3GPP TSG-RAN WG1 Meeting #101-e Tdoc R1-20xxxxx

e-Meeting, May 25th – June 5th, 2020

**Agenda Item: 8.3**

**Title: Email discussion summary #3 for Study on support of reduced capability NR devices (Step 2: Medium priority proposals)**

**Source: Rapporteur (Ericsson)**

**Document for: Discussion, Decision**

# 1 Introduction

This document captures the discussion in RAN1#101e post-meeting email discussion [101-e-Post-NR-RedCap], which follows an email discussion [101-e-NR-RedCap-01] held during RAN1#101e for the study item “Study on support of reduced capability NR devices” [1]. Both these email discussions focus on high-level topics and evaluation assumptions necessary to facilitate next step’s more concrete analysis and evaluations. For further background, see email discussion summary for the first email discussion in [3].

In this post-meeting email discussion [101-e-Post-NR-RedCap], the proposals are treated with the following priorities:

* High priority:
  + Proposals 7, 9, 22, 22a, 23, 26
* Medium priority:
  + Proposals 14, 14a, 15, 21, 28, 30
* Medium priority, to be discussed after sufficient progress has been reached on Cov. Enh. SI assumptions:
  + Proposals 16, 17, 18, 19, 20
* Low priority:
  + Proposals 0, 1, 3, 6, 12, 13, 24a, 25a, 27, 29, 32

This document deals with the Medium priority proposals and one High priority proposal (Proposal 9), which have been updated to address the concerns expressed in Section 9 in [3] and in the email discussion [101-e-Post-NR-RedCap]. The full list of proposals can be found in [3]. The fact that a proposal is listed with lower priority in this email discussion should not be interpreted as a suggestion that it will have lower priority in future meetings.

# 6 Evaluation methodology

## 6.1 Evaluation methodology for UE complexity reduction

Regarding Proposal 9, in the email discussion [101-e-Post-NR-RedCap] different views have been expressed about what bands, band combinations and duplex modes that are most relevant for the reference NR device. Some comments mentioned that including TDD in FR1 is important, some comments expressed concerns about focusing on single band in FR1, while some other comments noted that if the reference NR device has many different combinations then the workload in the study might become unnecessarily large. The updated proposal below tries to address these concerns by adding a single additional case in FR1.

Furthermore, in the proposal below, the MCS table references have been removed and the modulation scheme ranges have been replaced by indications of the maximum supported modulation scheme, which is thought to be the interesting aspect from cost driver point of view.

**Proposal 9:** The reference NR device for evaluation of cost/complexity reduction supports the following:

* All mandatory Rel-15 features (with or without capability signaling)
* Single RAT
* Band and duplex mode support:
  + FR1 case 1: Single FDD band
  + FR1 case 2: One FDD band and one TDD band
  + FR2: Single TDD band
* Maximum bandwidth:
  + For FR1: 100 MHz for DL and UL
  + For FR2: 200 MHz for DL and UL
* Antennas:
  + For FR1 FDD: 2Rx/1Tx
  + For FR1 TDD: 4Rx/1Tx
  + For FR2: 2Rx/1Tx
* Power class: PC3
* Processing time: Capability 1
* Modulation:
  + For FR1: support 256QAM for DL and 64QAM for UL
  + For FR2: support 64QAM for DL and 64QAM for UL
* Access: Direct DL/UL access between UE and gNB

