**3GPP TSG-RAN WG4 Meeting #94-e Draft R4-2002693**

**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*
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*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.

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| --- | --- |
| 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:

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| 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 |

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| 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** |
| Nokia, Nokia Shanghai Bell | In our view it is important to enable fast indication from the UE that UE is experiencing difficult MPE situation. Fast indication can be enabled e.g. by event-triggered reporting of detected MPE event, which is sent based on the event threshold(s) set by the network. The signaling needs to be defined so that short reporting delay is possible for event-triggered reporting to allow fast emergency type of signaling. The fast event-triggered reporting from the UE is more important in the first phase than the very fine resolution P-MPR. The reporting could be defined so that it is up to the network to configure if the actual P-MPR value is reported together with the event or initially only the event.  |
| LG Electronics | We think that the fast alert signal is needed to apply P-MPR or Dynamic/multiple duty cycle when UE apply P-MPR or change duty cycle to comply the MPE regulatory requirements. And then the UE will apply the P-MPR and dynamic duty cycle based on previous one. |
| Mediatek | We support Option 1 |
| InterDigital | We support Option 1. Also, this includes P-MPR = 0 reports that can be combined with Energy Headroom as we are supporting a preemptive approach. |
| Qualcomm | The details of the emergency signal are not clear i.e. what would be the criteria for a UE to send such “emergency signal” have not been discussed but we are ready to explore introduction of such signal. Option 2 is straight forward.  |
| ZTE | We prefer to Option 2. |
| OPPO | Prefer option 2. The introduction of fast emergency signal actually has large impact on the MPE solution and should be get consensus first. Take PMPR reporting based solution as an example, the fast emergency signal and potential PMPR actually can be signaled together, i.e. when UE find there is MPE issue and large PMPR will be applied then UE will send PMPR value to the NW. Here the PMPR reporting itself takes the role of pre-warning. Therefore, the introduction of fast emergency signal might be not necessary. |
| vivo | We prefer option2. It is not clear how to trigger the “emergency signal”. We believe PMPR over MAC-CE is fast enough for RLF handling. |
| Samsung | We prefer Option 2. How much fast might depend on P-MPR triggering condition and MAC-CE design |
| Apple | We prefer Option 2. It is not clear how the "emergency signal" would work and how a UE can even predict the MPE scenario. Furthermore, sending first "emergency signal" would mean that a UE detects the MPE scenario, but actually does not apply power back-off. This is a new behavior for the UE and all the implication are not known. In that sense, sending P-MPR can be already construed as the "emergency signal".  |
| Intel | Our preference is Option 2. More discussion is needed for Option 1, since how the emergency signal will be approached needs clarification (for instance, how are the triggering conditions for the emergency signal different from P-MPR).  |
| Ericsson | Option 2: MPE is a slow process |
| SONY | Option 2: We think it is sufficient to send PMPR value.  |
| Huawei | We prefer option 2, but want to further discuss on the transfer method. We understand that option 1 may provide a preemptive approach which give the network time on scheduling before PMPR is applied. But it depends on several issues be consensuses: e.g. time order between UE and network. Generally option 2 is realistic for R-16.  |
| **Status summary:**1. 1st round supporting companies is approximately as below:
* 4 companies support option 1, i.e. a fast emergency signal needs to be sent before PMPR reporting.
* 10 companies support option 2, i.e. only PMPR reported;
1. Based on the comments, it seems the motivation of introducing fast emergency signal before PMPR reporting is to give NW a very short delay indication of the situation. There are also views that event triggered PMPR reporting itself can actually take the role of “fast emergency signal”.

**Recommended WF:** 1. Further clarify difference between “fast emergency signal” and event based PMPR reporting.
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**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** |
| Nokia, Nokia Shanghai Bell | In our view it would be desirable that the UE would send short and fast event-triggered report before applying P-MPR if possible, for the UE to do that. However, it cannot be mandated to UE not to apply P-MPR before the report has been sent. But it should be allowed for the UE to do so.  |
| LG Electronics | If RAN4 define fast alert signal, then the UE shall inform the alert signal, then UE applied the P-MPR or dynamic duty cycle based previous one. And inform to NW the applied levels |
| Mediatek | We support Option 2 |
| InterDigital | We support option 1 |
| Qualcomm | We prefer option 2.Details for option 1 are not clear, what assumptions UE should make to define the P-MPR in future.  |
| ZTE | Option 2. Like PHR reporting, the real-time P-MPR is reported.  |
| OPPO | Prefer option 1. Our understanding is the target of reporting MPE issue or PMPR values are trying to avoid of radio link failure which means the PMPR shall be reported before it is applied otherwise NW cannot receive the PMPR reporting. Regarding how the mechanism works like utilizing some threshold, etc. can be up to UE implementation, but the meaning of PMPR reporting is clear. When BS received the PMPR reporting, BS knows how much PMPR the UE will apply if continues to schedule higher power or more UL duty cycle. Then BS can choose to reduce power or schedule less UL slots to avoid of radio link failure.If PMPR is reported after it is applied, we need to understand better how this PMPR reporting can be received by BS if PMPR is large. |
| vivo | We prefer option 2. Not clear how to predict P-MPR in future. |
| Samsung | We prefer Option 2 as PHR triggering conditions |
| Apple  | We prefer Option 2 as it is not clear how a UE can predict the MPE scenario. |
| Ericsson | Should be consistent with PHR reporting. |
| SONY | Option 1: We think PMPR can be reported as an estimated value (before it applied) to help the network to configure the UL scheduling.  |
| Huawei | Support option 2. Additionally, PMPR is better to be transferred with certain UL grant.  |
| **Status summary:**Better understanding between option 1 and option 2 is needed. And option 3 can be removed.1. The questions need to be clarified for option 1:
* How to predict the MPE scenario and PMPR value in future?
1. The questions need to be clarified for option 2:
* How to make sure NW can receive PMPR reporting if PMPR applied is large?

