MPE is obtained if configured;
  + else if the second joint/UL TCI is applied for a real PUSCH transmission,
    - the Pcmax associated to the PUSCH transmission for the second joint/UL TCI is obtained
    - the corresponding MPE is obtained if configured.

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| **Company** | **Y/N** | **Reason/Comment** |
| LGE | N | According to 6.2K.4 in 38.101-2, P-MPR value is also associated with joint/UL TCI state.  P-MPRf,c,k is the power management maximum output power reduction P-MPRf,c for each of indicated joint/UL TCI states. P-MPRf,c is defined in clause 6.2.4.  Thus, in addition to Pcmax, the value for the corresponding MPE field should be associated with joint/UL TCI state. For example,   * + If the first joint/UL TCI is applied for a real PUSCH transmission or if there is no real PUSCH transmission,     - the Pcmax associated to the PUSCH transmission for the first joint/UL TCI is obtained,     - the corresponding MPE value associated to the PUSCH transmission for the first joint/UL TCI is obtained if configured; |
| Huawei, Hisilicon | See comments | Agree with the rule in Q6 about how to select on Pcmax value.  In addition, how to select one MPE value mentioned by LGE is also a valid issue. Agree with LGE that we can use the same rule when selecting one MPE value. |

Rapp: for LG’s comment, the corresponding MPE value means the value associated to the selected Pcmax. The comment can be addressed in the TP.

* **Agreeable**

**Q7: If Q6 is agreed, do you agree the following the TP (in red block) for clause 5.4.6 (based on TP in R2-2409024) to clarify how to obtain one Pcmax from two available values calculated in PHY?**

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| *…unnecessary part…*  4> else (i.e. if this MAC entity is not configured with *phr-AssumedPUSCH-Reporting*):  5> if this MAC entity is configured with *twoPHRMode* and at least one Serving Cell belonging to this MAC entity is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:  6> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN* and the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:  7> obtain two values for the corresponding PCMAX,f,c,k fields from the physical layer.  7> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:  8> obtain two values for the corresponding MPEk fields from the physical layer.  6> else:  7> obtain the value for the corresponding PCMAX,f,c field from the physical layer.  7> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:  8> obtain the value for the corresponding MPE field from the physical layer.  5> else if this MAC entity is configured with *twoPHRMode* and at least one Serving Cell belong to this MAC entity is configured with PUSCH repetition:  6> if this serving cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN* and the MAC entity this serving cell belongs to is configured with *twoPHRmode*:  7> if the first *TCI-State* or *TCI-UL-State* is applied for a real PUSCH transmission or if there is no real PUSCH transmission at the slot where the PHR MAC CE is transmitted:  8> obtain the value for the PCMAX,f,c field for the PUSCH transmission associated to the first *TCI-State* or *TCI-UL-State* from the physical layer.  8> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:  9> obtain the value for the corresponding MPE field for the PUSCH transmission associated to the first *TCI-State* or *TCI-UL-State* from the physical layer.  7> else if the second *TCI-State* or *TCI-UL-State* is applied for a real PUSCH transmission:  8> obtain the value for the PCMAX,f,c field for the PUSCH transmission associated to the second *TCI-State* or *TCI-UL-State* from the physical layer.  8> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:  9> obtain the value for the corresponding MPE field for the PUSCH transmission associated to the second *TCI-State* or *TCI-UL-State* from the physical layer.  5> else:  6> if this MAC entity has UL resources allocated for transmission on this Serving Cell; or  6> if the other MAC entity, if configured, has UL resources allocated for transmission on this Serving Cell and *phr-ModeOtherCG* is set to *real* by upper layers:  7> obtain the value for the corresponding PCMAX,f,c field from the physical layer.  7> if *mpe-Reporting-FR2* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:  8> obtain the value for the corresponding MPE field from the physical layer.  *…unnecessary part…* |

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| --- | --- | --- |
| **Company** | **Y/N** | **Reason/Comment** |
| LGE | comment | As mentioned in Q6, the value for the corresponding MPE field should be associated with joint/UL TCI state. |
| Huawei, Hisilicon | See comments | Agree with LGE |

Rapp: Addressed the comments to make it clearer for MPE, adding “for the PUSCH transmission associated to the first *TCI-State* or *TCI-UL-State”* to MPE steps, as shown above.

**=> agreeable**

## 2.4 Issue 4: Ambiguity on subscript k

R2-2409141 Clarification on the k values in the STx2P PHR MAC CE Huawei, HiSilicon CR Rel-18 38.321 18.3.0 1970 - F NR\_MIMO\_evo\_DL\_UL-Core

In Rel-18 STx2P, PH value is associated with the first or the second TCI state, instead of TRP. In clause 6.1.3.81, the description of “PH value for the corresponding TRP” is not suitable.