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| **Company** | **Comments** |
| Sierra Wireless | We now have “concerns” that the Multi-band option has now been removed. As a suggestion, we can follow what Brian suggested – we document in the TR which of the complexity reduction techniques accumulate across multi-bands (or not). So if we add the **“green”** text as shown below, then it would be agreeable to Sierra:   * Band and duplex mode support:   + FR1 case 1: Single FDD band   + FR1 case 2: One FDD band and one TDD band   + FR2: Single TDD band   + Note: Capture when a complexity reduction technique accumulates across multi-bands (or not) |
| Huawei, HiSilicon | Fine with proposal 9 and Sierra Wireless’ modification based on Brian’s comments is also good. |
| Samsung | For band and duplex mode support, we still think multiple band is not necessary. We suggest to make “FR1 case 2 as optional” to avoid have too many “baseline/reference”.  On the other hand, we are OK to provide analysis for a UE that can support multiple bands. However, we don’t think this proposal is a proper place to capture the following note, since this mainly discussed on how to calculate cost/complexity reduction for a certain technique and not related to the proposal to define a “reference UE”.  Note: Capture when a complexity reduction technique accumulates across multi-bands (or not) |
| DOCOMO | Agree with Proposal 9. We are also fine to add the clarification proposed by Sierra Wireless. |
| China Telecom | Fine with the proposal. We are also fine to add the clarification proposed by Sierra Wireless. |
| CMCC | Fine with the proposal. |
| LG | Okay with the proposal. (with and without the Note from Sierra Wireless) |
| MediaTek | Fine with the proposal. |
| Nokia, NSB | We are fine with the proposal |

## 6.2 Evaluation methodology for UE power saving

For Proposals 14 and 14a, two comments in Section 9 in [3] suggested that only one of the two proposals would be needed. Proposals 14 and 14a have been merged into a single new Proposal 14.

Proposal 14: For wearables, use the traffic models FTP model 3 and VoIP from TR 38.840 to characterize the RedCap service types including IM, VoIP, heartbeat, etc. with proper modification of at least packet size and mean inter-arrival time for RedCap use cases. Values are FFS.

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| **Company** | **Comments** |
| Qualcomm | We support the new Proposal 14 after merging. |
| Huawei, HiSilicon | Fine |
| vivo | Fine with the proposal |
| SONY | OK with the proposal. When is the FFS meant to be resolved? In this email discussion? |
| Ericsson | Support Proposal 14 |
| ZTE,Sanechips | The wording of the proposal may need some improvement, this proposal is meant for the traffic types for wearable use case for the RedCap UEs.  ‘Use the traffic models FTP model 3 and VoIP from TR 38.840 to characterize the wearables service types including IM, VoIP, heartbeat, etc. with proper modification of at least packet size and mean inter-arrival time ~~for RedCap use cases~~. Values are FFS.’ |
| OPPO | The modification from ZTE is ok to us. We support the proposal. |
| Samsung | We are ok to consider FTP model 3 and VoIP. But in TR 38.840, DRX setting is included for FTP traffic and VoIP. That’s not necessary for the evaluation for RedCap since the goal of reduction PDCCH monitoring already agreed in SID.  We suggest the following modification:  Proposal 14: For wearables, use the traffic models FTP model 3 and VoIP without DRX setting from TR 38.840 to characterize the RedCap service types including IM, VoIP, heartbeat, etc. with proper modification of at least packet size and mean inter-arrival time for RedCap use cases. Values are FFS. |
| DOCOMO | Agree with Proposal 14 (with/without modification from ZTE) |
| China Telecom | Fine |
| Spreadtrum | Fine |
| CMCC | Fine with the proposal. |
| MediaTek | We are fine with the proposal.  Regarding Samsung’s proposal to exclude the DRX setting, we don’t agree with this modification. It is expected that the network utilizes the available power saving features for RedCap UE to reduce the power consumption. Certainly the NW can’t rely only on reduced PDCCH monitoring feature to achieve the required battery life.  Also, the assumptions regarding Rel-16 power saving features should be included in the proposal:  Proposal 14: For wearables, use the traffic models FTP model 3 and VoIP from TR 38.840 to characterize the RedCap service types including IM, VoIP, heartbeat, etc. with proper modification of at least packet size and mean inter-arrival time for RedCap use cases. Values are FFS.   * In addition to DRX, other Rel-16 power saving features such cross-slot scheduling and WUS/DCP are applied as baseline configuration. |
| Nokia, NSB | We are fine with the proposal |
| Sequans | We are fine with the proposal + modification from ZTE. |

Proposal 15: For industrial wireless sensor use cases, use a traffic model based on the service performance requirements for the process monitoring use case in TS 22.104 Table 5.2-2. At least [64 bytes] message size and [100 ms] transfer interval should be considered (other values are not precluded).

