**3GPP TSG-RAN WG4 Meeting #94-e R4-20xxxxx**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.14.1.1

**Source:** OPPO

**Title:** Email discussion summary for RAN4#94e\_#20\_NR\_RF\_FR2\_req\_enh\_Part\_1

**Document for:** Information

# Introduction

*RAN4#93 agreed the WF R4-1916170 reproduced as below.*

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| --- |
| * *RAN2 based signaling solutions are sufficiently fast for the FR2 MPE purposes* * *RAN4 shall request RAN2 to develop signaling for FR2 MPE purposes with the following assumptions;*   + *RAN4 understands MAC-CE is suitable method*   + *MPE event related assistance Information provided by the UE to the network*     - *P-MPR is indicated to the network and is agreed in RAN4#93*     - *Dynamic duty cycle will be further discussed in RAN4#94*     - *Single entry PHR will be further discussed in RAN4 #94*   + *Report should be configurable as periodic, or event triggered. Configurable periods and trigger conditions are FFS* * *RAN4 will send LS to RAN2 in RAN4 #93 to inform RAN2 that MAC-CE signaling may be required for MPE solutions. RAN4 will inform RAN2 on the complete solution in RAN4 #94* |

*In this meeting, the following open issues will be further discussed:*

1. *Details of P-MPR reporting mechanism and will focus on items that have RAN2 or RAN4 specification impacts*
2. *Necessity of dynamic duty cycle report, and if reported how it will looks like*
3. *whether we need to add P-bit into the single entry PHR*
4. *RAN4 LS to RAN2 if possible*

*List of candidate target of email discussion for 1st round and 2nd round*

* *1st round: Clarify companies opinions on the open issues, and find the possible compromised solutions of each open issue*
* *2nd round: Further collecting comments and find the tentative agreements on some of the open issues.*