**Q8: Do you agree the following change?**

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| 6.1.3.81 Enhanced Single Entry PHR for multiple TRP STx2P MAC CE  The Enhanced Single Entry PHR for multiple TRP STx2P MAC CE is identified by a MAC subheader with eLCID as specified in Table 6.2.1-2b.  The two PHs together with two PCMAX,f,c,k for the Serving Cell are reported if UE is configured with *twoPHRMode* and *multipanelSchemeSDM* or *multipanelSchemeSFN*, as specified in clause 5.4.6.  It has a fixed size and consists of four octets defined as follows (Figure 6.1.3.81-1):  - R: Reserved bit, set to 0;  - Power Headroom k (PH k): This field indicates the power headroom level for k = 1, 2, where PH 1 is associated with the first *TCI-State* or *TCI-UL-State* for a real or reference PUSCH transmission and PH 2 is associated with the second *TCI-State* or *TCI-UL-State* for a real or reference PUSCH transmission, as specified in TS 38.213 clause 7.7.1 [6]. PH fields for a Serving Cell are included in ascending order based on k. The length of the field is 6 bits. The reported PH and the corresponding power headroom levels are shown in Table 6.1.3.8-1 (the corresponding measured values in dB are specified in TS 38.133 [11]);  - Pk: If *mpe-Reporting-FR2* is configured and the Serving Cell operates on FR2, the MAC entity shall set this field to 0 if the applied P-MPR value associated with PCMAX,f,c,k, to meet MPE requirements, as specified in TS 38.101-2 [15], is less than P-MPR\_00 as specified in TS 38.133 [11] and to 1 otherwise. If *mpe-Reporting-FR2* is not configured or the Serving Cell operates on FR1, this field indicates whether power backoff is applied due to power management (as allowed by P-MPRc as specified in TS 38.101-1 [14], TS 38.101-2 [15], and TS 38.101-3 [16]). The MAC entity shall set the Pk field to 1 if the corresponding PCMAX,f,c,k field would have had a different value if no power backoff due to power management had been applied;  - Vk: This field indicates if the PH value for the corresponding *TCI-State* or *TCI-UL-State* is based on a real transmission or a reference format for PH k. For Type 1 PH, the Vk field set to 0 indicates real transmission on PUSCH and the Vk field set to 1 indicates that a PUSCH reference format is used;  - PCMAX,f,c,k: This field indicates the configured transmitted power PCMAX,f,c,k (as specified in TS 38.213 [6]) used for calculation of the preceding PH k field. The reported PCMAX,f,c,k and the corresponding nominal UE transmit power levels are shown in Table 6.1.3.8-2 (the corresponding measured values in dBm are specified in TS 38.133 [11]);  - MPEk: If *mpe-Reporting-FR2* is configured, and the Serving Cell operates on FR2, and if the Pk field is set to 1, this field indicates the applied power backoff to meet MPE requirements, as specified in TS 38.101-2 [15]. This field indicates an index to Table 6.1.3.8-3 and the corresponding measured values of P-MPR levels in dB are specified in TS 38.133 [11]. The length of the field is 2 bits. If *mpe-Reporting-FR2* is not configured, or if the Serving Cell operates on FR1, or if the Pk field is set to 0, R bits are present instead. |

|  |  |  |
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| **Company** | **Y/N** | **Reason/Comment** |
| Huawei, HiSilicon | Y | Proponent. This issue is about how to select one PH when two are generated, which is also relevant to Issue 3 (How to select one Pcmax), followed by the same principle, i.e. the particular Pcmax/PH is associated with the corresponding TCI state. Given that we have attempted to avoid using TRP in procedural text in Stage 3 spec, it is necessary to keep consistent with all relevant aspects. Note that it is not a functionality change wo NBC risk. |
| LGE | N | We think it would be better to use the same text as used in Multiple Entry PHR for STx2P, i.e.,  This field indicates if the PH k value ~~for the corresponding TRP~~ is based on a real transmission or a reference format for k = 1, 2 ~~PH k~~. |

HW: LG’s suggestion is better

Rapp: agree with LG’s suggestion

* **go with LG’s suggestion**

In Rel-18 STx2P, for Type 1 PH, the UE reports two PH values and two Pcmax values for a serving cell. For Type 2 and Type 3 PH, the UE only reports one PH value and one Pcmax value, since the Rel-18 (and also Rel-17) PH reporting related enhancement is for PUSCH, not for SRS or PUCCH. However, in clause 6.1.3.82, the “for k = 1, 2” in the MAC CE field description causes confusion without distinguishing Type. The similar confusion exists for P, V, and MPE fields.