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| **Company** | **Comments** |
| Qualcomm | We are fine with Proposal 15. |
| Huawei, HiSilicon | Fine |
| vivo | In general fine with reusing the traffic characteristic as in TS22.104 for wireless sensors. For details we have some comments below   1. Clarify the traffic model is only used for UL evaluation 2. Not sure why 64bytes is picked for message size as it is differrent from 20bytes in TS22.104 Table 5.2-2 |
| SONY | We are basically OK with the proposal. The following should be clarified in the proposal:   * Messages are transmitted periodically with a periodicity of [100ms] * Messages are transmitted in UL * Header sizes (MAC, RLC etc) to be attached to the [64 byte] message size. We would be OK with any reasonable value, but RAN1 should just fix on one header size for evaluation purposes   We think that the periodic UL traffic model discussed in this proposal is just an example traffic model that we should study. We would like to avoid Redcap being “optimised” for this specific traffic model – Redcap should be generally applicable to IWS traffic models.  In response to Vivo’s comment, we understand that the 64 byte message size is related to this note in TS22.104 / table 5.2-2:  NOTE 5: The application-level messages in this use case are typically transferred over Ethernet. For small messages, the minimum Ethernet frame size of 64 bytes applies and dictates the minimum size of the PDU sent over the air interface. |
| Ericsson | Support the proposal. Regarding message size, our understanding is that “note 5” in TS 22.104 Table 5.2-2 states that “*For small messages, the minimum Ethernet frame size of 64 bytes applies and dictates the minimum size of the PDU sent over the air interface.*” |
| ZTE,Sanechips | OK. |
| OPPO | OK |
| Samsung | We are fine |
| DOCOMO | Agree with Proposal 15 |
| China Telecom | Fine |
| CMCC | Fine with the proposal. |
| MediaTek | Fine with the proposal. |
| Nokia, NSB | We are fine with the proposal |
| Sequans | We are fine with the proposal. |

## 6.4 Evaluation methodology for other performance impacts

For Proposal 21, one comment proposes to include power consumption in the first sentence, another comment proposes to include spectral efficiency in the first sentence, and a third comment states that other system performance impacts shouldn’t be excluded, such as PDCCH blocking probability. The proposal has been updated accordingly.

Proposal 21: The evaluation of performance impacts includes at least peak data rate, latency, power consumption and spectral efficiency. Other performance metrics such as PDCCH blocking probability are not precluded.