**Recommended WF:** 1. Further clarify above questions.
 |

**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** |
| Nokia, Nokia Shanghai Bell | At least network controlled event-triggered reporting is needed but it might be safer to support also periodical reporting as well. |
| LG Electronics | We think event based triggered reporting is mandatory supported and the periodical reporting is optional.  |
| MediaTek | We support Option 1 |
| InterDigital | We support option 2 |
| Qualcomm | Prefer option 2, they should be configurable.  |
| ZTE | In our view, both periodic reporting and event-triggered reporting are needed. We support Option 2. |
| OPPO | In our understanding, event triggered reporting is needed since the MPE issue only happens in certain scenario which is event based. Not sure of the additional benefits of supporting periodic reporting. Therefore, we prefer option 1. |
| vivo | We prefer option2. P-MPR is in the same MAC-CE as PHR, it is straight forward to reuse all trigger conditions of PHR. Enhancements can be considered if necessary.  |
| Apple | Echoing vivo’s comment, if we reuse the existing PHR MAC CE, then both options will be possible. It will be up to the network implementation/configuration how often the network can receive it, because at the end it is the network scheduler that will account for this information. |
| Intel | Our preference is Option 2, both are needed. Again, if we follow current PHR, both periodic and event-driven reporting are possible. |
| Ericsson | Option 1, only event triggering for a dedicated MAC-CE (periodic available in PHR) |
| SONY | Option 1: we think event-triggered reporting of P-MPR is sufficient. As we already have the Rel-15 *maxULdutycycle* capability*,* it is not likely that a UE would apply P-MPR very often. Therefore, a periodic reporting of P-MPR may cause some overhead unnecessarily.  |
| Huawei | Want to clarify that whether RAN4 will introduce a new MAC-CE for PMPR transfer? The current PHR is with both periodic and event triggering mechanism, if PMPR is transferred with PHR, we don’t need to discuss on such issue. |
| **Status summary:**1. Triggered reporting is agreeable.
2. Companies have different view on the necessity of periodic reporting. It seems if PHR reporting mechanism is reused then most companies tentatively agree periodic reporting can be introduced since periodic reporting is already included in PHR reporting. Otherwise, the necessity of periodic reporting needs to be further discussed.

**Recommended WF:** 1. If PHR reporting is reused, then option 2 (both periodic and triggered reporting are needed) might be agreeable. Otherwise, further discussion is needed regarding periodic reporting.
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**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** |
| Nokia, Nokia Shanghai Bell | It would be desirable to re-use PHR reporting as much as possible. Though generally the range from 10 ms to 4 s seems reasonable as well. |
| InterDigital | Option 2. We have a proposal in our Tdoc, but if option 2 is acceptable to everyone we can agree to this one. |
| ZTE | Considering that the P-MPR value is reported along with the PHR MAC-CE, the candidate values for the periodic timer of PHR reporting in NR Rel-15 can be reused herein, i.e., “sf10, sf20, sf50, sf100, sf200, sf500, sf1000, and infinity” |
| OPPO | Prefer option 2 if periodic reporting is defined to make the signaling definition easier. |
| vivo | We prefer option2 as in our Tdoc. |
| Samsung | Support Option 2 for PHR reporting reuse.  |
| Apple | Our preference is to leverage as much as possible existing PHR reporting, which includes the existing reporting period.  |
| Intel | Option 2 is preferred |
| Tentative Agreement: 1. Option 2, Reuse PHR reporting period, i.e. {sf10, sf20, sf50, sf100, sf200, sf500, sf1000, and infinity} if periodic reporting is defined.
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**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** |
| Nokia, Nokia Shanghai Bell | In our view the threshold for event-triggered reporting should be configurable by the network (option 2). Additionally, timers may need to be applied. Default value for the threshold can also be defined if preferred, In our view it is not sufficient to only define threshold based on how much P-MPR has changed since the last report as the same amount of change may have very different implications and severity depending on the actual P-MPR level. Also the existing PHR trigger conditions as not good enough as MPE solution. |
| InterDigital | Option 3 looks more flexible and it can signal also the end of P-MPR condition. **One comment here:** We are supporting also triggering based on Energy headroom that is reported on a proximity sensing. The situation can be as follows: The human proximity is sensed by UE. The duty cycle and the averaged radiated power does not trigger a P-MPR back off yet. Still, the UE can start reporting the energy headroom with P-MPR = 0 preemptively in order to get the network aware of the possible future issues. |
| Qualcomm | Prefer Option 3, trigger should be a change in conditions. Option 4 might work too.  |
| ZTE | Option 3. |
| OPPO | Prefer option 3. |
| vivo | We prefer option4 as in our tdoc. P-MPR is in the same MAC-CE as PHR, it is straight forward to reuse all trigger conditions of PHR. Enhancements can be considered if necessary. |
| Samsung | We prefer Option 4 |
| Apple | For the sake of implementation and specification simplicity, our main preference is Option 4. We already have conditions in TS 38.321 for setting P-bit, so the same conditions can be re-used. Since the network can configure flexibly periodic- and event-triggered reporting, it is not clear whether additional triggering conditions for P-MPR reporting will bring any noticeable gain. |
| Intel | Our preference is Option 4, this option is comprehensive enough to capture what is needed |
| Ericsson | Option 2, a configurable threshold, Option 4 could be acceptable  |
| SONY | We think option 2 is a more reasonable choice.  |
| Huawei | Option 4 is the current mechanism, we think is enough for PMPR indicating. |
| Status summary:1. Option 1 can be removed.
2. Most companies agree a prohibit timer to triggering the PMPR reporting is needed.
3. All companies agree the PMPR reporting threshold is a configurable value.
4. About detailed PMPR threshold, two options can be further discussed.
	* Option A: P-MPR is higher than a configurable threshold
	* Option B: P-MPR changes comparing to last report is higher than a configurable threshold

Recommended WF: 1. Agree that a prohibit timer to triggering the PMPR reporting will be introduced.
2. Agree that the PMPR reporting threshold is a NW configurable value.
3. Further down select between option A and option B and focus on solving radio link issue itself rather than current PHR framework.
	* Option A: P-MPR is higher than a configurable threshold
	* Option B: P-MPR changes comparing to last report is higher than a configurable threshold
 |