**Q9: Do you agree the following change?**

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| --- |
| 6.1.3.82 Enhanced Multiple Entry PHR for multiple TRP STx2P MAC CE  The Enhanced Multiple Entry PHR for multiple TRP STx2P MAC CE is identified by a MAC subheader with eLCID as specified in Table 6.2.1-2b.  It has a variable size, and includes the bitmaps, a Type 2 PH field and an octet containing the associated PCMAX,f,c field (if reported) for SpCell of the other MAC entity, one or multiple Type 1 PH fields and one or multiple octets containing the associated PCMAX,f,c,k fields (if reported) for the PCell. It further includes, in ascending order based on the *ServCellIndex*, one or multiple of Type 1 PH fields and one or multiple octets containing the associated PCMAX,f,c,k fields (if reported) or one Type 3 PH field with one octet containing the associated PCMAX,f,c field (if reported) for Serving Cells other than PCell indicated in the bitmap for indicating the presence of PH(s).  The presence of Type 2 PH field for SpCell of the other MAC entity is configured by *phr-Type2OtherCell* with value *true*.  A single octet bitmap is used for indicating the presence of PH(s) per Serving Cell when the highest *ServCellIndex* of Serving Cell with configured uplink is less than 8, otherwise four octets are used.  The MAC entity determines whether PH value for an activated Serving Cell is based on real transmission or a reference format by considering the configured grant(s) and downlink control information which has been received until and including the PDCCH occasion in which the first UL grant for a new transmission that can accommodate the MAC CE for PHR as a result of LCP as defined in clause 5.4.3.1 is received since a PHR has been triggered if the PHR MAC CE is reported on an uplink grant received on the PDCCH or until the first uplink symbol of PUSCH transmission minus PUSCH preparation time as defined in clause 7.7 of TS 38.213 [6] if the PHR MAC CE is reported on a configured grant.  For a band combination in which the UE does not support dynamic power sharing, the UE may omit the octets containing Power Headroom field and PCMAX,f,c,k field for Serving Cells in the other MAC entity except for the PCell in the other MAC entity and the reported values of Power Headroom and PCMAX,f,c,k for the PCell are up to UE implementation.  The two PHs together with two PCMAX,f,c,k for the Serving Cell configured with *multipanelSchemeSDM* or *multipanelSchemeSFN* are reported if the MAC entity is configured with *twoPHRMode*, as specified in clause 5.4.6.  The Enhanced Multiple Entry PHR for multiple TRP STx2P MAC CEs are defined as follows:  - Ci: This field indicates the presence of PH field(s) for the Serving Cell with *ServCellIndex* i as specified in TS 38.331 [5]. The Ci field set to 1 indicates that PH field(s) for the Serving Cell with *ServCellIndex* i is reported. The Ci field set to 0 indicates that a PH field for the Serving Cell with *ServCellIndex* i is not reported;  - R: Reserved bit, set to 0;  - Vk: This field indicates if the PH k value is based on a real transmission or a reference format for k = 1, 2. For Type 1 PH, the Vk field set to 0 indicates real transmission on PUSCH and the Vk field set to 1 indicates that a PUSCH reference format is used. For Type 2 PH, the Vk field set to 0 indicates real transmission on PUCCH and the Vk field set to 1 indicates that a PUCCH reference format is used. For Type 3 PH, the Vk field set to 0 indicates real transmission on SRS and the Vk field set to 1 indicates that an SRS reference format is used. Furthermore, for type 1 PH of a reported Serving Cell not configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*,the Vk field set to 0 indicates the presence of the octet containing the associated PCMAX,f,c,k field and the MPEk field, and the Vk field set to 1 indicates that the octet containing the associated PCMAX,f,c,k field and MPEk field is omitted; for Type 2, and Type 3 PH, the Vk field set to 0 indicates the presence of the octet containing the associated PCMAX,f,c,k field and the MPEk field, and the Vk field for the Serving Cell set to 1 indicates that the octet containing the associated PCMAX,f,c,k field and the MPEk field is omitted;  - Power Headroom k (PH k): This field indicates the power headroom level. For PHR with *twoPHRmode*, if the Serving cell is configured with *multipanelSchemeSFN* or *multipanelSchemeSDM,* PH 1 is associated with the first *TCI-State* or *TCI-UL-State* for a real or reference PUSCH transmission and PH 2 is associated with the second *TCI-State* or *TCI-UL-State* for a real or reference PUSCH transmission, as specified in TS 38.213 clause 7.7.1 [6]; if the Serving cell is configured with multiple TRP PUSCH repetition, PH 1 is associated with the *SRS-ResourceSet* with a lower *srs-ResourceSetId* and PH 2 is associated with the SRS-ResourceSet with a higher *srs-ResourceSetId*. PH fields for a Serving Cell are included in ascending order based on k. The length of the field is 6 bits. The reported PH and the corresponding power headroom levels are shown in Table 6.1.3.8-1 (the corresponding measured values in dB for the NR Serving Cell are specified in TS 38.133 [11] while the corresponding measured values in dB for the E-UTRA Serving Cell are specified in TS 36.133 [12]);  - Pk: If *mpe-Reporting-FR2* is configured and the Serving Cell operates on FR2, the MAC entity shall set this field to 0 if the applied P-MPR value associated with PCMAX,f,c,k, to meet MPE requirements, as specified in TS 38.101-2 [15], is less than P-MPR\_00 as specified in TS 38.133 [11] and to 1 otherwise. If *mpe-Reporting-FR2* is not configured or the Serving Cell operates on FR1, this field indicates whether power backoff is applied due to power management (as allowed by P-MPRc as specified in TS 38.101-1 [14], TS 38.101-2 [15], and TS 38.101-3 [16]). The MAC entity shall set the Pk field to 1 if the corresponding PCMAX,f,c,k field would have had a different value if no power backoff due to power management had been applied;  - PCMAX,f,c, PCMAX,f,c,k: If present, this field indicates the configured transmitted power PCMAX,f,c,k (as specified in TS 38.213 [6]) for the NR Serving Cell and the PCMAX,c or P̃CMAX,c (as specified in TS 36.213 [17]) for the E-UTRA Serving Cell used for calculation of the preceding PH k field. For the SpCell of the other MAC entity and a reported Serving Cell not configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*, PCMAX,f,c is presented (i.e., the index k is omitted). The reported PCMAX,f,c,k and the corresponding nominal UE transmit power levels are shown in Table 6.1.3.8-2 (the corresponding measured values in dBm for the NR Serving Cell are specified in TS 38.133 [11] while the corresponding measured values in dBm for the E-UTRA Serving Cell are specified in TS 36.133 [12]);  - MPEk: If *mpe-Reporting-FR2* is configured, and the Serving Cell operates on FR2, and if the Pk field is set to 1, this field indicates the applied power backoff to meet MPE requirements, as specified in TS 38.101-2 [15]. This field indicates an index to Table 6.1.3.8-3 and the corresponding measured values of P-MPR levels in dB are specified in TS 38.133 [11]. The length of the field is 2 bits. If *mpe-Reporting-FR2* is not configured, or if the Serving Cell operates on FR1, or if the Pk field is set to 0, R bits are present instead.  NOTE: In the description of Vk, PH k, Pk, PCMAX,f,c,k, and MPEk, for Type 1 PH, k = 1, 2; for Type 2 and Type 3 PH, k =1. |

