**3GPP TSG**

3GPP TSG-RAN WG4 Meeting # 104-e R4-22xxxxx

**Online Meeting, Aug. 2022**

**Title:** [Draft] Reply LS to RAN1 on UE power limitation for STxMP in FR2

**Response to:** -

**Source:** RAN4

**To:** RAN1

**Contact Person:**

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**Send any reply LS to: 3GPP Liaisons Coordinator,** **mailto:3GPPLiaison@etsi.org**

**1. Overall Description:**

RAN4 would like to thank RAN1 for LS on UE power limitation for STxMP in FR2. RAN4 responses to RAN1 questions are below. We continue to use the following definitions for Assumptions 1 and 2:

* Assumption 1: Power limitation per panel for STxMP
* Assumption 2: A total power limitation per UE over all UE panels used for STxMP

Before RAN4 can analyze the questions in the LS, RAN4 kindly requests clarifications for terms used:

* Panel: What is the RAN1 definition of panel that will be applied for feature STxMP? RAN4 specification currently does not have a definition for this entity.
* [Power limitation: Seems this question may not be needed. Proponent questions may be addressed by this phrase in R1 LS: ‘Above power limitation includes both total radiated power and EIRP’ ]
* is it EIRP-based or TRP-based or both? Moreover, are the “per panel power limitation”, “per UE power limitation”, “total power limitation” and “existing power limitation” identical to this concept of power limitation?

**2. Date of Next TSG WG RAN4 Meetings:**

TSG-RAN WG4 Meeting #104Bis-e Oct. 2022 online

TSG-RAN WG4 Meeting #105 Nov. 2022 TBD

*Moderator’s note: Discussion will be transferred to email discussion document at the end of 2nd round, any agreements from discussion will be incorporated into draft LS:*

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| Company | Panel question: |
| Huawei | Panel: What is the RAN1 definition of panel that will be applied for feature STxMP? RAN4 specification currently does not have a definition for this entity. |

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| Company | Power Limitation question: |
| Samsung | For the clarification on ‘power limitation’, we have a sample in our paper as we had a similar question on the LS before. We hope this general wording works to everyone which is based on 38.817-01. As we mentioned in the last GTW, we see no reason to continue the discussion in the next meeting since it is just for the clarification, no agreement here. “Power limitation: Unlike conventional FR1 power class specified as a nominal value with +/- tolerance, the power class of FR2 UEs is specified as a package of the minimum peak EIRP, maximum allowed TRP, maximum allowed EIRP and EIRP spherical coverage as specified in 6.2.1 of 38.101-2. Although each requirement contains a different sense of signification, it should be taken into account together for STxMP since they are all related to one another from the aspect of UE implementation.” |
| Huawei | Power limitation: From RAN4 perspective, there are several concepts related to the power radiated by UE:1. Power class: The definition of power class (e.g. TS 38.101-2 clause 6.2.1.x), which is a package composed of below requirements
	1. Min peak EIRP (The lower limit of EIRP at Tx beam peak direction);
	2. Max EIRP (This is derived from regulatory requirements) and Max TRP;
	3. Spherical coverage (The minimum EIRP at the Nth percentile of the distribution of power measured over the full sphere around the UE).
2. Configured transmitted power: PCMAX, f, c, which is used in RAN1 spec TS 38.213 power control part, and also applied in TS 38.101-2 clause 6.2.4: “The configured UE maximum output power PCMAX,f,c for carrier f of a serving cell c is defined as that available to the reference point of a given transmitter branch that corresponds to the reference point of the higher-layer filtered RSRP measurement as specified in TS 38.215”. It is noted that PCMAX used by RAN1 power control mechanism for FR2 is considered at the virtual antenna connector which is not testable from RAN4 perspective.
3. Total power concept: In Rel-17, RAN4 had a discussion about “total power concept”, which is a maximum output power limitation for a FR2 UE from implementation perspective, but there is no conclusion and the related discussion is still ongoing in Rel-18. In general, it means the actual radiation power of a UE considering multiple implementation aspects e.g. MPE limitation and heat dissipation. In this sense, the actual TRP limitation of the UE is not identical to the max limitation, i.e. Max TRP as defined for the power class of the UE.
4. P-max: The parameter p-Max (i.e. p-UE-FR2) similar to FR1 p-UE-FR1 was introduced by RAN2 spec, which is the maximum total transmit power to be used by the UE across all serving cells in frequency range 2 (FR2) across all cell groups. However, the feasibility of P-max for FR2 is questionable in RAN4, which is not reflected in RAN4 requirements yet. In addition, whether such parameter to limit the max output power of UE should be EIRP based or TRP based is not clear during previous discussion in RAN4.