# Topic#1: FR2 MPE

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000114 | Qualcomm | **P-MPR reporting:**  **Proposal 1:** Reported P-MPR shall be calculated based on the PUSCH grant that carries the MAC-CE element where the P-MPR is reported  **Proposal 2:** Maximum period for periodic P-MPR reporting is 4 seconds  **Proposal 3:** The minimum reporting period for P-MPR is set to 10 msec.  **Proposal 4:** Threshold for P-MPR report shall be configurable with 3 dB increments on applied P-MPR.  **Proposal 5:** Granularity of the P-MPR report is 1 dB  **Proposal 6:** Range of reported P-MPR is from 0 to 20 dB  **Dynamic duty cycle reporting:**  Observation 1: Dynamic duty cycle gives more information to the network if the report is referred to maximum power  Observation 2: For triggered report of *dynamic duty cycle*, UE’s ability for transmissions is difficult to quantify exactly since the evaluation period of duty cycle is unknown  **Proposal 7:** UE signals its uplink duty cycle based on its current situation using the transmission where it reports the dynamic duty cycle as a reference  **Proposal 8:** Reported dynamic duty cycle is referred to 0 dB PHR.  **Proposal 9:** UE shall report Dynamic duty cycle, PHR and P-MPR in same time  **Proposal 10:** For triggered report, applicability period of the dynamic duty cycle is left for UE consideration  **Proposal 11:** For a periodic reporting of *dynamic duty cycle* the applicability period is the periodicity of the report  **Proposal 12:** For triggered report of dynamic duty cycle, the trigger condition shall be 10 % change in dynamic duty cycle capability |
| R4-2001231 | OPPO | **MPE objective**  Observation 1: The FR2 WID shows that the targeted MPE issue in Rel-16 is to avoid radio link failures and connection releases due to significant and unpredictable UE P-MPRs.  Observation 2: The MPE objective can be considered achieved by already agreed PMPR reporting.  Observation 3: The leftover issue of PMPR reporting is the configurable periods, trigger conditions and values.  **Proposal 1:** The RLF issue caused by MPE shall focus on PMPR reporting mechanisms.  **PMPR reporting**  Observation 4: In duty cycle based solution, PMPR reporting could be independent from maxUplinkdutycycle capability.  Observation 5: In duty cycle based solution, the definition of duty cycle “Threshold” could rely on UE implementation which is easy and could apply to UE that do not support maxUplinkdutycycle capability.  **Proposal 2:** The PMPR reporting condition, i.e. duty cycle “Threshold”, is depending on UE implementation.  **Proposal 3:** The candidate PMPR values could be {6, 8, 10, 12, 14, 16 and 18}.  **Dynamic duty cycle**  Observation 6: Dynamic duty cycle reporting is a performance enhancement rather than solving RLF.  Observation 7: PMPR reporting and dynamic duty cycle reporting are two unrelated reporting.  **Proposal 4:** A UE supporting PMPR reporting is not necessarily required to report dynamic duty cycle capability.  **Proposal 5:** It is up to UE implementation to decide per-beam based or per-UE based duty cycle capability if reported.  **Single entry PHR**  Observation 8: There is no clear answer about the reason why there is no P bit in single entry PHR.  Observation 9: No problem has been found due to no P bit in single entry PHR.  Observation 10: The P bit is not necessarily to be introduced for the MPE enhancement.  **Proposal 6:** It is encouraged to discuss the introduction of P bit to single entry PHR in RAN2 directly rather than RAN4. |
| R4-2000006 | Apple | Observation 1: A UE can always apply transmission power back-off mechanism (P-MPR) to meet the exposure requirements, but it will impact the UL coverage potentially leading to the link failure.  Observation 2a: The maximum UL duty cycle mechanism can solve the UL coverage issue, but it will limit the maximum achievable throughput.  Observation 2b: In extreme cases, a UE still may resort for applying P-MPR even if it is scheduled according to the indicated maximum UL duty cycle.  **Proposal 1:** Report applied P-MPR value as the MPE assistance information.  **Proposal 2a:** Introduce P-bit into the single-entry PHR (aligning it with the multiple-entry PHR).  **Proposal 2b:** Enhance existing single and multiple entry PHR MAC CE with additional MPE related information.  **Proposal 2c:** To complete specification work, RAN WG2 needs to know how many different values will be reported, while the exact values can be further defined by RAN WG4. |
| R4-2000124 | vivo | Observation1: intension of WI is to deal with possible rapid change of UE environment (proximity to human body etc.) and prevent RLF.  Observations 2: with UE static max duty cycle capability, “dynamic duty cycle” can be derived from P-MPR and does not provide additional information. P-MPR can also be used as “long term” method by UE implementation.  **Proposal1:** Dynamic duty cycle is not reported by UE based on the agreement that P-MPR is indicated to the network.  **Proposal2:** introduce P-bit and P-MPR indicator in single-entry PHR. introduce P-MPR indicator in multi-entry PHR.  **Proposal3:** use two reserved "R" bits to indicate magnitude of the P-MPR, corresponding lookup table could be as below.   |  |  | | --- | --- | | 2 bits indicator | PMPR magnitude (dB) | | 00 | 0~3 | | 01 | 3~6 | | 10 | 6~9 | | 11 | >9 |   **Proposal4:** reuse PHR trigger condition for P-bit/P-MPR reporting. |
| R4-2000197 | Interdigital | **Proposal 1:** The MAC-CE report shall aggregate its measurement per Cell Group, and this can be a single-entry report.  **Proposal 2:** The new MAC-CE report to be named Energy Headroom Report (EHR).  **Proposal 3:** The Energy Headroom Report is defined as the unused/overused energy as a percentage relative to the total energy based on the maximum duty cycle at the maximum UE power that complies with MPE limit.  **Proposal 4:** Use 64 range values for energy headroom reporting values.  **Proposal 5:** Use a 32 range values for P-MPR reporting values.  **Proposal 6:** EHR transmission shall have a high priority. |
| R4-2000318 | Samsung | Observation 1: RAN4 agreed to send the P-MPR information to the network as a compromised solution, and needs to further discuss the concrete method such as configurable periods and trigger conditions.  Observation 2: It is highly recommended that RAN4 concentrates their efforts only on the method already agreed to meet the Rel-16 timeframe.  **Proposal:** RAN4 is recommended focused efforts on the detail of P-MPR information instead of considering other option, i.e. dynamic duty cycle, in order to have the method on time. |