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| **Company** | **Comments** |
| Qualcomm | For performance evaluation, we think it is well-justified to consider peak data rate, power consumption and PDCCH blocking probability for RedCap UE.  However, we are not sure about the definition and evaluation methodology for “spectral efficiency.” Clarification and justification are needed for invoking “spectral efficiency” in the performance evaluation of RedCap UE. |
| Huawei, HiSilicon | Fine with the proposal except for power consumption - which is already in the objective of SID for specific scenarios (e.g. delay tolerant) thus do not belong to “other performance impacts”.  In response to Qualcomm’s comments: the motivation is to look at the impact of (a large number of) RedCap UEs on network performance as it is well understood that the low capability UE could lower the system performance in e.g. spectral efficiency. We should not only focus on benefits that can be enabled to UE side by RedCap and thus the potential penalty on network/operator side should also be captured by e.g. widely used throughput analysis, so as to provide a complete technical report for all 3GPP players. |
| vivo | Fine with the proposal |
| SONY | Agree with proposal.  In response to Huawei’s point ‘except for power consumption - which is already in the objective of SID for specific scenarios (e.g. delay tolerant) thus do not belong to “other performance impacts”’… That text in the SID is referring to power saving enhancements, not the evaluation of performance impacts.  We think that the point of the proposal is that if a company proposed a complexity reduction scheme that had power consumption impacts, then those power consumption impacts should be noted.  E.g. if there were a proposal for a UE that had a peak data rate of 100kbps, rather than another proposal for a UE with a peak data rate of 1Mbps, the proponent could observe that the 100kbps UE needed to be “on” for ten times as long and hence note that there is an adverse power consumption impact. |
| Ericsson | We do not think spectral efficiency needs to be included in the study as connection density is not an SI objective according to the SID. Additionally, we agree with Huawei that it is not necessary to include power consumption. |
| ZTE,Sanechips | Adding evaluation for ‘spectral efficiency’ is not necessary , considering it is not the focus of the this SID and for lots of use cases, for example wireless sensors, there is no strong interest for this metric. |
| Huawei, HiSilicon02 | In response to E//, ZTE: Coexistence is one of the objective in the SID - it is our understanding that system performance will be impacted by coexistence with legacy UEs. |
| OPPO | We do not see the need for adding spectrum efficiency. First it is not our purpose for discussing RedCap UE in Rel-17. It is also to be proven not a good way, when we try to discuss how many legacy UE and RedCap UE in the network. |
| Samsung | We prefer to move “spectral efficiency” to “other performance metrics”. In addition, in order to reduce evaluation load, we suggest to add “at least qualitatively” in general. |
| DOCOMO | Agree with Proposal 21. We think it’s beneficial to evaluate system performance, e.g., spectral efficiency and PDCCH blocking probability, to ensure the coexistence with legacy UE. |
| China Telecom | Fine with the proposal, and we agree with Samsung that it is better to move “spectral efficiency” to “other performance metrics”. |
| Spreadtrum | Prefer to remove “spectral efficiency” in the first sentence. If it is UE level SE, the RedCap UE does not have sufficient SE. If it is NW level SE, the metric is necessary for the eMBB scenario but not for the MTC scenario, and RedCap UE addresses the MTC scenario. |
| CMCC | We also think spectral efficiency can be removed, since it is not in the SID and the evaluation method will need more discussion e.g., the ratio between eMBB UE and RedCap UE in the network.  In addition, we think the power consumption should be included. The power consumption evaluation in this proposal is to analyse the power consumption performance impact due to reduced UE complexity features, which is different from the motivation of power consumption evaluation in power saving techniques e.g., BD and CCE limits reduction. |
| LG | We prefer to remove the spectral efficiency in the proposal. We understand the intention, but we don’t think we have the details to evaluate the potential spectral efficiency loss caused by the RedCap UEs yet. |
| MediaTek | We are in general fine to keep the “spectral efficiency” as a performance metric. In our understanding, it is expected that some of the complexity reduction features will impact the system spectral efficiency. Maybe the question will be: what is the level of this impact, and if it is acceptable or not. |
| Nokia, NSB | We are fine with the proposal. We prefer to keep spectral efficiency where it is as we think it is a useful metric. At least with the proposed data models, we can do some simulations to assess the impact of various techniques to system-level performance. |
| Convida Wireless | In general, we are okay with the proposal. However, agree with other companies regarding the spectral efficiency metric and prefer to remove it. We also propose to consider reliability for the performance impacts evaluation. We believe consideration to latency without reliability might not be very meaningful. |
| Sequans | We are fine with the proposal, although we’d prefer to have evaluation of spectral efficiency loss as lower priority for now. |

# 7 UE complexity reduction features

## 7.5 Relaxed UE processing time

For Proposal 28, one comment in Section 9 in [3] proposes to indicate that it can be studied with *“low priority”*. It seems (at least to the Rapporteur) highly likely that the N1/N2 relaxation will, even without an indication that it has low priority, be studied with lower priority than e.g. reduced UE bandwidth and reduced number of UE antennas, so it does not seem necessary to explicitly state that it has lower priority.

Proposal 28: Study a more relaxed UE processing time in terms of N1/N2 compared to capability #1, including the impacts on cost/complexity, power saving, latency and scheduling flexibility (at least qualitatively).

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| **Company** | **Comments** |
| Qualcomm | We are ok with Proposal 28. |
| Huawei, HiSilicon | Although we did not object the other aspects in P28 in our previous response, our comments still hold that the other metrics other than cost/complexity may not fall into the scope of SID, i.e. relaxed UE processing time can be studied only for cost/complexity reduction purpose. Power saving is already in SID with specific candidate techniques to specific scenarios, so we propose to remove that. For latency and scheduling flexibility, they are generic requirements that could be kept in our view. However, to avoid unnecessary debate at this stage, we suggest to maintain the objective as is   * Study a ~~more~~ relaxed UE processing time in terms of N1/N2 compared to capability #1~~, including the impacts~~ on cost/complexity analysis~~, power saving, latency and scheduling flexibility (at least qualitatively)~~. |
| vivo | Fine in general, but would be good to clarify why scheduling flexibility is relevant here. Regarding Huawei’s revision, we would like to keep power saving as one metric to decide whether to introduced relaxed UE processing time. |
| SONY | Agree with proposal, but maybe “power saving” should be “power consumption”. We tend to agree with Huawei that relaxed UE processing time is about complexity reduction, not power saving. However, as with all other cost / complexity reduction schemes, we should consider the power consumption impact. Our proposed wording would be:  Study a more relaxed UE processing time in terms of N1/N2 compared to capability #1, including the impacts on cost/complexity, power ~~saving~~ consumption, latency and scheduling flexibility (at least qualitatively). |
| Ericsson | Fine with the proposal, but it is preferred that the impact on cost and complexity is prioritized. |
| ZTE,Sanechips | We are not sure how to ‘qualitatively’ analyse ‘scheduling flexibility’. It would also be very difficult to do such analysis for relaxed UE processing time’s impact on cost/complexity etc. We suggest to remove it. |
| OPPO | For clarity, the scheduling flexibility should be removed. Power saving should be kept. |
| Samsung | We support to study relaxation on N1/N2, and don’t think it should be lower priority in SI phase. N1/N2 has nothing to do with PDCCH, so we suggest to remove “scheduling flexibility” in the proposal. |
| DOCOMO | Agree with Proposal 28 |
| China Telecom | Fine with the proposal, and we agree with ZTE that it’s hard to ‘qualitatively’ analyse ‘scheduling flexibility’. |
| Spreadtrum | We share the similar view with ZTE, ‘scheduling flexibility’ is hard to quantify, so we suggest to remove “scheduling flexibility”. |
| CMCC | We think the “scheduling flexibility” can be removed. The performance requirements of cost/complexity, power saving and latency are clear in the different use cases in SID, but the scheduling flexibility is not and also difficult to evaluate. |
| LG | We are okay with the proposal as it is. If prioritization is deemed useful, then we prefer to prioritize the cost/complexity and take others as optional or low priority. |
| MediaTek | We agree with HW view regarding power saving. Also, if we would like to evaluate the power saving of relaxed N1/N2, the power model should be defined as well. Otherwise, we will end up with incomparable evaluations for such power saving gains.  Thus, the power saving part should be removed from the proposal:  Proposal 28: Study a more relaxed UE processing time in terms of N1/N2 compared to capability #1, including the impacts on cost/complexity, ~~power saving,~~ latency and scheduling flexibility (at least qualitatively). |
| Nokia, NSB | We are fine with the proposal |
| Convida Wireless | Yes |
| Sequans | We are fine with the proposal. Our understanding is that optional study of impacts compared to capability #2 is not excluded as in fact it could be useful to have a comparison of impact when moving from #2 to #1 vs. moving from #1 to more relaxed (#0?) capability. |

## 7.6 Relaxed UE processing capability

For Proposal 30, two comments in Section 9 in [3] propose that reduced maximum UE bandwidth for data transmission and reception should be included in the bullet list, and one or two other comments propose that reduced number of HARQ processes should be included in the bullet list, whereas one comment states that nothing further is acceptable but can be discussed in the RAN plenary as needed. During the email discussion documented in [2] and [3], peak data rate relaxation related to reduced number of HARQ processes has seemed rather controversial whereas perhaps peak rate relaxation related to reduced UE bandwidth may be less controversial, and the proposal has been updated accordingly.

Proposal 30: Study peak data rate relaxation and focus at least on:

* Maximum modulation order restriction
* Reducing the maximum number of MIMO layers
* Reduced maximum UE bandwidth for data transmission and reception

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| **Company** | **Comments** |
| Qualcomm | Different from the NR reference UE discussed in Proposal 9, the restricted modulation order supported by RedCap UE is not necessarily the highest modulation order in NR Rel-15 MCS table(s). Therefore, it is necessary to clarify the impacts of maximum MCS. Meanwhile, the formula for max data rate calculation in TS 38.306 also needs to be revisited if necessary. |
| Huawei, HiSilicon | Fine. |
| vivo | According to the several rounds of feedback, we see many companies explicitly indicated the interest to study the reduced number of HARQ processes (Sony, Spreadtrum, DOCOMO, vivo, China Telecom, Apple) and there seems no objection to include it for study. Although currently the soft buffer size requirement is not explicitly defined according to the number of HARQ processes, but technically the buffer size should be able to reduce (thus reduced the cost/complexity) if the number of HARQ-processes is significantly reduced.  Therefore we believe reduced number of HARQ processes should be added. |
| SONY | Agree with proposal. We think that all three aspects affect the peak data rate in NR.  Agree with Vivo. We think that reduction of number of HARQ processes is also a method of relaxation of UE processing capability. This is a decision that can be made by RAN1 experts. |
| Ericsson | Support Proposal 30. |
| ZTE,Sanechips | We suggest to add ‘maximum TBS restriction’ |
| OPPO | We suggest to add maximum number of HARQ process and TBS. |
| Samsung | We are ok to study the first two and remove the third bullet. |
| DOCOMO | Agree with proposal 30 and also agree to add reduced number of HARQ processes. |
| China Telecom | Fine with the proposal and vivo’s comment is also good. |
| Spreadtrum | Agree and it is better to add “the maximum number of HARQ process” and “the maximum TBS”. We should be open at the study stage. |
| CMCC | Fine with the proposal. |
| LG | We are okay with the first two bullets. For the third one, it seems we need further clarifications. The bandwidths for UL/DL transmission/reception (perhaps smaller than the maximum UE bandwidth) can be supported by gNB configuration. In this case, it doesn’t have to do with the peak rate supported by the device. |
| MediaTek | We agree with Samsung’s view to remove the third bullet.  Also, we are fine with studying reduced number of HARQ processes as proposed by Vivo and some other companies. |
| Nokia, NSB | We are fine with 1st & 2nd bullet points. For 3rd bullet point, we are OK to include it as part of the study. However, we think another bullet point on restriction the maximum TBS can be considered as well. It is similar to 3rd bullet point but we think it has less impact on implementation. |
| Convida Wireless | We support this proposal and we’re also okay to add a bullet for the reduction of number of HARQ processes. |
| Sequans | We are fine in principle with the proposal, but we believe that also CA/SUL feature should become of focus and studied (at least later on) and maybe considered together with the maximum UE bandwidth aspect. |

# References

[1] [RP-193238](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_86/Docs/RP-193238.zip), ”New SID on support of reduced capability NR devices”

[2] [R1-2004731](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2004731.zip), “Email discussion for Study on support of reduced capability NR devices”, Rapporteur (Ericsson)

[3] [R1-2005048](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2005048.zip), “Email discussion summary #2 for Study on support of reduced capability NR devices”, Rapporteur (Ericsson)