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Reason/Comment** |
| Huawei, HiSilicon | Y | For single entry format, it can be easily concluded from the format itself that only PH Type 1 is reported, and thus no clarification is needed. However, for multiple entry format, given that Type 1/2/3 can be possibly included in the MAC CE, it is beneficial to clarify the condition how to consider to avoid ambiguity from reading the format. Note that it is not a functionality change wo NBC risk. |
| LGE | Comment | No strong view.  However, we think k value can be known implicitly based on the procedure text for PHR, e.g. for Type 1, two PH value, two Pcmax value and two MPE values can be obtained. For Type 2 and Type 3, one PH, one Pcmax and one MPE value are obtained. |

Rapp: After further checking the current clause, it is already mentioned, as highlighted above: for type 2 and type 3 only one PH field and Pcmax are reported, V field is associated to PH field, P and MPE fields are associated with Pcmax field, so there is no ambiguity. Adding the note creates some duplication.

* Proposal: do not add the note.

# Conclusion

**Proposal 1: Confirm the procedure on whether to generate R17 or R18 mTRP PHR MAC CE:**

* If the MAC entity generating and transmitting the PHR MAC CE (i.e., MAC1) is configured with R18 feature multi-panel scheme (i.e., twoPHRmode and at least one serving cell belong to this MAC entity is configured with multi-panel scheme):
  + R18 multi-entry PHR MAC CE for STx2P is generated;
  + Up to 2 Type 1 PH, 2 Pcmax, and 2 MPE can be reported for each serving cell belonging to this MAC entity or the other MAC entity.
* Else if the MAC entity generating and transmitting the PHR MAC CE (i.e., MAC1) is configured with R17 feature mTRP PUSCH repetition (i.e., twoPHRmode and at least one serving cell belong to this MAC entity is configured with mTRP PUSCH repetition):
  + R17 multi-entry PHR MAC CE for mTRP is generated;
  + Up to 2 Type 1 PH, 1 Pcmax, and 1 MPE can be reported for each serving cell belonging to this MAC entity or the other MAC entity.

**Proposal 2: Agree the procedure on reporting Pcmax in R17/R18 mTRP PHR MAC CE:**

* If the MAC entity generating and transmitting the PHR MAC CE (i.e., MAC1) is configured with R18 feature multi-panel scheme (i.e., twoPHRmode and at least one serving cell belong to this MAC entity is configured with multi-panel scheme):
  + R18 multi-entry PHR MAC CE for STx2P is generated;
  + If a serving cell is configured with STx2P multi-panel scheme and belongs to a MAC entity configured with twoPHRmode:
    - Obtain two Pcmax values and two MPEs.
  + Else:
    - Obtain one Pcmax value and one MPE.
* Else if the MAC entity generating and transmitting the PHR MAC CE (i.e., MAC1) is configured with R17 feature mTRP PUSCH repetition (i.e., twoPHRmode and at least one serving cell belong to this MAC entity is configured with mTRP PUSCH repetition):
  + R17 multi-entry PHR MAC CE for mTRP is generated;
  + If a serving cell is configured with STx2P multi-panel scheme and belonging to a MAC entity configured with twoPHRmode:
  + If the first joint/UL TCI is applied for a real PUSCH transmission or if there is no real PUSCH transmission,
    - the Pcmax associated to the PUSCH transmission for the first joint/UL TCI is obtained,
    - the corresponding MPE is obtained if configured;
  + else if the second joint/UL TCI is applied for a real PUSCH transmission,
    - the Pcmax associated to the PUSCH transmission for the second joint/UL TCI is obtained
    - the corresponding MPE is obtained if configured.