**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** |
| Nokia, Nokia Shanghai Bell | In our view the reporting range needs to be sufficiently large at least from 0 dB or 1 dB to 20 dB in minimum but up to 31 dB would cover more cases. Thus, the option 5 is our preference but also option 1 may be sufficient. The options 3 and 4 have far too small reporting range for well covering different scenarios. |
| LGE | LGE prefer the reported PMPR as {1=<P<4, 4=<P<7, 7=<P<10, P>10} since 0dB MPR is not need to report PMPR. |
| MediaTek | We prefer Option 1 and 5. Smaller step with flexible range can let UE suffer less unnecessary power reduction for MPE issue. |
| InterDigital | Option 5 (We propose it), but we can agree with Option 1 as well. Here is all about how many bits we want for the granularity |
| ZTE | Option 5. The forward-compatibility should be considered |
| OPPO | Ok with reporting more values, but did not see the benefit of reporting small values like 1dB, 2dB, 3dB. Generally fine with option 5. |
| vivo | We proposed option4 in our Tdoc. We are also support option3 in case the trigger threshold is fixed as 3dB. 4 ranges like {0~6, 6~9, 9~12, >12} might also work. Basically our view is that using 2bits to indicate 4 ranges.  |
| Samsung | Support Option 3. In our view, no 1dB granularity is necessary to avoid RLF |
| Apple | Purely from the specification perspective, four values (Option 3 or 4) are the easiest approach as we can re-cast existing unused bits to report P-MPR; and then RAN4 can discuss further about the exact values and range.  |
| Intel | Preference is option 1 and option 5, but as stated in our paper, we are open to discuss (considering bits and granularity) |
| Ericsson | Option 3 |
| SONY | We prefer option 3. We do not think a very large P-MPR value needs to be reported since a link with such a large power backoff is not likely to be used anyway. In addition, since we think the P-MPR reporting can be designed as event-triggered, the gNB can assume 0 dB P-MPR if UE stops reporting it. So there is no need to report 0 dB.  |
| Update to the options after 1st round comments:1. Option 2 can be removed;
2. Option 1 and 5 can be merged as: Range from 1dB to [20, 31]dB, with [5] bits;
3. Option 3 and 4 can be merged as: Range from 1dB to [>10]dB, with 2 bits (4 values);

Recommended WF: 1. Focus on the PMPR values that is necessary for NW to avoid the radio link failure issue. And discuss the following two options:
	* Option A: Range from 1dB to [20, 31]dB, with [5] bits (up to 32 values), 1dB step;
	* Option B: Range from 1dB to [>10]dB, with 2 bits (4 values) like {1~3, 4~6, 7~9, >=10} or {1~5, 6~8, 9~11, >=12};
2. If the outcome of needed values is more than 4, then either extent current PHR format or introducing new MAC CE is needed. If the outcome of needed values is less than or equal to 4, it might be possible to reuse current voided PHR bits. However, it is up to RAN2 decide how to design the signaling.
3. Further discuss whether PMPR needs to be reported together with PHR or can be reported alone.
 |

### 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** |
| Nokia, Nokia Shanghai Bell | In our view potential dynamic duty cycle reporting should not be mixed with P-MPR reporting. We do not see need for dynamic duty cycle reporting but if specified it would be separate from the P-MPR reporting and it should also optional and configurable by the network 🡪 option 2 or option 3 |
| LGE | LGE prefer option3 the dynamic duty cycle would be reported optionally and separately. However, the fast alert signal would be considered as same P-MPR  |
| MediaTek | We support Option 1. Report PMPR and dynamic duty cycle together can reflect UE behavior well.  |
| InetrDigital | Option 1. We also propose for the duty cycle an Energy Headroom which is more generic and valid for a Cell Group. |
| Qualcomm | Prefer option 1 |
| ZTE | In our views, the benefit of dynamical duty cycle reporting is unclear, except that the beam or panel-specific feature is introduced for duty cycle reporting. |
| OPPO | Prefer option 3, the PMPR is straight forward to avoid radio link failure which is the target of this whole topic, and dynamic duty cycle might also works if the fast emergency signal in issue 1-1-1 is agreed. We are fine with reporting dynamic duty cycle but should be considered as optional and separate from PMPR reporting. In other words, to solve the MPE issue, UE can report PMPR only, report dynamic duty cycle only, or report PMPR + dynamic duty cycle, which actually depends on UE implementation. |
| vivo | We prefer option2 as in our Tdoc. Dynamic duty cycle does not provide additional information on top of PMPR. |
| Samsung | Support Option 2. We believe P-MPR reporting is enough with static duty cycle |
| Apple | Option 2 is the main preference. Our current understanding is that if a UE reports P-MPR, then reporting sustained duty cycle value can be viewed as redundant because the network can do exactly the same calculations and estimations for the preferred duty cycle. Furthermore, since a UE does not know the UL grant sizes that will be allocated by the network, it can do its estimation only based on the last UL grants. On the contrary to it, the network can plan its scheduling strategy and make a much better decision on the sustained duty cycle accounting for the UL grants it plans to use. So, the main question is whether we report sustained duty cycle or not; and how we do it is not the biggest issue.  |
| Intel | Option 1 is preferred |
| Ericsson | Option 2: dynamic duty-cycle indication not needed; the gNB is equipped with UL link adaptation. |
| SONY | Option 2: No. The MPE level (free space power density), transmitted power, and uplink duty cycle are in a linear relation. So, it is sufficient for the gNB to optimize the uplink scheduling from P-MPR reporting.  |
| Huawei | Prefer option 2. As we discussed in the paper, reporting dynamic duty cycle may not help on gNB scheduling. There are reference duty cycle could adopted by the network, and it can be converged after power control procedure in nature. Like PHR, the power control process is not so fast and is enough for PMPR issue. |
| Status summary:The supporting companies of each option is approximately as below:* Option 1 (dynamic duty cycle together with PMPR) 4 supporting companies
* Option 2 (no dynamic duty cycle) 7 supporting companies
* Option 3 (dynamic duty cycle optionally separately reported) 3 supporting companies

Regarding the additional benefit of introducing dynamic duty cycle report, it seems there are different views. One view is that this dynamic duty cycle could reflect UE behavior well and give more information to NW, while other view is that this dynamic duty cycle could not provide additional information and may not help on gNB scheduling. Therefore, the benefit of dynamic duty cycle needs to be further discussed and consensus needs to be reached since it affects all other dynamic duty cycle reporting issues.Recommended WF: 1. Further discuss the additional benefit of dynamic duty cycle reporting, including how to better improve UE performance and also help gNB scheduling.
 |

**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** |
| Nokia, Nokia Shanghai Bell | If dynamic duty cycle related assistance signaling is defined, it should be specified in rather detailed manner for network to be able to utilize. This may be difficult due to different implementation assumptions and because anyway, it is expected that the UE can only utilize the current configuration. However, the needed duty cycle may be significantly different if different configuration is used in the scheduling e.g. much less PRBs are used for the transmission.  |
| LGE | It is not dominant issue how to apply dynamic duty cycle to comply MPE. We think that this is fully related of UE implementation. |
| InterDigital | In our opinion it should be per cell group no matter how many beams are active (now is one, but in the future may be more than one).We should connect this issue with a UE RF chain that serves a Cell Group or been served by the same MAC entity. |
| OPPO | Agree with option 1, i.e. up to UE implementation since only UE itself knows the MPE situation. |
| Tentative WF: More clarification on how network utilize dynamic duty cycle is needed before further discuss reporting manners. |