| R4-2000495 | ZTE | Observation: The mechanism and benefit of additional information about dynamic duty cycle are unclear, considering that the periodic or event-driven MAC-CE reporting for P-MPR has been introduced for MPE mitigation.  **Proposal-1:** Enhance PHR MAC-CE format(s) to carry the P-MPR value for a PUSCH-PHR result in PCell.   * The PHR MAC-CE format(s) includes both single entry PHR MAC-CE and multiple entry PHR MAC-CE.   **Proposal-2:**   * The configurable values for the periodic PHR reporting, i.e., {sf10, sf20, sf50, sf100, sf200, sf500, sf1000, and infinity}, can be reused for the MAC-CE reporting for P-MPR * When the change of a P-MPR value exceeds a threshold since the last P-MPR report and a prohibit timer expires, the MAC-CE for P-MPR is triggered for transmission.   + The value of the prohibit timer expiration and the threshold are RRC configurable. |
| R4-2000955 | Intel | Observation 1: Reporting a duty cycle preference, along with P-MPR, and PHR provides gNB with the necessary information to best determine what step to take to prevent potential link failures.  **Proposal 1:** In addition to P-MPR, the report should include a preferred duty cycle referenced to Pcmax and the PHR.  Observation 2: The report should be event driven and include a timer expiration as one of the triggering conditions.  **Proposal 2:** RAN4 should align on and finalize the full list of triggering conditions for the report. PHR triggering conditions can be used as guideline for discussion.  **Proposal 3:** RAN4 should discuss the value, range and granularity of the reported parameters. |
| R4-2001198 | LG Electronics | Observation 1. “Rapid indication methods” require huge RAN1 impact and work load at physical layer stage.  Observation 2. MPE solution based on “Assistance information methods” such as Dynamic uplinkDutyCycle, can be solved RLF problems by accumulated a proper middle-scale information in Rel-16.  Observation 3. “Assistance information methods” are beneficial in aspect of scheduling flexibility in gNB.  Observation 4. If power reduction is used on “Headroom reporting” methods, actual uplink spectral efficiency will be reduced.  Observation 5. “Headroom reporting” might need some additional UE specific parameter which is used to translate reported headroom to MPE margin.  Observation 6. If method within “Headroom reporting” is introduced, the accuracy of reported headroom might need to be considered.  **Proposal 1.** RAN4 can specify MPE solution using dynamic maxUplinkDutyCycle as optional feature. |
| R4-2001324 | Ericsson, Sony | Observation 1: The MPE (free space power density) linearly grows with the UE transmitted power and the UL duty cycle, therefore it is sufficient to indicate the P-MPR value to the gNB.  Observation 2: For exsiting P-MPR triggered PHR reporting, the actual P-MPR value would not be known by the network, and an explicit P-MPR value report could be beneficial.  Observation 3: The UE is capable of estimating its P-MPR for a UL scheduling.  **Proposal 1:** Configure P-MPR reporting as event-triggered (threshold reporting), which will only be reported if the P-MPR value that the UE applied or predicted is higher than a threshold value *P\_MPRChange* (e.g. 3 dB).  **Proposal 2:** Following a triggered P-MPR report, a resulting change (reduction) of the scheduled UL duty cycle should by the network should lead to a reduction of the P-MPR applied by the UE  **Proposal 3:** Configure P-MPR reporting as follows:   |  |  | | --- | --- | | Reported Value | Applied Value (dB) | | P\_MPR\_0 | 3 ≤ P-MPR < 6 | | P\_MPR\_1 | 6 ≤ P-MPR < 9 | | P\_MPR\_2 | 9 ≤ P-MPR < 12 | | P\_MPR\_3 | P-MPR ≥ 12 | |
| R4-2001382 | Nokia | Observation 1:By UE indicating its FR2 MPE event to the network the usage of FR2 system and spectrum could be better optimized and in practical deployments even increased.  **Proposal 1:** Send fast emergency signal of detected MPE event to the network before restricting its UL power and/or transmission).  **Proposal 2:** After having sent the emergency signal, the UE may constrain its UL power and/or transmission. Then, the UE should provide further assistance to the network by sending BackOff (P-MPR) reports.  **Proposal 3:** MAC CE based UE MPE reporting mechanisms should include the following aspects:   * Event-triggered reporting when UE detects MPE event   + Network defines threshold for MPE event-triggering in terms of amount of BackOff (P-MPR) the UE at least needs due to MPE reasons to trigger an event (e.g. with 5 dB threshold the MPE event would be triggered to the network if UE needs 5 dB or more P-MPR due to MPE compliance reasons)   + This MPE event report is reported by the UE before restricting its transmit power   + This MPE event reporting may also optionally include rough BackOff (P-MPR) report if the reporting can be done without restricting UE transmit power and without further delays * Assistance reporting during MPE event (after MPE event-triggered reporting) the UE may be requested to provide further BackOff (P-MPR) assistance reporting to the network   + This BackOff (P-MPR) reporting may be event-triggered reporting (one event after the emergency MPE event reporting) or periodical BackOff (P-MPR) reporting, where e.g. periodicity may be configured by the network   **Proposal 4:** The MPE event-triggered emergency signaling may be MAC CE, e.g. PHR indicating that an MPE event has been triggered. The message may also include an indication of the BackOff power (P-MPR) in relation to the current UL duty cycle.  **Proposal 5:** The MPE assistance mode signaling may be MAC CE or RRC, e.g. the network can request or periodically schedule BackOff reports (e.g. PHR with P-MPR) in response to receiving the MPE emergency signaling. BackOff reports enable the UE to dynamically report P-MPR and/or UL duty cycle during MPE events. |
| R4-2001383 | Nokia | LS to RAN2 |
| R4-2001781 | Huawei | **Proposal 1:** RAN4 agrees to specify P-bit in single entry PHR for FR2 in Rel-16, and send LS to RAN2 ASAP.  **Proposal 2:** RAN4 agrees to define new UE capability on reference PCMAX which is the PCMAX value without addition of any MPR, AMPR and PMPR for FR2.  **Proposal 3:** RAN4 don't need to define PMPR report triggering mechanism.  **Proposal 4:** The UE do not need to dynamically report the maxUplinkDutyCycle to the network. |