**Proposal 3: Adopt the TP in the Appendix A of R2-2409221.**

**Proposal 4: For the first change in R2-2409141 (i.e. in clause 6.1.3.81), revise to “This field indicates if the PH k value ~~for the corresponding TRP~~ is based on a real transmission or a reference format for k = 1, 2 ~~PH k~~.” Adopt the TP in the Appendix B of R2-2409221.**

**Proposal 5: For the second change in R2-2409141 (i.e., in clause 6.1.3.82), the note is not needed.**

# Reference

[1] R2-2409092 Remaining issue on STx2P PHR LG Electronics Inc. discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core

[2] R2-2408748 Considerations on Remaining UP Issues for R18 MIMO ZTE Corporation discussion Rel-18 NR\_MIMO\_evo\_DL\_UL-Core

[3] R2-2409024 Correction on multi-entry PHR for MIMO STx2P multi-panel scheme Samsung CR Rel-18 38.321 18.3.0 1959 - F NR\_MIMO\_evo\_DL\_UL-Core

[4] R2-2409141 Clarification on the k values in the STx2P PHR MAC CE Huawei, HiSilicon CR Rel-18 38.321 18.3.0 1970 - F NR\_MIMO\_evo\_DL\_UL-Core

# Appendix A

5.4.6 Power Headroom Reporting

The Power Headroom reporting procedure is used to provide the serving gNB with the following information:

- Type 1 power headroom: the difference between the nominal UE maximum transmit power and the estimated power for UL-SCH transmission per activated Serving Cell;

- Type 2 power headroom: the difference between the nominal UE maximum transmit power and the estimated power for UL-SCH and PUCCH transmission on SpCell of the other MAC entity (i.e. E-UTRA MAC entity in EN-DC, NE-DC, and NGEN-DC cases);

- Type 3 power headroom: the difference between the nominal UE maximum transmit power and the estimated power for SRS transmission per activated Serving Cell;

- MPE P-MPR: the power backoff to meet the MPE FR2 requirements for a Serving Cell operating on FR2;

- DPC: the adjustment to maximum output power for a given power class for a Serving Cell operating on FR1;

- DPCBC: the adjustment to maximum output power for a given power class for a Band Combination operating on FR1.

RRC controls Power Headroom reporting by configuring the following parameters:

- *dpc-Reporting-FR1*;

- *phr-AssumedPUSCH-Reporting*;

- *phr-PeriodicTimer*;

- *phr-ProhibitTimer*;

- *phr-Tx-PowerFactorChange*;

- *phr-Type2OtherCell*;

- *phr-ModeOtherCG*;

- *multiplePHR*;

- *mpe-Reporting-FR2*;

- *mpe-ProhibitTimer*;

- *mpe-Threshold*;

- *numberOfN*;

- *mpe-ResourcePoolToAddModList*;

- *twoPHRMode*.

A Power Headroom Report (PHR) shall be triggered if any of the following events occur:

- *phr-ProhibitTimer* expires or has expired and the path loss has changed more than *phr-Tx-PowerFactorChange* dB for at least one RS used as pathloss reference for one activated Serving Cell of any MAC entity of which the active DL BWP is not dormant BWP since the last transmission of a PHR in this MAC entity when the MAC entity has UL resources for new transmission;

NOTE 1: The path loss variation for one cell assessed above is between the pathloss measured at present time on the current pathloss reference and the pathloss measured at the transmission time of the last transmission of PHR on the pathloss reference in use at that time, irrespective of whether the pathloss reference has changed in between. The current pathloss reference for this purpose does not include any pathloss reference configured using *pathlossReferenceRS-Pos* in TS 38.331 [5].

- *phr-PeriodicTimer* expires;

- upon configuration or reconfiguration of the power headroom reporting functionality by upper layers, which is not used to disable the function;

- activation of an SCell of any MAC entity with configured uplink of which *firstActiveDownlinkBWP-Id* is not set to dormant BWP;

- activation of an SCG;

- addition of the PSCell except if the SCG is deactivated (i.e. PSCell is newly added or changed);

- *phr-ProhibitTimer* expires or has expired, when the MAC entity has UL resources for new transmission, and the following is true for any of the activated Serving Cells of any MAC entity with configured uplink:

- there are UL resources allocated for transmission or there is a PUCCH transmission on this cell, and the required power backoff due to power management (as allowed by P-MPRc as specified in TS 38.101-1 [14], TS 38.101-2 [15], and TS 38.101-3 [16]) for this cell has changed more than *phr-Tx-PowerFactorChange* dB since the last transmission of a PHR when the MAC entity had UL resources allocated for transmission or PUCCH transmission on this cell.

- Upon switching of activated BWP from dormant BWP to non-dormant DL BWP of an SCell of any MAC entity with configured uplink;

- if *dpc-Reporting-FR1* is configured, ΔPPowerClass /ΔPPowerClass, CA/ΔPPowerClass, EN-DC/ΔPPowerClass, NR-DC reporting is triggered upon uplink duty cycle exceedance or upon return to the power class after the duty cycle exceedance, as specified in TS 38.101-1 [14] and TS 38.101-3 [16]).

- if *mpe-Reporting-FR2* is configured, and *mpe-ProhibitTimer* is not running:

- the measured P-MPR applied to meet FR2 MPE requirements as specified in TS 38.101-2 [15] is equal to or larger than *mpe-Threshold* for at least one activated FR2 Serving Cell since the last transmission of a PHR in this MAC entity; or

- the measured P-MPR applied to meet FR2 MPE requirements as specified in TS 38.101-2 [15] has changed more than *phr-Tx-PowerFactorChange* dB for at least one activated FR2 Serving Cell since the last transmission of a PHR due to the measured P-MPR applied to meet MPE requirements being equal to or larger than *mpe-Threshold* in this MAC entity.

in which case the PHR is referred below to as 'MPE P-MPR report'.