**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** |
| Nokia, Nokia Shanghai Bell | More details than just per-cell or per cell group is needed for making it possible to the network to utilize such information. |
| LGE | The dynamic duty-cycle ratio will be reported to serving cell only. |
| InterDigital | Option 2. We should connect this issue with a UE RF chain that serves a Cell Group or been served by the same MAC entity. Also, if we have FR2 CA intraband with 2 contiguous UL CCs. These CCs would be served by the same beam and MAC entity.  |
| OPPO | Prefer option 1. We understand that for intra or even inter CA the UE might use same antenna panel to transmit signals. If it is defined as per cell group, then it should be clear on which cell group the reported value is for, and actually it is highly depends on UE implementation. To make it simple per-cell based reporting might be much clearer for UE and also for NW to utilize. |
| Tentative WF: More clarification on how network utilize dynamic duty cycle is needed before further discuss per-cell or per cell group reporting. |

**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** |
| Nokia, Nokia Shanghai Bell | It is difficult to define the reference power before the definition is clear. |
| LGE | The reference is max out power. So the PHR=0dB is reasonable. |
| MediaTek | We support Option 1. Refer to a fixed value can easily reflect UE situation. |
| InterDigital | We suggested the Energy Headroom that is relative to the MPE compliant duty cycle and can have positive and negative values depending on the P-MPR been taken or not.Comment: The option presented here works only when a single cell is configured. For multiple cells (FR2 CA for example), this option is not working, unless more details would be added. |
| Qualcomm | Prefer option 1 to define a clear reference for calculations. |
| OPPO | OK with option 1, i.e. max output power. |
| Intel | Option 1 works |
| Tentative WF: Option 1 (Refer to 0 dB PHR) might be agreeable in case of introduction of dynamic duty cycle and clarification of definition. |

**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** |
| Nokia, Nokia Shanghai Bell | If event-triggered reporting for dynamic duty cycle is defined, it should be configurable. Exact details depends on the definition. |
| LGE | Maybe option1 is reasonable that means the triggered condition is change of reported dynamic duty cycle comparing to last reported duty-cycle exceed over ± 10% duty ratio.  |
| MediaTek | We support Option 1 |
| InterDigital | We support Option 2. In our Tdoc we explained how this will help the preemptive approach. |
| Qualcomm | We prefer option 1.  |
| OPPO | Prefer option 1 and the detailed change values can be configured by NW. |
| Intel | Preference is Option 1, but the % change value may need more discussion |
| Tentative WF: “Trigger condition shall be x% change in dynamic duty cycle capability” might be agreeable where x% is FFS if triggered report dynamic duty cycle is introduced and with further clarification on how to utilize dynamic duty cycle. |

**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** |
| Nokia, Nokia Shanghai Bell | The network does not have any newer information than the latest report and therefore, it has to assume that the previous report is accurate. On other hand since the previous dynamic duty cycle reporting, the UE may have sent event-triggered reporting of worse P-MPR and the network should immediately take actions based on that (at least if the situation is severe). Thus, it is unclear how the network could utilize dynamic duty cycle reporting in addition to P-MPR reporting.  |
| LG Electronics | It would be not specify the periodic report of dynamic duty cycle. Just report the duty cycle ratio when the latest duty cycle ratio shall be changed. If do not report any new inform from UE, then the latest report is accurate. |
| InterDigital | Option 1. |
| Qualcomm | Prefer option 1.  |
| OPPO | Option 1. |
| Tentative WF: Option 1 (applicability period is the periodicity of the report) might be agreeable if periodic dynamic duty cycle is introduced and with further clarification on how to utilize dynamic duty cycle. |

### 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** |
| Nokia, Nokia Shanghai Bell | As discussed earlier in RAN4, in our view P bit is not sufficient and suitable for indicating that UE is experiencing MPE issue. Therefore, option 2 or option 3 is ok in our view. |
| LG Electronics | RAN4 send LS to RAN2 for the agreement of P-MPR and dynamic duty cycle method to comply MPE regulatory requirements. And RAN2 and RAN4 joint discuss on this topic how to solve the P-bit. |
| InterDigital | Option 2/Option 3. It depends on RAN2 decision. But if this is a new report, it may not be necessary. |
| ZTE | Option 1. Multi-entry PHR also can be considered for P-MPR reporting |
| OPPO | Option 3. RAN4 can send LS to RAN2 about the MPE solutions in the end and pointed out there is misalignment found in P-bit between single entry PHR and multi-entry PHR, and it depends on RAN2 to discuss how to cope with it. |
| Samsung | Support Option2. However, the decision is up to RAN2 |
| Apple | The way we see the whole discussion is that P-bit can be construed as an independent topic, which should not be mixed with the MPE issue. We prefer to consider aligning single- and multiple-entry PHRs. And if RAN4 can see some value in doing that, then as suggested by OPPO we can indicate to RAN2 that there is a misalignment between single- and multiple-entry PHR, while further changes if any will be considered by RAN2.  |
| Intel | Option 2, though of course it is up to RAN2 |
| Ericsson | Option 2: alignment with the multi-entry report, and could be used in conjunction with P-MPR reporting |
| SONY | We think option 2 is good. |
| Huawei | We support Option1. P-bit is already designed with PHR mechanism and triggering cases, clearly enough on time applicability and which UL grant is used for(even not only for PUSCH). It is mature. We cannot expect that gNB can support all the issues discussed in RAN4 immediately, there is no discussion on network behavior. But P-bit may have more ensurance than others. |
| Tentative WF: Inform RAN2 about the misalignment in P-bit between single entry PHR and multi-entry PHR, and it depends on RAN2 to discuss how to cope with it. |