With the RAN1 definition of panel, RAN4 would like to ask about the concept of power limitation in the LS R1-2205639, is it EIRP-based or TRP-based or both? Moreover, are the “per panel power limitation”, “per UE power limitation”, “total power limitation” and “existing power limitation” identical to this concept of power limitation? If not, please further explain those definitions from RAN1 perspective.  |

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| Company | Other: |
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# Discussion on Question 1

***Question 1****: From RAN4 perspective, is Assumption 1 is feasible?*

Summary from 1st round discussion:

Is assumption 1 (Power limitation per panel for STxMP) feasible? If you think it is not feasible, please further clarify a) it is not feasible from implementation’s perspective or b) it is not feasible from RAN4 current requirement’s perspective

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| **Proposal based on 1st round discussion:** Yes, assumption 1 is feasible. |

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| Company | Agree, or include your own reworded proposal here: |
| vivo | The per panel power limitation is feasible but it is hard to be verified under simultaneous Tx condition when both panels are activated, we cannot get a specific mapping relationship between each panel and Pumax/Ptmax. So it may be better to inform RAN1 the per panel power limitation is hard be guaranteed by RAN4 requirement. The suggested wording is :“Yes, assumption 1 is feasible, however it is difficult to have per-panel requirement in RAN in the case simultaneous Tx condition. |
| Xiaomi | Agree the proposal |
| Huawei | First there is no clear definition of “panel” in RAN1 spec, whether a single physical panel or multiple panel that will be used for single TCI state is quite up to UE implementation. Thus we think RAN4 should avoid further misalignment if we rush to a simple feedback in this meeting. From RAN4 perspective, we think it is not feasible from RAN4 current requirement’s perspective given that the regulation is defined per UE. |
| Qualcomm | The LS includes a definition of panel and the answers apply to that. If there is an alternative definition of panel, we can discuss that too.Also it may be useful to differentiate implementation ability from determining a RAN4 requirement. We have not work on this WI and RAN1 know this, so they are not looking for how we would set up a requirement.So we are not aligned with Vivo on this aspect. Perhaps we can break the response to: Assumption 1 is feasible from an implementation perspective. RAN4 have not studied what requirements should apply however. |
| Huawei | We would like to better explain our views.From the regulatory perspective, the max EIRP requirement cannot be violated for the single band single CC case which could be a common understanding after related Rel-17 discussion in RAN4. For STxMP, there could be a risk for violation, e.g. when the angular offset between two Tx beam is relatively small.From implementation perspective, the max TRP requirement was defined by RAN4. Some critical factors like co-existence and thermal issue have been carefully considered for the derivation of this requirement. Like QC has pointed out, RAN4 has not studied on STxMP, thus we think it is inappropriate to directly say that it is feasible. |
| Samsung | We would like to focus on the Q1 itself which is about feasibility of per-panel power limitation. We do not have to consider ‘in-case’ for the reply that shall be based the concrete scenario of STxMP in the later stage. QC’s revision is acceptable. |
| InterDigital | Probably QC’s approach is the right one. |
| Apple | We consider Qualcomm’s suggestion to split the consideration of the question into implementation and requirement feasibility tracks useful. On the implementation side, we understand the question to imply whether potential power control procedures per panel could be feasible; on the requirement size we agree that RAN4 has not yet studied what requirements should apply. One aspect which is quite clear, however, is that regulatory limits and emissions requirements apply to the UE independently of any panel considerations.Our suggested response here would be:RAN4 will discuss further the feasibility and implications of Assumption 1 on UE implementation, as well as what requirements should apply in case of Assumption 1. From the perspective of regulatory and emissions requirements, they apply to the UE independently from Assumption 1. |
| Nokia | Agree with the answer |

# Discussion on Question 2

***Question 1****: From RAN4 perspective, is Assumption 2 is feasible?*

Summary from 1st round discussion:

Most companies agreed with Option 1. At the same time, there are two issues to further discuss: how to sum up the two “EIRP” in different directions and there could be performance issue in the UL.

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| **Proposal based on 1st round discussion:** Yes, assumption 2 is feasible, and the following issues need further study:1. how to sum up the two “EIRP” in different directions.
2. Per panel (or per TCI state) power would be reduced and may affect UL performance.
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*Moderator’s note: Discussion will be transferred to email discussion document at the end of 2nd round, any agreements from discussion will be incorporated into draft LS:*

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| Company | Agree, or include your own reworded proposal here: |
| vivo | Ok with proposal |
| Xiaomi | Agree the proposal |
| Huawei | Agree. |
| IDC | Agree. However, we explained in our contribution that some side conditions may need to be accounted for, |
| Apple  | OK with the proposal |
| Nokia | Agree with FFS that it should be clarified whether this assumption would limit achievable EIRP per panel (in case that both panels are directed in the same direction or in different directions) |

# Discussion on Question 3

***Question 3****: In either of Assumption1 or Assumption 2, whether the total power limitation per UE over all UE panels used for STxMP or the sum of per-panel power limitation for STxMP can be different from (greater than) the existing power limitation for a given power class?*

Summary from 1st round discussion:

Most companies agreed that UE must comply with regulation. The question to resolve is:

When total power limitation per UE over all UE panels used for STxMP or the sum of per-panel power limitation for STxMP exceeds the existing power limitation for a given power class, do we need a new set of requirements to ensure compliance, or is the existing requirement in Clause 6.5 of 38.101-2 sufficient?

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| **Proposal based on 1st round discussion:** RAN4 confirm that existing UE RF requirements are framed so standards compliance implies regulation compliance (clause 6.5x in TS38.101-2). Any additional limitation like the sum over all panels of the per-panel power limitation for STxMP can be chosen to be greater than the existing power limitation for a given power class without consequence to legality. |

*Moderator’s note: Discussion will be transferred to email discussion document at the end of 2nd round, any agreements from discussion will be incorporated into draft LS:*

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| Company | Agree, or include your own reworded proposal here: |
| vivo | The description is only valid for EIRP but it is noted that the TRP is not only related to the legality. However, the TRP value was also proposed not to change, since it was used for co-existence study in R15, which means if the total TRP is larger than current value, the ACIR need be re-evaluated, and the ACS/ACLR requirement will be also impact. so we prefer separate this issue to 2 cases and the suggested wording can be:“RAN4 confirm that existing UE RF requirements are framed so standards compliance implies regulation compliance (clause 6.5x in TS38.101-2). For EIRP, any additional limitation like the sum over all panels of the per-panel power limitation for STxMP can be chosen to be greater than the existing power limitation for a given power class without consequence to legality.For TRP, the sum over all panels of the per-panel power limitation for STxMP is not expected to exceed the existing power limitation for a given power class” |
| Xiaomi | Similar comments with vivo for TRP, support vivo’s modified wording. |
| Huawei | Since only the per UE power limitation is feasible from RAN4 perspective, we think the proposal here should be: The sum over all panels for STxMP cannot be greater than the existing power limitation for a given power class. |
| Qualcomm | I think we made a mistake in the framing of the proposal – the TRP and EIRP limits are guaranteed by the power class definition, not 6.5 as we stated. The power class definition has the same TRP and EIRP limits for all features (CA, ULMIMO) and this is not expected to change for new features. So any UE that declares its power class will automatically comply with regulation and no further limitations are necessary for regulation compliance. We do not see the point of instituting new requirements in RAN4 that achieve the same goal.RAN4 confirm that existing UE power class definitions comply with common regulations for TRP and EIRP (clause 6.2x.1 in TS38.101-2). Any additional limitation like the sum over all panels of the per-panel power limitation for STxMP can be chosen to be greater than the existing power limitation for a given power class without consequence to legality. |
| Huawei | Like we explained for Question 1, we think the following reply to RAN1 is reasonable:In Assumption 2, the total power limitation per UE over all UE panels used for STxMP cannot be greater than the existing power limitation for a given power class. |
| Samsung | Although we understand the concern from vivo, the change from vivo might have confused them even more like the framed power class is actually not framed between EIRP and TRP. QC’s revision is fine for us.  |
| Apple | We agree with the comments that existing power class requirements shall be met by the UE independently of the particular Tx feature, and the first sentence of Qualcomm’s latest comment is fine for us. Regarding the second sentence, we have two concerns: one with with using the term “legality” and the other with the fundamental implication of introducing a power limitation which is greater than the allowed limit by regulatory. What would be the meaning of such a requirement? Since the UE would need to comply with a regulatory emission limit, which is more stringent, why would the loose requirement be in the spec? We think further discussion is needed to understand the kind of requirement we intend to introduce (this was also covered in the answer to Question 1). So our suggestion is to just have the following sentence:RAN4 confirm that existing UE power class definitions comply with common regulations for TRP and EIRP (clause 6.2x.1 in TS38.101-2). |
| Nokia | Agree with Qualcomm’s proposal. In the case that each TCI state is served with a UE panel individually reaching the maximum power class limit and that the two TCI states are in the same angular direction, there may be a risk with compliance thus a total power restriction for simultaneous UL transmission  |

# Discussion on Question 4

***Question 4****: If both Assumption 1 and Assumption 2 are feasible, whether both assumptions can/shall be applied to a same UE, and what is the relationship between the per-panel power limitation and total power limitation if both are applied (e.g., the sum of per-panel power limitation can be larger than the total power limitation per UE, or should be always the same)?*

Summary from 1st round discussion: (there is overlap with Q3, no dedicated discussion in round 1). Proposal below is constructed from various Tdoc proposals.

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| **Proposal:** The sum of per-panel power limitation is not comparable with total power limitation in the general case. RAN4 confirm that the per-panel power limitation values can be the same as total per-UE power limitation values. Both requirement types can be satisfied simultaneously and the detail can be left to implementation. RAN4 already covers assumption 2 (per-UE power limits) and additional per-UE limits are not necessary for regulation compliance. |

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| Company | Agree, or include your own reworded proposal here: |
| vivo | Agree.Actually this description seems quite general, and some of the details may related to previous question. |
| Xiaomi | Agree |
| Huawei | No need for feedback on Question 4 since it is not RAN4 conclusion that both Assumption 1 and Assumption 2 are feasible. |
| Qualcomm | We also think this information is better to convey to RAN1. |
| Samsung | Agree with this general comment. No easy to answer to this question directly but it is useful information to RAN1 for their discussion. |
| InterDigital | Agree with the proposal. |
| Apple | We are OK with this response |