NOTE 2: The MAC entity should avoid triggering a PHR when the required power backoff due to power management decreases only temporarily (e.g. for up to a few tens of milliseconds) and it should avoid reflecting such temporary decrease in the values of PCMAX,f,c/PH when a PHR is triggered by other triggering conditions.

NOTE 3: If a HARQ process is configured with *cg-RetransmissionTimer* and if the PHR is already included in a MAC PDU for transmission on configured grant by this HARQ process, but not yet transmitted by lower layers, it is up to UE implementation how to handle the PHR content.

If the MAC entity has UL resources allocated for a new transmission the MAC entity shall:

1> if it is the first UL resource allocated for a new transmission since the last MAC reset:

2> start *phr-PeriodicTimer*.

1> if the Power Headroom reporting procedure determines that at least one PHR has been triggered and not cancelled; and

1> if the allocated UL resources can accommodate the MAC CE for PHR which the MAC entity is configured to transmit, plus its subheader, as a result of LCP as defined in clause 5.4.3.1:

2> if *multiplePHR* with value *true* is configured:

3> for each activated Serving Cell with configured uplink associated with any MAC entity of which the active DL BWP is not dormant BWP; and

3> for each activated Serving Cell with configured uplink associated with E-UTRA MAC entity:

4> if this MAC entity is configured with *twoPHRMode*:

5> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN* and the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:

6> obtain two values of the Type 1 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213 [6] for NR Serving Cell.

5> else if this Serving Cell is configured with multiple TRP PUSCH repetition (i.e., not configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*) and the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:

6> obtain two values of the Type 1 or the value of Type 3 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213 [6] for NR Serving Cell.

5> else:

6> obtain the value of the Type 1 or Type 3 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213 [6] for NR Serving Cell and clause 5.1.1.2 of TS 36.213 [17] for E-UTRA Serving Cell.

4> else (i.e. this MAC entity is not configured with *twoPHRMode*):

5> if this Serving Cell is configured with multiple TRP PUSCH repetition or *multipanelSchemeSDM* or *multipanelSchemeSFN* and if the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:

6> if there is at least one real PUSCH transmission at the slot where the PHR MAC CE is transmitted:

7> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

8> if the first *TCI-State* or *TCI-UL-State* is applied for a real PUSCH transmission:

9> obtain the value of the Type 1 power headroom of the real PUSCH transmission associated with the first *TCI-State* or *TCI-UL-State* for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

8> else:

9> obtain the value of the Type 1 power headroom of the real PUSCH transmission associated with the second *TCI-State* or *TCI-UL-State* for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

7> else if this Serving Cell is configured with multiple TRP PUSCH repetition:

8> obtain the value of the Type 1 power headroom of the first real transmission of the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

6> else if there is no real PUSCH transmission at the slot where the PHR MAC CE is transmitted:

7> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

8> obtain the value of the Type 1 power headroom of the reference PUSCH transmission associated with the first *TCI-State* or *TCI-UL-State* for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

7> else if this Serving Cell is configured with multiple TRP PUSCH repetition:

8> obtain the value of the Type 1 power headroom of the reference PUSCH transmission associated with the *SRS-ResourceSet* with a lower *SRS-resourceSetID* or the value of the type 3 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213[6] for NR Serving Cell.

5> else:

6> obtain the value of the Type 1 or Type 3 power headroom for the corresponding uplink carrier as specified in clause 7.7 of TS 38.213 [6] for NR Serving Cell and clause 5.1.1.2 of TS 36.213 [17] for E-UTRA Serving Cell.

4> if this MAC entity is configured with *phr-AssumedPUSCH-Reporting*:

5> if this MAC entity has UL resources allocated for transmission on this Serving Cell; or

5> if the other MAC entity, if configured, has UL resources allocated for transmission on this Serving Cell and *phr-ModeOtherCG* is set to *real* by upper layers:

6> if *dynamicTransformPrecoderFieldPresenceDCI-0-1-r18* or *dynamicTransformPrecoderFieldPresenceDCI-0-2-r18* is set to *enabled* in the active BWP of this Serving Cell:

7> obtain the value for the corresponding PCMAX,f,c field for assumed PUSCH from the physical layer if available, as specified in clause 7.7 of TS 38.213 [6].

6> obtain the value for the corresponding PCMAX,f,c field from the physical layer.

6> if *mpe-Reporting-FR2* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:

7> obtain the value for the corresponding MPE field from the physical layer.

4> else (i.e. if this MAC entity is not configured with *phr-AssumedPUSCH-Reporting*):

5> if this MAC entity is configured with *twoPHRMode* and at least one Serving Cell belonging to this MAC entity is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

6> if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN* and the MAC entity this Serving Cell belongs to is configured with *twoPHRMode*:

7> obtain two values for the corresponding PCMAX,f,c,k fields from the physical layer.

7> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:

8> obtain two values for the corresponding MPEk fields from the physical layer.

6> else:

7> obtain the value for the corresponding PCMAX,f,c field from the physical layer.

7> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:

8> obtain the value for the corresponding MPE field from the physical layer.

5> else if this MAC entity is configured with *twoPHRMode* and at least one Serving Cell belong to this MAC entity is configured with PUSCH repetition:

6> if this serving cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN* and the MAC entity this serving cell belongs to is configured with *twoPHRmode*:

7> if the first *TCI-State* or *TCI-UL-State* is applied for a real PUSCH transmission or if there is no real PUSCH transmission at the slot where the PHR MAC CE is transmitted:

8> obtain the value for the PCMAX,f,c field for the PUSCH transmission associated to the first *TCI-State* or *TCI-UL-State* from the physical layer.

8> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:

9> obtain the value for the corresponding MPE field for the PUSCH transmission associated to the first *TCI-State* or *TCI-UL-State* from the physical layer.

7> else if the second *TCI-State* or *TCI-UL-State* is applied for a real PUSCH transmission:

8> obtain the value for the PCMAX,f,c field for the PUSCH transmission associated to the second *TCI-State* or *TCI-UL-State* from the physical layer.

8> if *mpe-Reporting-FR2* is configured for the MAC entity this Serving Cell belongs to and this Serving Cell operates on FR2:

9> obtain the value for the corresponding MPE field for the PUSCH transmission associated to the second *TCI-State* or *TCI-UL-State* from the physical layer.

5> else:

6> if this MAC entity has UL resources allocated for transmission on this Serving Cell; or

6> if the other MAC entity, if configured, has UL resources allocated for transmission on this Serving Cell and *phr-ModeOtherCG* is set to *real* by upper layers:

7> obtain the value for the corresponding PCMAX,f,c field from the physical layer.

7> if *mpe-Reporting-FR2* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:

8> obtain the value for the corresponding MPE field from the physical layer.

7> if *mpe-Reporting-FR2-r17* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:

8> obtain the value for the corresponding MPEi field from the physical layer;

8> obtain the value for the corresponding Resourcei field from the physical layer.

7> if *dpc-Reporting-FR1* is configured and ΔPPowerClass /ΔPPowerClass, CA/ΔPPowerClass, EN-DC/ΔPPowerClass, NR-DC reporting is triggered and this Serving Cell operates on FR1 and this Serving Cell is associated to this MAC entity:

8> obtain the value for the corresponding DPC field(s) from the physical layer.

3> if *phr-Type2OtherCell* with value *true* is configured:

4> if the other MAC entity is E-UTRA MAC entity:

5> obtain the value of the Type 2 power headroom for the SpCell of the other MAC entity (i.e. E-UTRA MAC entity);

5> if *phr-ModeOtherCG* is set to *real* by upper layers:

6> obtain the value for the corresponding PCMAX,f,c field for the SpCell of the other MAC entity (i.e. E-UTRA MAC entity) from the physical layer.

3> if this MAC entity is configured with *mpe-Reporting-FR2-r17*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Multiple entry PHR as defined in clause 6.1.3.49 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *twoPHRMode* and at least one Serving Cell belonging to this MAC entity is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Multiple Entry PHR for multiple TRP STx2P MAC CE as defined in clause 6.1.3.82 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *twoPHRMode* and at least one Serving Cell belonging to this MAC entity is configured with multiple TRP PUSCH repetition:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Multiple Entry PHR for multiple TRP MAC CE as defined in clause 6.1.3.51 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *phr-AssumedPUSCH-Reporting*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Multiple Entry PHR with assumed PUSCH MAC CE as defined in clause 6.1.3.79 based on the values reported by the physical layer.

3> else:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Multiple Entry PHR MAC CE as defined in clause 6.1.3.9 based on the values reported by the physical layer.

2> else (i.e. Single Entry PHR format is used):

3> if this MAC entity is configured with *twoPHRMode* for multiple TRP PUSCH repetition or *multipanelSchemeSDM* or *multipanelSchemeSFN*:

4> obtain two values of the Type 1 power headroom from the physical layer for the corresponding uplink carrier of the PCell.

3> else:

4> obtain the value of the Type 1 power headroom from the physical layer for the corresponding uplink carrier of the PCell.

3> if this MAC entity is configured with *phr-AssumedPUSCH-Reporting*:

4> if *dynamicTransformPrecoderFieldPresenceDCI-0-1-r18* or *dynamicTransformPrecoderFieldPresenceDCI-0-2-r18* is set to *enabled* in the active BWP of this Serving Cell:

5> obtain the value for the corresponding PCMAX,f,c field for assumed PUSCH from the physical layer, if available, as specified in clause 7.7 of TS 38.213 [6].

3> if this MAC entity is configured with *twoPHRMode* and if this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

4> obtain two values for the corresponding PCMAX,f,c,k fields from the physical layer.

4> if *mpe-Reporting-FR2* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:

5> obtain two values for the corresponding MPEk fields from the physical layer.

3> else:

4> obtain the value for the corresponding PCMAX,f,c field from the physical layer;

4> if *mpe-Reporting-FR2* is configured and this Serving Cell operates on FR2:

5> obtain the value for the corresponding MPE field from the physical layer.