### 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** |
| Nokia, Nokia Shanghai Bell | In our view P-MPR based reporting mechanism are sufficient (option 2) |
| LG Electronics  | We prefer option2. |
| MediaTek | We support Option 2. While both “PMPR and duty cycle“ mechanisms are used, headroom concept is actually applied. |
| InterDigital | Option 1. This is like Duty Cycle reporting but is relative to the MPE compliance level, so it may be transparent to the network and UE implementation based. Also, this can be a solution for the UEs that does not report a max Duty Cycle capability for FR2 |
| Qualcomm | We prefer option 2. |
| ZTE | We also think the current P-MPR based reporting mechanism are sufficient. No need for EHR. Option 2 is our preference. |
| OPPO | Prefer option 2. |
| vivo | We prefer option2. |
| Samsung | We prefer Option 2 |
| Apple | We prefer Option 2. To be honest, there are interesting points in reporting energy headroom to the network. However, the whole industry needs better understanding which performance metrics can be reported, which calculations a UE has to perform, and how the energy headroom can be translated into the scheduling cycle at the network side. As far as we remember, there were concerns from both UE and the network side that quite many aspects were unclear. |
| Intel | Our preference is Option 2 |
| Ericsson | Option 2 |
| SONY | Option 2 |
| Huawei | We prefer option 2. |
| Tentative WF: Option 2 “Energy Headroom Report (EHR) is not needed” might be agreeable. |

**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** |
| Nokia, Nokia Shanghai Bell | It is ok for the UE to report also PCMAX in addition to P-MPR based reporting. But it is also ok to define reporting mechanisms based on P-MPR only. In any case the needed P-MPR is related to the UE’s Tx power and UL configuration that is used at that moment. |
| LG Electronics | Yes, the PCMAX is based on decide P-MPR and dynamic duty cycle. |
| MediaTek | We support Option 2. While P-MPR report is sufficient for network to know the corresponding Pcmax. |
| InterDigital | Option 2. It is irrelevant in this context, as P-MPR is to be reported as an absolute value. |
| Qualcomm | Is the assumption that PHR is reported with P-MPR and duty cycle? In that case, pcmax is not needed.  |
| OPPO | Prefer option 2. The PMPR reporting can work without the reference PCMAX reporting. |
| Samsung | We prefer Option 2. Not sure how it works with P-MPR reporting |
| Apple | Pcmax is already included into e.g. PHR MAC CE, and this is also the reason why our preference is to leverage it. Otherwise indeed additional reference values might be needed. |
| Intel | From previous discussion points, we assume PHR info is included (this is our preference, the solution could be viewed as an enhanced PHR), so it is not needed |
| Ericsson | Option 2 (and the actual PCMAX is already reported in the multi-entry PHR) |
| SONY | Option 2 |
| Huawei | PMPR indicating with an absolute value have some drawbacks:1. PMPR reporting is all dependent on UE side, no verification can ensure the exact value of the reported PMPR. UE may just want to change scheduling for other reasons. We highly doubt on this point.
2. ‘UE need to indicate PMPR value on each triggered entry, consuming on much overhead.
3. The range of PMPR is not easy to decide, it may not only depending on PC3 UE, but PC3 UEs are allowed with a unnecessary range.

While the reference PCMAX means the Pcmax with no MPR/AMPR/PMPR, it is the UE RF ability. It can be reported with UE capability one time, then the network can use the instantaneous PCMAX to calculating PMPR. This method have some obvious advantages:1. Accurately transfer the PMPR UE used to the network
2. Simple and effective, transfer dynamic PMPR with only a static UE capability
3. Do not need to consider the PMPR range

To Qualcomm, it is not the assumption with PMPR and duty cycle. With reference Pcmax, PMPR absolute value is not needed. |
| **Status summary:**It seems people have different understanding on the definition of “reference PCMAX”, one understand is that the reference Pcmax is UE RF ability with no MPR/AMPR/PMPR and will not be changed once reported, the other understanding is that the “reference PCMAX” means real time actual PCMAX which is changing with transmit power. This need to be first aligned then further discuss the necessity of introducing “reference PCMAX” UE capability.**Tentative WF:** 1. Further discuss the definition of “reference PCMAX” and collect views on the necessity of introducing “reference PCMAX” UE capability.
 |

**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** |
| Nokia, Nokia Shanghai Bell | If the network has taken action to help the UE’s MPE situation by reducing the amount of UL traffic and the UE’s MPE situation has not become severe (e.g. proximity sensor has not detected human body even closer to the device), it should expected that UE reduces the amount of P-MPR it needs. This reduction should not only be tight to UL duty cycle but also other relevant network actions to help the UE. |
| LG Electronics | If NW change (reduce) the UL duty cycle, then the UE shall be reduced P-MPR values compare to previous P-MPR in previous Duty cycle |
| InterDigital | I guess all the effects shall be reflected in the reporting, including P-MPR = 0 situation. |
| Qualcomm | “shall be expected” is a bit vague for spec language. Since condition of the UE may not be known, it may be better not to specify this at all or then include statement like with no change in path loss, UE grip, RB allocation etc. reduction of P-MPR is expected.  |
| OPPO | Generally it is correct the reduce of UL duty cycle can lead to reduction of PMPR, but there are many other conditions this conclusion rely on, like there is no other wireless triggered in the phone, etc. Therefore, it is difficult to be specified in the spec but can be considered as a general guidance to NW scheduler. |
| Apple | It is not clear how we can mandate certain actions at the UE side after the network changes the UL duty cycle; a UE anyway follows the network scheduling. Furthermore, applied/reported P-MPR is an independent event to the network scheduling. If a UE proximity sensor instructs to limit maximum transmission power by e.g. 3dB, this condition will remain regardless of what the network scheduler does. In other words, it should be enough for the network to know UE conditions to change the UL duty cycle, but it is somewhat obscure to anticipate certain UE actions after the UL cycle changes.  |
| Ericsson | Option 1: a change of the scheduled UL duty cycle following an MPE report should be followed by an expected action by the UE. |
| SONY | Yes, this is necessary. Otherwise, the P-MPR reporting may become meaningless for the network. |
| Huawei | Not to specify in the spec. |
| **Status summary:**Generally companies agree that the reduction of UL duty cycle should relaxed UE MPE situation if other conditions are unchanged. But regarding whether UE shall reduce PMPR and whether this is appropriate to specify in the spec, there is no consensus.**Tentative WF:** Make it common understanding that the P-MPR applied by UE is expected to be reduced when the UL duty cycle scheduled by NW is reduced and all other conditions are unchanged. Whether UE shall reduce PMPR and whether this is appropriate to specify in the spec, there is no consensus. |

## Summary for 1st round

*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.*

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

After 1st round dicussion, the PMPR solution still cannot finnalized, and following open issues needs further discussion:

1. High level issues:
	1. Whether “Fast emergency signal” needs to be reported before the PMPR reporting;
	2. Whether PMPR reporting shall be combined with PHR reporting and reuse PHR report mechanism;
2. Detailed PMPR reporting design:
	1. Whether PMPR should be reported before it is applied or after it is applied;
	2. Whether periodic PMPR reporting will be introduced;
	3. Definition of PMPR report threshold for triggered reporting;
	4. PMPR value ranges and granularity;

There are also some tentative agreements:

1. For the periodic PHR reporting, the PHR reporting period will be reused, i.e. {sf10, sf20, sf50, sf100, sf200, sf500, sf1000, and infinity};
2. A prohibit timer to trigger the PMPR reporting will be introduced.
3. PMPR reporting threshold is a NW configurable value.