## Open issues summary

### Sub-topic 1-1: PMPR reporting

*Sub-topic description: The PMPR reporting mostly impacts RAN2 specification and has already been agreed to be reported to the network in RAN4#93. However, details needs to be further discussed like whether both periodic and event triggered reporting are needed, and period definition, trigger condition definition, PMPR values, etc.*

**Issue 1-1-1: Whether MPE event and PMPR values need to be signalled separately**

* Proposals
  + Option 1: Firstly send fast emergency signal of detected MPE event, then send P-MPR reports
  + Option 2: Only PMPR is sent
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Mediatek | We support Option 1 |

**Issue 1-1-2: Whether PMPR shall be reported before it applied or after it is applied.**

* Proposals
  + Option 1: Before it is applied
  + Option 2: After it is applied
  + Option 3: Does not report at all
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Mediatek | We support Option 2 |

**Issue 1-1-3: Whether both periodic reporting and event triggered reporting are needed**

* Proposals
  + Option 1: No, only event triggered reporting is needed
  + Option 2: Yes both are needed
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| MediaTek | We support Option 1 |

**Issue 1-1-4: For periodic reporting, the definition of period**

* Proposals
  + Option 1: From 10ms to 4s
  + Option 2: Reuse PHR reporting period, i.e.{sf10, sf20, sf50, sf100, sf200, sf500, sf1000, and infinity}
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-5: For triggered reporting, the definition of triggering condition**

* Proposals
  + Option 1: P-MPR is higher than a predefined threshold
  + Option 2: P-MPR is higher than a configurable threshold
  + Option 3: Change of reported P-MPR comparing to last reported PMPR exceeds a configurable threshold and a prohibit timer expires
  + Option 4: Reuse PHR trigger condition, i.e. PMPR is larger than the configured *phr-Tx-PowerFactorChange* value and *phr-ProhibitTimer* expires
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-6: PMPR values, ranges, granularity**