4> if *mpe-Reporting-FR2-r17* is configured and this Serving Cell operates on FR2 and this Serving Cell is associated to this MAC entity:

5> obtain the value for the corresponding MPEi field from the physical layer;

5> obtain the value for the corresponding Resourcei field from the physical layer.

4> if *dpc-Reporting-FR1* is configured and this Serving Cell operates on FR1:

5> obtain the value for the corresponding DPC field from the physical layer.

3> if this MAC entity is configured with *mpe-Reporting-FR2-r17*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Single entry PHR as defined in clause 6.1.3.48 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *twoPHRMode* and this Serving Cell is configured with *multipanelSchemeSDM* or *multipanelSchemeSFN*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Single Entry PHR for multiple TRP STx2P MAC CE as defined in clause 6.1.3.81 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *twoPHRMode* and this Serving Cell is configured with multiple TRP PUSCH repetition:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Enhanced Single Entry PHR for multiple TRP MAC CE as defined in clause 6.1.3.50 based on the values reported by the physical layer.

3> else if this MAC entity is configured with *phr-AssumedPUSCH-Reporting*:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Single Entry PHR with assumed PUSCH MAC CE as defined in clause 6.1.3.78 based on the values reported by the physical layer.

3> else:

4> instruct the Multiplexing and Assembly procedure to generate and transmit the Single Entry PHR MAC CE as defined in clause 6.1.3.8 based on the values reported by the physical layer.

2> if this PHR report is an MPE P-MPR report:

3> start or restart the *mpe-ProhibitTimer*;

3> cancel triggered MPE P-MPR reporting for Serving Cells included in the PHR MAC CE.

2> start or restart *phr-PeriodicTimer*;

2> start or restart *phr-ProhibitTimer*;

2> cancel all triggered PHR(s).

All triggered PHRs shall be cancelled when there is an ongoing SDT procedure as in clause 5.27 and the UL grant(s) can accommodate all pending data available for transmission but is not sufficient to additionally accommodate the PHR MAC CE plus its subheader.

# Appendix B

6.1.3.81 Enhanced Single Entry PHR for multiple TRP STx2P MAC CE

The Enhanced Single Entry PHR for multiple TRP STx2P MAC CE is identified by a MAC subheader with eLCID as specified in Table 6.2.1-2b.

The two PHs together with two PCMAX,f,c,k for the Serving Cell are reported if UE is configured with *twoPHRMode* and *multipanelSchemeSDM* or *multipanelSchemeSFN*, as specified in clause 5.4.6.

It has a fixed size and consists of four octets defined as follows (Figure 6.1.3.81-1):

- R: Reserved bit, set to 0;

- Power Headroom k (PH k): This field indicates the power headroom level for k = 1, 2, where PH 1 is associated with the first *TCI-State* or *TCI-UL-State* for a real or reference PUSCH transmission and PH 2 is associated with the second *TCI-State* or *TCI-UL-State* for a real or reference PUSCH transmission, as specified in TS 38.213 clause 7.7.1 [6]. PH fields for a Serving Cell are included in ascending order based on k. The length of the field is 6 bits. The reported PH and the corresponding power headroom levels are shown in Table 6.1.3.8-1 (the corresponding measured values in dB are specified in TS 38.133 [11]);

- Pk: If *mpe-Reporting-FR2* is configured and the Serving Cell operates on FR2, the MAC entity shall set this field to 0 if the applied P-MPR value associated with PCMAX,f,c,k, to meet MPE requirements, as specified in TS 38.101-2 [15], is less than P-MPR\_00 as specified in TS 38.133 [11] and to 1 otherwise. If *mpe-Reporting-FR2* is not configured or the Serving Cell operates on FR1, this field indicates whether power backoff is applied due to power management (as allowed by P-MPRc as specified in TS 38.101-1 [14], TS 38.101-2 [15], and TS 38.101-3 [16]). The MAC entity shall set the Pk field to 1 if the corresponding PCMAX,f,c,k field would have had a different value if no power backoff due to power management had been applied;

- Vk: This field indicates if the PH k value for the corresponding TRP is based on a real transmission or a reference format for k = 1, 2. For Type 1 PH, the Vk field set to 0 indicates real transmission on PUSCH and the Vk field set to 1 indicates that a PUSCH reference format is used;

- PCMAX,f,c,k: This field indicates the configured transmitted power PCMAX,f,c,k (as specified in TS 38.213 [6]) used for calculation of the preceding PH k field. The reported PCMAX,f,c,k and the corresponding nominal UE transmit power levels are shown in Table 6.1.3.8-2 (the corresponding measured values in dBm are specified in TS 38.133 [11]);

- MPEk: If *mpe-Reporting-FR2* is configured, and the Serving Cell operates on FR2, and if the Pk field is set to 1, this field indicates the applied power backoff to meet MPE requirements, as specified in TS 38.101-2 [15]. This field indicates an index to Table 6.1.3.8-3 and the corresponding measured values of P-MPR levels in dB are specified in TS 38.133 [11]. The length of the field is 2 bits. If *mpe-Reporting-FR2* is not configured, or if the Serving Cell operates on FR1, or if the Pk field is set to 0, R bits are present instead.

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**Figure 6.1.3.81-1: Enhanced Single Entry PHR for multiple TRP STx2P MAC CE**