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| Issue 1-1-1: Whether MPE event and PMPR values need to be signaled separately | **Status summary:**1. 1st round supporting companies is approximately as below:
* 4 companies support option 1, i.e. a fast emergency signal needs to be sent before PMPR reporting.
* 10 companies support option 2, i.e. only PMPR reported;
1. Based on the comments, it seems the motivation of introducing fast emergency signal before PMPR reporting is to give NW a very short delay indication of the situation. There are also views that event triggered PMPR reporting itself can actually take the role of “fast emergency signal”.

**Recommended WF:** Further clarify difference between “fast emergency signal” and event based PMPR reporting. |
| Issue 1-1-2: Whether PMPR shall be reported before it applied or after it is applied. | **Status summary:**Better understanding between option 1 and option 2 is needed. And option 3 can be removed.1. The questions need to be clarified for option 1:
* How to predict the MPE scenario and PMPR value in future?
1. The questions need to be clarified for option 2:
* How to make sure NW can receive PMPR reporting if PMPR applied is large?

**Tentative WF:** Further clarify above questions. |
| Issue 1-1-3: Whether both periodic reporting and event triggered reporting are needed | **Status summary:**1. Triggered reporting is agreeable.
2. Companies have different view on the necessity of periodic reporting. It seems if PHR reporting mechanism is reused then most companies tentatively agree periodic reporting can be introduced since periodic reporting is already included in PHR reporting. Otherwise, the necessity of periodic reporting needs to be further discussed.

**Recommended WF:** If PHR reporting is reused, then option 2 (both periodic and triggered reporting are needed) might be agreeable. Otherwise, further discussion is needed regarding periodic reporting. |
| Issue 1-1-4: For periodic reporting, the definition of period | **Tentative Agreement:** Option 2, Reuse PHR reporting period, i.e. {sf10, sf20, sf50, sf100, sf200, sf500, sf1000, and infinity} if periodic reporting is defined. |
| Issue 1-1-5: For triggered reporting, the definition of triggering condition | **Status summary:**1. Option 1 can be removed.
2. Most companies agree a prohibit timer to triggering the PMPR reporting is needed.
3. All companies agree the PMPR reporting threshold is a configurable value.
4. About detailed PMPR threshold, two options can be further discussed.
	* Option A: P-MPR is higher than a configurable threshold
	* Option B: P-MPR changes comparing to last report is higher than a configurable threshold

**Tentative WF:** 1. Agree that a prohibit timer to triggering the PMPR reporting will be introduced.
2. Agree that the PMPR reporting threshold is a NW configurable value.
3. Further down select between option A and option B and focus on solving radio link issue itself rather than current PHR framework.
	* Option A: P-MPR is higher than a configurable threshold
	* Option B: P-MPR changes comparing to last report is higher than a configurable threshold
 |
| Issue 1-1-6: PMPR values, ranges, granularity | Update to the options after 1st round comments:1. Option 2 can be removed;
2. Option 1 and 5 can be merged as: Range from 1dB to [20, 31]dB, with [5] bits;
3. Option 3 and 4 can be merged as: Range from 1dB to [>10]dB, with 2 bits (4 values);

**Tentative WF:** 1. Focus on the PMPR values that is necessary for NW to avoid the radio link failure issue. And discuss the following two options:
	* Option A: Range from 1dB to [20, 31]dB, with [5] bits (up to 32 values), 1dB step;
	* Option B: Range from 1dB to [>10]dB, with 2 bits (4 values) like {1~3, 4~6, 7~9, >=10} or {1~5, 6~8, 9~11, >=12};
2. If the outcome of needed values is more than 4, then either extent current PHR format or introducing new MAC CE is needed. If the outcome of needed values is less than or equal to 4, it might be possible to reuse current voided PHR bits. However, it is up to RAN2 decide how to design the signaling.
3. Further discuss whether PMPR needs to be reported together with PHR or can be reported alone.
 |

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

No conclusioin is reached after 1st round discussion regarding the introduction of dynamic duty cycle capability.

* The additional benefit of dynamic duty cyle needs to be further discussed.
* Other issues can be further discussed in case of consensus of introducing dynamic duty cycle is reached.

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| Issue 1-2-1: Whether dynamic duty cycle is reported? | **Status summary:**The supporting companies of each option is approximately as below:* Option 1 (dynamic duty cycle together with PMPR) 4 supporting companies
* Option 2 (no dynamic duty cycle) 7 supporting companies
* Option 3 (dynamic duty cycle optionally separately reported) 3 supporting companies

Regarding the additional benefit of introducing dynamic duty cycle report, it seems there are different views. One view is that this dynamic duty cycle could reflect UE behavior well and give more information to NW, while other view is that this dynamic duty cycle could not provide additional information and may not help on gNB scheduling. Therefore, the benefit of dynamic duty cycle needs to be further discussed and consensus needs to be reached since it affects all other dynamic duty cycle reporting issues.**Tentative WF:** Further discuss the additional benefit of dynamic duty cycle reporting, including how to better improve UE performance and also help gNB scheduling. |
| Issue 1-2-2: If dynamic duty cycle reported, is it per-beam or per-UE based reporting? | **Tentative WF:** More clarification on how network utilize dynamic duty cycle is needed before further discuss reporting manners. |
| Issue 1-2-3: If dynamic duty cycle reported, is it per-cell or per cell-group reporting? | **Tentative WF:** More clarification on how network utilize dynamic duty cycle is needed before further discuss per-cell or per cell group reporting. |
| Issue 1-2-4: If dynamic duty cycle reported, what’s the dynamic duty cycle calculation reference power? | **Tentative WF:** Option 1 (Refer to 0 dB PHR) might be agreeable after the introduction of dynamic duty cycle and clarification of definition. |
| Issue 1-2-5: For triggered report, what’s the triggering condition for dynamic duty cycle report? | **Tentative WF:** “Trigger condition shall be x% change in dynamic duty cycle capability” might be agreeable where x% is FFS if triggered report dynamic duty cycle is introduced and with further clarification on how to utilize dynamic duty cycle. |
| Issue 1-2-6: For periodic report, what’s the dynamic duty cycle periodicity? | **Tentative WF:** Option 1 (applicability period is the periodicity of the report) might be agreeable if periodic dynamic duty cycle is introduced and with further clarification on how to utilize dynamic duty cycle. |

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

Most companies believe the P bit in single entry PHR issue has no relation to the MPE issue while companies agree there is inconsistence of P bit between single entry PHR and multi-entry PHR.