* Proposals
  + Option 1: Granularity of the P-MPR report is 1 dB, range is from 0 to 20 dB
  + Option 2: Candidate PMPR values could be {6, 8, 10, 12, 14, 16 and 18}
  + Option 3: Four PMPR values, with ranges from 3dB to above 12dB
  + Option 4: Four PMPR values, with ranges from 0dB to above 9dB
  + Option 5: Use a 32 range values for P-MPR reporting values, from 1dBm to above 31dBm
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| MediaTek | We prefer Option 1 and 5. Smaller step with flexible range can let UE suffer less unnecessary power reduction for MPE issue. |

### Sub-topic 1-2: Dynamic duty cycle

*Sub-topic description: Dynamic duty cycle reporting has been discussed in RAN4#93 however without conclusion and it was agreed to be further discussed in this meeting. In this section, issue 1-2-1 and 1-2-2 are fundamental issue in this section and shall be solved in the 1st round discussion. If consensus can be reached on the introduction of dynamic duty cycle details in issue 1-2-3, 1-2-4, and 1-2-5 will be further discussed.*

**Issue 1-2-1: Whether dynamic duty cycle is reported?**

* Proposals
  + Option 1: Yes, shall be reported together with PMPR
  + Option 2: No
  + Option 3: Could be reported optionally and separately
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| MediaTek | We support Option 1. Report PMPR and dynamic duty cycle together can reflect UE behavior well. |

**Issue 1-2-2: If dynamic duty cycle reported, is it per-beam or per-UE based reporting?**

* Proposals
  + Option 1: Up to UE implementation
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-3: If dynamic duty cycle reported, is it per-cell or per cell-group reporting?**

* Proposals
  + Option 1: Per-cell
  + Option 2: Per cell group
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-4: If dynamic duty cycle reported, what’s the dynamic duty cycle calculation reference power?**

* Proposals
  + Option 1: Refer to 0 dB PHR
  + Option 2: Other?
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| MediaTek | We support Option 1. Refer to a fixed value can easily reflect UE situation. |

**Issue 1-2-5: For triggered report, what’s the triggering condition for dynamic duty cycle report?**

* Proposals
  + Option 1: trigger condition shall be 10 % change in dynamic duty cycle capability
  + Option 2: configurable threshold for the Energy Headroom
  + Option 3: Other?
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| MediaTek | We support Option 1 |

**Issue 1-2-6: For periodic report, what’s the dynamic duty cycle periodicity?**

* Proposals
  + Option 1: applicability period is the periodicity of the report
  + Option 2: Other?
* Recommended WF

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| **Company** | **Comments** |
| XXX |  |

### Sub-topic 1-3: P bit in single entry PHR

**Issue 1-3-1: Whether P bit in single entry PHR shall be defined?**

* Proposals
  + Option 1: Yes, needed for MPE solution
  + Option 2: Yes, Not needed for MPE solution but to align with multiple entry PHR
  + Option 3: Up to RAN2
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |

### Sub-topic 1-4: Other proposals

*There are Energy Headroom Report (EHR) in R4-2000197 and Reference PCMAX (PCMAX value without addition of any MPR, AMPR and PMPR for FR2) report in R4-2001781. These two alternatives are different from previous PMPR, dynamic duty cycle and P bit reporting.*

**Issue 1-4-1: Is Energy Headroom Report (EHR) needed?**

* Proposals
  + Option 1: Yes, EHR is needed in addition to P-MPR reporting
  + Option 2: No, not needed
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| MediaTek | We support Option 2. While both “PMPR and duty cycle“ mechanisms are used, headroom concept is actually applied. |

**Issue 1-4-2: Is reference PCMAX need to be reported?**

* Proposals
  + Option 1: Yes, reference PCMAX needs to be reported
  + Option 2: No, not needed
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| MediaTek | We support Option 2. While P-MPR report is sufficient for network to know the corresponding Pcmax. |

**Issue 1-4-3: UE behaviour after the network change (reduction) of the scheduled UL duty cycle?**

* Proposals
  + Option 1: a reduction of the P-MPR applied by the UE shall be expected.
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary** |
| **Issue xxxx** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

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| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*It is likely that no RAN4 CRs or TPs are needed in MPE discussion.*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |