**3GPP TSG-RAN WG4 Meeting # 100-e R4-210XXXX**

**Electronic Meeting, 16th – 27th August, 2021**

**Agenda item:** 10.5

**Source:** Moderator (China Unicom)

**Title:** Email discussion summary for [100-e][146] FS\_NR\_PC2\_UE\_FDD

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

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

* 1st round: TBA
* 2nd round: TBA

# Topic #1: PC2 for NR FDD band

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2113001 | vivo, Huawei, HiSilicon, ZTE | TP to capture the study on performance evaluation by dynamic system level simulation. |
| R4-2113025 | vivo | Observation: The performance gain of FDD HPUE under higher resource utilization traffic model is still considerable. |
| R4-2112427 | China Unicom | Text Proposal for the SAR Scheme and conclusion part of the SI on high power UE (power class 2) for one NR FDD band. |
| R4-2112428 | China Unicom | Observation 1: In addition to P-MPR, optional report of duty cycle capability is also considered as a feasible method for SAR compliance in existing HPUEs.Observation 2: There is no restriction on network or UE behaviours by introducing optional capability of duty cycle reporting.Proposal: To include the optional duty cycle reporting feature for NR FDD. |
| R4-2112999 | vivo | Proposal 1: To avoid possible link failure, the optional UE capability for duty cycle is proposed. Proposal 2: To compatible with inter-band CA SAR solution, the capability for the duty cycle is needed for FDD HPUE. |
| R4-2113301 | Xiaomi | Proposal 1: if the dutycycle based approach is introduced for HP UE FDD bands, UE needs to report the maximum dutycycle capability to the network.Observation 1: 1Tx architecture is the best choice from implementation of view if commercial components are ready. |
| R4-2113905 | OPPO | Observation 1: To make sure UE capability can be guaranteed, NW need to calculate the duty cycle capability based on per frame window length with 1 symbol moving step.Observation 2: It is meaningless for NW to know the exact duty cycle capability of FDD UE.Proposal 1: It is proposed to conclude that the FDD duty cycle capability is not reported and is only used by UE to meet the SAR regulation requirements. |
| R4-2112834 | LGE | Text proposals to capture the expected sensitivity degradation in n1/n3 by high power transmission and wide CBW in n3. Also, we provide current RF component characteristics and parameters for PA and Duplexer in FDD band. |
| R4-2112911 | ZTE | Observation 1. For band n1, assuming additional 4dB total noise caused by increasing 3dB MOP, then ~3dB duplexer rejections on top of the existing one could be needed to guarantee the existing PC3 REFSEN requirements for PC2.Observation 2. For band n3, assuming additional 6dB total noise caused by increasing 3dB MOP, then ~5dB additional duplexer rejections on top of the existing one could be needed to guarantee the existing PC3 REFSEN requirements for PC2. |
| R4-2114695 | Skyworks | **Table 1 n3 PC2 REFSENS levels and Table 2 Uplink Configuration.**Table 1: **n3 PC2 REFSENS**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS****(kHz)** | **5** **MHz****(dBm)** | **10** **MHz****(dBm)** | **15** **MHz****(dBm)** | **20** **MHz****(dBm)** | **25** **MHz****(dBm)** | **30****MHz****(dBm)** | **35 MHz****(dBm)** | **40 MHz****(dBm)** | **45** **MHz****(dBm)** | **50****MHz****(dBm)** | **Duplex mode** |
| CA\_n5B | 15 | -97.0 | -93.8 | -92.0 | -90.8 | -89.7 | -88.9 | -86.0 | -81.7 | -78.8 | -76.6 | FDD |
| 30 |  | -94.1 | -92.1 | -91.0 | -89.8 | -89.0 | -86.1 | -81.8 | -78.9 | -76.7 |
| 60 |  | -94.5 | -92.4 | -91.2 | -90.0 | -89.1 | -86.2 | -82.0 | -79.0 | -76.8 |
| NOTE 1: Four Rx antenna ports shall be the baseline for this operating band except for two Rx vehicular UE. NOTE 2: The transmitter shall be set to PUMAX as defined in clause 6.2.4  |

Table 2: **n3 PC2 REFSENS Uplink Configuration**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CA configuration** | **SCS****(kHz)** | **5** **MHz****(dBm)** | **10** **MHz****(dBm)** | **15** **MHz****(dBm)** | **20** **MHz****(dBm)** | **25** **MHz****(dBm)** | **30****MHz****(dBm)** | **35 MHz****(dBm)** | **40 MHz****(dBm)** | **45** **MHz****(dBm)** | **50****MHz****(dBm)** | **Duplex mode** |
| CA\_n5B | 15 | 25 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | 501 | FDD |
| 30 |  | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 | 241 |
| 60 |  | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 | 101 |
| NOTE 1: UL resource blocks shall be located as close as possible to the downlink operating band but confined within the transmission bandwidth configuration for the channel bandwidth (Table 5.3.2-1). |

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## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1 Duty Cycle in FDD bands

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 1-1: NR FDD duty cycle**

* Proposals：The optional UE capability for duty cycle is reported to the network.

Note 1: UE-implementation based method (P-MPR) is the baseline SAR solution, which covers the method that duty cycle is not reported but used by UE implementation.

Note 2: There is no restriction on network behaviours by introducing optional capability of duty cycle reporting.

* Recommended WF
	+ To check whether duty cycle reporting as an optional capability can be introduced for FDD HPUE.

### Sub-topic 1-2 Interference

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 1-2: Interference**

The following proposals are summarized based on inputs in this meeting.

Proposal 1: To capture the available MSD values in R4-2112911 and R4-2114695 into the TR 38.861 as a reference. Alignment of calculated and measurement results will be further discussed in the WI stage.

Proposal 2: Current analyses are based on existing RF components. Parameters of new components with higher power handling capability and larger rejection capability, if available, can be considered at WI stage.

* Recommended WF
	+ TBA

### Sub-topic 1-3 SI Conclusion

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 1-3: SI Conclusion**

Comments can be made in the 1.3.2 CR/TP comments section, R4-2112427.

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1 Duty Cycle in FDD bands

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | In last meeting it is agreed that “*Using UE implementation based method to handle duty cycle capability.*”, this means how the duty cycle is calculated is up to UE implementation. With this situation, there is no meaning to report this capability since BS cannot know how to use this capability in the scheduling.In our view, any capability reported to NW should have the benefits in NW side, otherwise, the capability is not meaningful even we say it is optional and UE can choose to not report. If there are many such meaningless signalling designed the NR system performance is burdened. Therefore, it is not recommend to report the never been used capability unless companies can explain how this capability will benefit the NW. |
| Huawei | We may not agree with OPPO that the reported capability is meaningless for NW. Whether to utilize the capability to assist UE to mitigate the SAR issue is up to NW implementation decision, but if NW does consider the duty cycle in its scheduling, definitely it would be helpful to solve the issue. For UE side, measuring the duty cycle by itself is just implementation method, it doesn't mean that the capability is useless, otherwise, duty cycle based solution is invalid for all relevant HPUE WIs.  |
| Ericsson | We agree with OPPO, support Proposal 1 in R4-2113905 and agree with the conclusion therein that the problem is the same for all the duty cycle capability based HPUEs. |
| Apple | ***maxUplinkDutyCycle-PC2-FR1*** has already been introduced for NR FR1 bands since Rel-15 which to our understanding is generic to all NR FR1 bands with PC2 capability. Whether the capability would be reported to the network is UE’s own choice. And there is no guarantee that the network would schedule UE’s uplink transmission based on this reported capability. On the other hand, even if this capability is not reported, it also does not prevent the network from scheduling UE uplink transmission by assuming less than 50% duty cycle is required for PC2 at Pmax.Since SAR is not a 3GPP requirement, we tend to agree that the UE uplink duty cycle monitoring and P-MPR application would be up UE’s own implementation and does not need to be standardized.  |
| LGE | LGE can support moderator proposal for FDD duty cycle. Based on reported Duty cycle ratio, NW can consider for scheduling of the UE type. But it is not mandate UE behaviour. |
| Xiaomi | From the perspective of standard consistency, we tend to support the similar dutycycle mechanism for all relevant high power UE. However, we also recognize the issue of how to ensure UE and BS having the same knowledge of UL dutycycle for FDD case. If this issue could not be solved, the UE implementation based dutycycle approach with UE power class fall back considered also acceptable for us. |
| ZTE | We also support moderator proposals on the duty cycle for HPUE FDD band. We think BS could know the UE behaviour via duty cycle reporting in case of power fallback happen. Otherwise, it may cause link failure when UE is located in the cell edge. This is similar with other HPUE topic. Moreover, Duty cycle solution is optional. |
| China Unicom | From our view, the optional feature of duty cycle reporting can be introduced. Upon receiving of the capability information, it is up to network’s implementation how to consider the reported value for scheduling. Same as the optional duty cycle reporting in existing and ongoing HPUEs (single band, and CA/DC).For UEs with good SAR management capabilities, the implementation-based method power control can be used. However, for UEs which are not able to handle SAR well, the Tx power has to be kept low for SAR compliance. In this case, duty cycle based method would be a useful method to satisfy SAR requirements while maintain high Tx power, which is preferable from UL performance perspective. |
| Samsung | We echo OPPO’s view. The UE’s implementation-based solution and with no restriction on network behaviors by introducing optional capability of duty cycle reporting would be meaningless. However, we can support the moderator’s WF hoping that we can make a concrete solution in the future after the SI. |
| T-Mobile USA | We agree with Oppo and Ericsson. We think that if the traffic is bursty, the burstiness itself will active and inactive periods for the UE to manage it’s power over. If the traffic is not busty, then there would be no benefit of the network imposing a duty cycle.  |
| Qualcomm | We don’t think it is very useful, but we don’t object to including the duty cycle capability as optional on both UE and network side. We also don’t understand how the reported capability will be used by the network. But, on the other hand, providing more information is generally beneficial if the network can interpret it. For example, by providing a duty cycle capability, if the UE drops power or falls back to the default power class, the network might have an indication of why the power was reduced. However, due to the uncertainty in the observation window between the UE and the BS, we don’t believe the additional information can be very precise, but only a general indication. We would have preferred, if anything, to have a more precise mechanism and understood behavior from both UE and network side, but that does not seem to be the case. Perhaps it can be considered in future releases as an enhancement if this basic capability is introduced now. |
| vivo | We support moderator proposals on the duty cycle. SAR limits are from regulation, if the traffic is burst, when smartphone reach the SAR limits, the power fall back of smartphone is inevitable whether duty cycle is report or not. The UE’s implementation-based solution is always the baseline solution. In this stage, there is no guarantee that PMPR will meet SAR limit and not break the link at the same time in the field. The duty cycle report is an option solution to improve it. |

Sub topic 1-2 Interference

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Skyworks | Please find updated measurements data in R4-2114695 (inbox). Assumptions of noise rise in R4-2112911 are aligned with our measurement data: we measure a noise rise of PC2 vs PC3 at 40MHz and 50MHz slightly higher than 6dB. So calculated MSD should be aligned with our proposal if we consider identical duplexer rejection. We propose MSD levels based on current RAN4 50dB duplexer rejection assumptions. We think duplexer Tx-Rx isolation assumptions should remain consistent between PC3 and PC2. That’s why we assume 50dB in our analysis. |
| Huawei | We support the proposals summarized for the interference issue. For the different values proposed in different inputs, some assumptions should be aligned when we define the specific MSD requirements in WI stage.  |
| Apple | We appreciate the efforts from the companies on evaluating the potential REFSENS degradation under PC2 either by simulations or measurements. Followings are a few comments from our side:1. It looks like all the REFSENS degradation evaluations only considered either the Tx thermal noise floor or spectrum regrowth due to Tx nonlinearity leaking into Rx band. However, the REFSENS impact could also be contributed by Tx blocker induced Rx IM2, Rx LO reciprocal mixing, and noise figure degradation which would all be elevated when UL power is increased from 23 dBm to 26 dBm.
2. For n3, despite UL RB allocations were substantially restricted for wider channel BW, we can still observe significant REFSENS degradation. This would prompt the concern as whether PC2 FD-FDD with 50% duty cycle and heavy UL RB allocation restriction would truly benefit the UL throughput performance.
3. In the Study Item phase, what is more important is not simply presenting the MSD numbers, but on how to interpret these numbers and their implication as whether the feature would truly benefit the network and UE performance. And the conclusion would help companies to decide whether there is enough justification to move into work item phase or not.
 |
| LGE | We have a TP in the Receiver sensitivity degradation evaluation in interference section. In R4-2112834, we provide Text Proposals to capture the expected sensitivity degradation in n1/n3 by high power transmission in normal CBW (10MHz) and wide CBW impact by CIMD5 in n3. Also, we provide current RF component characteristics and parameters for PA and Duplexer in UE implementations section. Hence, our TP is considered as baseline TP to capture the interference issues and UE implementation issues. Based on this TP, RAN4 can capture the all proposed TP from interested companies.For the ZTE (R4-2112911) paper and SKW (R4-2114695) paper, they consider 50dB duplexer isolation level only. But the real interference impact will be determined by the mixed RF component performance such as Duplexer isolation, RFIC and PA raised noise level characteristics. So need to analyze the sensitivity evaluation for 10MHz CBW in n1/n3 by mixed RF component performance for PC2 FDD UE. Also we need to analyze the wide CBW impact in n3. |
| ZTE | We see different directions among companies for the duplexer isolation, reduce the current duplexer isolation (i.e. 48dB from R4-2112834), reusing the current duplexer isolation (i.e. 50 dB from R4-2114580) and possible better than the current duplexer isolation (i.e. from R4-2112911) . We agree to use LGE’s TP as baseline to reflect/inlude all the possible solutions/papers. |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2113001TP on system level simulation | Apple: Thanks companies for the efforts on providing the system simulation results and the sourcing companies on composing them together into a text proposal. While most of the simulation results were showing the UL throughput gain with PC2 as compared to PC3, to us it is still rather counterintuitive. As PC2 requires 50% UL duty cycle to fulfill the SAR requirement, and PC3 with 50% resource allocation can achieve the same SNR as PC2 with 100% allocation, the overall UL throughput performance should theoretically be a “par” between PC2 and PC3. On the other hand, even without taking into account the potential REFSENS degradation, from UL performance point of view, PC2 with full UL allocation could be subject to much higher MPR/A-MPR as compared to PC3 with 50% allocation in inner region. In this situation, PC3 should outperform PC2 in UL performance. Lastly, for certain FDD bands, substantial REFSENS degradation can be expected in wider channel BW. If heavy UL RB restriction would be applied to salvage the REFSENS, the PC2 UL performance could be further discounted. One potential mitigation to retain the desired PC2 UL performance is to enable half-duplex operation for certain FDD bands in HPUE regime, as proposed in R4-2110163. We would like to encourage companies to give another look before counting out this feature for PC2 FDD. |
|  vivo: we agree with that: due to the limits of the system simulation, REFSENS degradation, MPR/A-MPR are not covered. This TP only collects all the simulation results inputs, we propose to include these factors in the SI conclusion. |
| Qualcomm: Regarding the system gain with REFSENS degradation, in our paper of R4-2107119, the de-sense values are simulated from 0dB to 2dB with 0.2dB’s step to evaluate the impact to DL throughput. Per our simulation, we have the following observation: “the potential DL degradation due to Tx/Rx de-sense does not lead to substantial performance degradation in typical interference limited scenarios. For noise limited scenarios, the performance degradation might be seen which depends on operator’s deployment”. We suggest including this evaluation in the TR (either a new TP or capture in other TP) to reflect the scenarios we covered in the evaluation. In our view, for the scenarios evaluated, the positive gain can be observed.  |
| R4-2112427TP on SAR Scheme and SI conclusion | Ericsson: we do not support the conclusion that an “optional report of duty cycle capability can be used for SAR compliance”. But otherwise the P-MPR method, the specification of MSD for PC2 and the system benefits should be included.It could be mentioned that duty-cycle estim.ation can be used for internal UE purposes but that the reporting is of no value to the network for it depends on how the UL performs the duty-cycle calculation. |
|  vivo: REFSENS degradation, MPR/A-MPR are not covered in the system simulation. SI conclusion is proposed to include the negative impact of REFSENS degradation, MPR/A-MPR for the system performance gain.  |
| Qualcomm: Regarding the system gain with REFSENS degradation, in our paper of R4-2107119, the de-sense values are simulated from 0dB to 2dB with 0.2dB’s step to evaluate the impact to DL throughput. Per our simulation, we have the following observation: “the potential DL degradation due to Tx/Rx de-sense does not lead to substantial performance degradation in typical interference limited scenarios. For noise limited scenarios, the performance degradation might be seen which depends on operator’s deployment”. We suggest to taking this evolution into account in the SI conclusion part. In our view, for the scenarios evaluated, the positive gain can be observed. |
| R4-2112834TP on interference and UE implementation | Skyworks: Thank you for the detailed breakdown analysis. * 6.1.1: we assume same duplexer Tx/Rx isolation for PC2 than for PC3, ie 50dB,
* 6.1.2: 15dB noise rise due to 3dB Tx power boosting for n3 40MHz and 50MHz seems underestimated as we measure 6dB or higher,

For the other sub-clauses, since the calculated n3 REFSENS levels are lower than the PC3 agreed levels, it may be good to adopt the delta MSD approach we have used when the measured MSD levels resulted in REFSENS levels that were lower than the legacy/agreed REFSENS levels. |
| Ericsson: a comprehensive study that should be included. To Skyworks: should the ‘delta-MSD method’ be applied regardless of the resulting ratio of the estimated PC2 REFSENS and the legacy PC3 REFSENS (the latter is sometimes based on early releases of E-UTRA)?The Skyworks results should also be captured in the TR. |
| LGE 🡪 To SKW: In your comment, you mentioned 15dB noise rise. But we just assumed the 1.5dB noise rise level. (15dB 🡪1.5dB). Maybe it is typo in your comment. For wide CBW, we also consider larger noise level by CIMD5 but it is smaller than your measurement level. The section 6.1.2 in our TP, is the analysis result for normal bandwidth (10MHz). Our analysis for wide CBW is in 6.1.4. Based on this TP, the interested companies’ results (ZTE, SKW) will be captured.To the SKW and ZTE, the sensitivity degradation evaluation for normal CBW with 10MHz for PC2 FDD UE in n1/n3 are needed considering with the mixed RF component performance.To Ericsson, the delta MSD will be captured in summary Table based on your comments.ZTE: We agree to use LGE’s TP as baseline to reflect/inlude all the possible solutions/papers. |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic #1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

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

## Discussion on 2nd round (if applicable)

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents

# Annex

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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)