* It is tentatively agree that this issue is within RAN2 scope and an LS can be sent to inform RAN2 about the inconsistence.

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| Issue 1-3-1: Whether P bit in single entry PHR shall be defined? | **Tentative WF:** Inform RAN2 about the misalignment in P-bit between single entry PHR and multi-entry PHR, and it depends on RAN2 to discuss how to cope with it. |

### 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.

* After the 1st round discussion, it is tentatively agree that “Energy Headroom Report (EHR) is not needed.
* And the definition of “reference PCMAX” needs further clarification.
* Tentatively common understanding can be reached, i.e. the P-MPR applied by UE is expected to be reduced when the UL duty cycle scheduled by NW is reduced and all other conditions are unchanged.

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| Issue 1-4-1: Is Energy Headroom Report (EHR) needed? | **Tentative WF:** Option 2 “Energy Headroom Report (EHR) is not needed” might be agreeable. |
| Issue 1-4-2: Is reference PCMAX need to be reported? | **Status summary:**It seems people have different understanding on the definition of “reference PCMAX”, one understand is that the reference Pcmax is UE RF ability with no MPR/AMPR/PMPR and will not be changed once reported, the other understanding is that the “reference PCMAX” means real time actual PCMAX which is changing with transmit power. This need to be first aligned then further discuss the necessity of introducing “reference PCMAX” UE capability.**Tentative WF:** Further discuss the definition of “reference PCMAX” and collect views on the necessity of introducing “reference PCMAX” UE capability. |
| Issue 1-4-3: UE behaviour after the network change (reduction) of the scheduled UL duty cycle? | **Status summary:**Generally companies agree that the reduction of UL duty cycle should relaxed UE MPE situation if other conditions are unchanged. But regarding whether UE shall reduce PMPR and whether this is appropriate to specify in the spec, there is no consensus.**Tentative WF:** Make it common understanding that the P-MPR applied by UE is expected to be reduced when the UL duty cycle scheduled by NW is reduced and all other conditions are unchanged. Whether UE shall reduce PMPR and whether this is appropriate to specify in the spec, there is no consensus. |

### Recommendations on WF/LS assignment

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| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| R4-2002819 | WF on MPE solutions | OPPO |
| R4-2002820 | LS to RAN2 about the misalignment in P-bit between single entry and multi-entry PHR | OPPO |
| R4-2002821 | LS on MPE enhancements | Nokia |

## Discussion on 2nd round

### Sub-topic 2-1: PMPR reporting

**Issue 2-1-1: To solve radio link failure issue, what’s the necessary PMPR values? If both can solve RLF, which one is preferred?**

*Moderator Note: After 1st round, the options can be merged into below two options, it is encouraged to further discuss the values and focus on necessary reported values to solve RLF itself rather than restricted to current PHR available bits.*

* + Option A: Range from 1dB to [20, 31]dB, with 5 bits (up to 32 values), 1dB step;
	+ Option B: Range from 1dB to [>10]dB, with 2 bits (4 values) like {1~3, 4~6, 7~9, >=10} or {1~5, 6~8, 9~11, >=12};

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| **Company** | **Comments** |
| Apple | For the sake of the specification simplicity in RAN2, our preference is to have 2 bits, i.e. Option 2. And that is all what RAN2 needs to know to complete its specification work because exact values will be anyway defined by RAN4 and captured in 38.133. With regards to exact values and range, we are open to discuss it further. Our initial preference was close to {1~3, 4~6, 7~9, >=10}, but we are more than open to consider all the arguments. |
| LGE | Support option B |
| Nokia | We support option A. In our opinion 2 bits and 4 values is too little especially as the signaling should be futureproof covering different scenarios and use cases. We can compromise something less that 5 bits and 32 values but the aim should be to cover the whole ranges from 1 dB to 31 dB or at least to 20 dBs. For instance, 4 bits and 16 values could be considered e.g. as follows where more fine resolution is used for smaller P-MPR amounts where also the network would be better able to adjust UL traffic and transmission configurations like number of PRBs etc.

|  |  |
| --- | --- |
| 1 | 1 dB |
| 2 | 2 dB |
| 3 | 3 dB |
| 4 | 4 dB |
| 5 | 5 dB |
| 6 | 6 dB |
| 7 | 7 dB |
| 8 | 8 dB |
| 9 | 9 dB |
| 10 | 10 dB |
| 11 | 11-13 dB |
| 12 | 14-16 dB |
| 13 | 17-20 dB |
| 14 | 21-24 dB |
| 15 | 25 - 29 dB |
| 16 | 30 dB and above |

 |
| Samsung | We still support Option B with the same reason. 1 dB step might be nothing to do with RLF. Also fine to discuss further. |
| vivo | We prefer option B. As in our Tdoc, we believe that 2bits (4 values) is enough for RLF handling purpose, smaller granularity can treated by link adaptation function of gNB. Regarding exact values. Our initial preference was close to {1~4, 4~7, 7~10, >=10}. |

**Issue 2-1-2: which PMPR reporting trigger threshold is feasible in solving radio link failure? If both are feasible, which one is preferred?**

*Moderator Note: Focus on solving RLF itself.*

* + Option A: P-MPR is higher than a configurable threshold
	+ Option B: P-MPR changes comparing to last report is higher than a configurable threshold

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| **Company** | **Comments** |
| Apple | Option A. We prefer to keep things simple by just letting a UE to report when P-MPR exceeds certain threshold without additional conditions and unnecessarily tangled logic. We cannot see any harm if a UE reports P-MPR value it applies, even if does not change, because the network will know that P-MPR is still being applied. |
| LGE  | Prefer option B. this is based on latest P-MPR level and threshold also considered. |
| Nokia | We support Option A: The option A is simple to configure and simple for the UE evaluate. Furthermore, absolute P-MPR levels are important information for the network. Relative increase or decrease in P-MPR does not provide sufficiently detailed information for the network to take right actions. Also events are likely to be triggered at wrong time from the network perspective as the network may plan different actions for different P-MPR levels for a given configuration used by the UE. The latest P-MPR level naturally needs to be considered in both of the options. The difference between the options is whether the actual P-MPR level matters or change. In our opinion the actual P-MPR level is more important and informative. |
| vivo | We prefer option B. It may not be very precise to answer the question in this way. Because we actually proposed to reuse/share the same trigger condition as current PHR. According to my understanding, current PHR trigger condition stated in TS 38.321 is close to option B i.e. “changed more than *phr-Tx-PowerFactorChange* dB…” |

**Issue 2-1-3: If PMPR is reported before it is applied by UE, do we still need to define “fast emergency signal”?**

*Moderator Note: In 1st round there are questions about the necessity of additional “fast emergency signal”. The intention of introducing “fast emergency signal” is to send pre-warning information to give NW time to react before PMPR is applied. If PMPR is reported before it is applied, is it possible that the PMPR reporting can take the role of “fast emergency signal”?*

* + Option A: Yes
	+ Option B: No

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| **Company** | **Comments** |
| Apple | Option B. As commented earlier, it is not clear how a UE can predict that P-MPR is going to happen.  |
| LGE | Option B, RAN4 can define fast emergency signal, then send emergency signal 🡪 applied UE 🡪 report the P-MPR level. |
| Nokia | In our view it is important that event-triggered reporting based on P-MPR is fast enough and therefore can act as fast emergency signaling. Furthermore, we see that whenever feasible for the UE, the UE should be allowed to send the P-MPR before applying it but for the compliance reasons the UE needs always be allowed to apply P-MPR right away and send the event-triggered reporting after that.In our view this information is not needed to be sent to RAN2 for the signaling definition but rather this should be part of the RAN4 requirement definition discussion. Thus, we could continue clarifying the details further in the next RAN4 meeting. |
| Qulacomm | Our preference is to report the P-MPR once it is taken so option B.  |
| Samsung | Option B.  |
| vivo | We prefer option B. As commented earlier, not clear how to predict P-MPR in future.  |

**Issue 2-1-4: If PMPR is reported after it is applied by UE, is it needed to define “fast emergency signal”?**

*Moderator Note: In 1st round there are questions about the necessity of additional “fast emergency signal”. The intention of introducing “fast emergency signal” is to give pre-warning information to give NW time to react before PMPR is applied.*

* + Option A: Yes
	+ Option B: No

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| **Company** | **Comments** |
| Apple | Option B. Reporting non-zero P-MPR value can work as emergency signal.  |
| LGE | Option A |
| Nokia.  | In our view it is important that event-triggered reporting based on P-MPR is fast enough and therefore can act as fast emergency signaling. Furthermore, we see that whenever feasible for the UE, the UE should be allowed to send the P-MPR before applying it but for the compliance reasons the UE needs always be allowed to apply P-MPR right away and send the event-triggered reporting after that.In our view this information is not needed to be sent to RAN2 for the signaling definition but rather this should be part of the RAN4 requirement definition discussion. Thus, we could continue clarifying the details further in the next RAN4 meeting. |
| Qualcomm | Our preference is option A. Or to clarify, P-MPR is reported from the grant is reported on. Not before or after technically. To Nokia: this ran2 un urgency is only true if we decide that only one signaling is needed. If we decide that both “before” and “after” P-MPR’s are reported and in addition a fast emergency signal is reported, ran2 would need to know.  |
| Samsung | Option B. It is not so clear how serious MPE needs the emergency signal and its benefit in addition to P-MPR value. Also fine to continue the discussion. |
| vivo | We prefer option B. As commented earlier, we believe P-MPR over MAC-CE is fast enough. |

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

**Issue 2-2-1: After PMPR reported, is there additional benefit of introducing dynamic duty cycle from improving UE performance and helping gNB scheduling perspective?**

*Moderator Note: In 1st round there are questions about the additional benefit of introducing dynamic duty cycle report. One view is that this dynamic duty cycle could reflect UE behaviour well and give more information to NW, while other view is that this dynamic duty cycle could not provide additional information and may not help on gNB scheduling. Therefore, the benefit of dynamic duty cycle needs to be further discussed and consensus needs to be reached since it affects all other dynamic duty cycle reporting issues.*

* + Option A: Yes, reason is…
	+ Option B: No, reason is…

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| **Company** | **Comments** |
| Option B | As explained in our discussion paper, by reporting Pcmax, PHR, P-MPR, the network will have enough information about the UE state and thus can plan better its scheduling strategy by deciding how frequent UL grants should be scheduled, and of which size. A UE cannot estimate accurately preferred UL duty cycle because it does not know how big UL grants will be. It can use previous UL grants and scheduling frequency as a reference point, but it is not clear how it will benefit the network because it is not realistic to assume that UL grants will be of the same size.  |
| LGE | Yes, the dynamic duty cycle will be keep the NW coverage compare to RAN4 only use P-MPR to comply MPE regulation. UE can applied reduce dutycycle and keep the current P-MPR when UE aware MPE issue and report dutycycle and P-MPR levels. |
| Nokia | Option B. We do not see dynamic duty cycle necessary. Also, it is difficult to use it from the network perspective as new duty cycle proposed by the UE would anyway valid for a given configuration. It is better to keep the UE reporting and assistance simple and defined only P-MPR based reporting at in Rel-16. The network is able to use P-MPR information to reduce the amount of UL data and e.g. number of PRBs or reduce amount of data scheduled within a given time. In any case the dynamic UL duty cycle assistance from the UE to the network cannot to help to the current transmission and coverage but instead if the UE cannot transmit, it has to use P-MPR.  |
| Qualcomm | Option A. We see the benefit of providing more information about the UE status to the network for enhanced scheduling. E.g. dynamic duty cycle is one way to inform network if UE’s close to the point when it needs to reduce UL power to comply with the exposure limits.  |
| Samsung | Option B. In our view, it is not so clear on the benefit of dynamic duty cycle in addition to the P-MPR information from network perspective. It might also need the new method on sort of UL scheduling if the dynamic duty cycle is to be meaningful. |
| vivo | Option B. Dynamic duty cycle does not provide additional information on top of PMPR. |

## 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”* |