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 1: High 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 initial focus is High priority proposals listed below:

* 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 High priority proposals, which have been updated to address the concerns expressed in Section 9 in [3]. 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

For Proposal 7, one of the comments in Section 9 in [3] suggested that the words “*only if obvious benefits observed*” are added at the end of Proposal 7. Here it is proposed to add “*if found beneficial*” as a compromise.

**Proposal 7:** Cost/complexity breakdowns can be separate for FR1 and FR2 if found beneficial.

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| **Company** | **Comments** |
| Qualcomm | We are fine with this proposal. |
| Ericsson | Support proposal 7 (with or without revision). |
| ZTE,Sanechips | OK. |
| Intel | Fine with the proposal. |
| Sierra Wireless | Agree with proposal |
| vivo | Fine with the proposal |
| Huawei, HiSilicon | Fine |
| CATT | Fine with the proposal |
| Samsung | OK. |
| DOCOMO | Agree with the proposal |
| Lenovo, Motorola Mobility | Fine with the proposal |
| Panasonic | OK. |
| OPPO | Fine with it. |
| LG | Okay with the proposal. |
| Sequans | We are fine with the proposal. |
| MediaTek | Agree with the proposal |
| FUTUREWEI | OK |
| Nokia, NSB | We are fine with the proposal with or without revision |
| InterDigital | We are fine with this proposal. |
| SONY | Agree with proposal |
| Apple | Agree with proposal |
| CMCC | Fine with the proposal |
| China Telecom | Fine |
| Spreadtrum | Fine with the proposal |

For Proposal 9, one comment in Section 9 in [3] requested that it is clarified that the purpose is to consider the simplest NR device defined in Rel-15/16 that can support the targeted use cases. This is also the understanding of the Rapporteur, and it is in line with how the reference LTE modem was defined in TR 36.888 for the LTE MTC SI (where Cat-1 was chosen as the reference LTE modem even though LTE devices available on the market at the time were typically significantly more advanced than Cat-1).

One comment proposed to clarify that the reference NR device is “*for evaluation of complexity reduction*”. The proposal has been updated accordingly.

Other comments concern to what extent the reference NR device needs to support all mandatory features, and whether it needs to support 4Rx in FR1 bands {n7, n38, n41, n77, n78, n79}. The Rapporteur suggests leaving the proposal as is.

Several comments concern multi-band support. Since the expressed views are opposite, and the current proposal tries to strike a balance between opposing views, the Rapporteur suggests trying again to agree the current proposal.

Three comments proposed to include not only FD-FDD but also TDD among the duplex bands for the FR1 reference NR device. TDD has been added below.

One comment suggests clarifying what MCS tables should be supported by the reference NR device. The proposal has been updated with proposed MCS tables.

**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 support:
	+ FR1: Single band
	+ FR1: Multiple bands (optional, details FFS)
	+ FR2: Single band
* Maximum bandwidth:
	+ For FR1: 100 MHz for DL and UL
	+ For FR2: 200 MHz for DL and UL
* Duplex mode:
	+ For FR1: FD-FDD, TDD
	+ For FR2: TDD
* Antennas:
	+ For FR1 bands {n7, n38, n41, n77, n78, n79}: 4Rx/1Tx
	+ For all other FR1/FR2 bands: 2Rx/1Tx
* Power class: PC3
* Processing time: Capability 1
* Modulation:
	+ For FR1: QPSK to 256QAM for DL, and QPSK to 64QAM for UL
	+ For FR2: QPSK to 64QAM for DL, and QPSK to 64QAM for UL
* MCS table:
	+ For FR1: 38.214 Table 5.1.3.1-2 for DL, and 38.214 Table 6.1.4.1-1 for UL
	+ For FR2: 38.214 Table 5.1.3.1-1 for DL, and 38.214 Table 6.1.4.1-1 for UL
* Access: Direct DL/UL access between UE and gNB

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| **Company** | **Comments** |
| Qualcomm | We are fine with this proposal. |
| Ericsson | Support proposal 9 (with or without revisions). |
| ZTE,Sanechips | OK. |
| Intel | Fine with the proposal. |
| Sierra Wireless | OK with proposal.For FR1: Our understanding is that there are 4 single-band optional configurations that may be evaluated:* Single-band FDD 2 RX Ant
* Single-band FDD 4 RX Ant (B7)
* Single-band TDD 2 RX Ant
* Single-band TDD 4 RX Ant

And maybe 1 Multi-band – FFS configMulti-band [4] FDD bands and [4] TDD bands 4 RX Ant |
| vivo | We have concern with the proposal (first sub-bullet). As we commented before, several mandatory with capability signaling features has not been implemented yet even for normal UEs, it is not reasonable to assume a reduced complexity UEs will support these features for sure. Therefore these feature has to be discussed case by case, if necessary. Suggested revision * All mandatory Rel-15 features ~~(with or without capability signaling)~~
 |
| Huawei, HiSilicon | Understand there could be different views on the band reference. However, considering the existing (wide) support of multi-bands, the potential popular deployment scenarios in future, as well as the spirit of consideration of a limited sets of NR RedCap devices, there might be a possibility that multi-band could be the baseline capability in practical when the feature is to be launched in market. From UE vendor point of view HiSilicon has a preference to see how much we could offer as a UE with reduced capability with support of multi-bands, compared with eMBB UEs with support of multi-bands.Perhaps a minor change could be removal of “optional” for “FR1: Multiple bands (details FFS)”, as it is already with FFSed details (similar to what Sierra Wireless indicated for multi-band). In addition, we don’t think the MCS table is needed - in the peak rate calculation as in 38306 modulation order is sufficient and the same order may be able to be used from different tables/waveforms, which we do not know yet but room for that can be kept for now.  |
| CATT | We are not quite clear about the intention of MCS tables. If the intention is that low SE MCS tables are not supported, Table 5.1.3.1-1 should be added for FR1 DL as well. |
| Samsung | To reduce the evaluation load and easy to conclude it. We still suggest to only keep one simple group of features for FR1 and FR2 respectively. However, we understanding that since all the features are supported in NR, some analysis on UE complexity/cost may be needed to support multiple bands, TDD in FR1 and the FR1 bands requires 4Rx. Therefore, we suggest:* Band support:
	+ FR1: Single band
		- Some further analysis on UE complexity/cost to support multiple bands in FR 1 can be provided, details are FFS
	+ FR2: Single band
* Duplex mode:
	+ For FR1: FD-FDD~~, TDD~~
		- Some further analysis on UE complexity/cost for TDD in FR 1 can be provided, details are FFS
	+ For FR2: TDD
* Antennas:
	+ For ~~all other~~ FR1/FR2 bands: 2Rx/1Tx
		- Some further analysis on UE complexity/cost for FR1 bands {n7, n38, n41, n77, n78, n79}with 4Rx/1Tx, details are FFS
 |
| DOCOMO | Agree with the proposal |
| Lenovo, Motorola Mobility | Fine with the proposal |
| Panasonic  | OK |
| OPPO | Addition the MCS table for UL and DL would help for understanding the baseline complexity. We support it. |
| LG | Okay in general with the following notes. * Prefer to leave the first bullet as it is.
	+ By removing the “with or without capability signaling”, there seems to be an ambiguity left for further discussion.
* Prefer to leave the multiband in FR1 as optional.

Okay to remove TDD for FR1. |
| Sequans | We are fine with the proposal as it is. We note though that we should also be able eventually to evaluate benefits from reductions in axis of CA, MIMO, capability #2 |
| MediaTek | Fine with the proposal |
| FUTUREWEI | It is important to keep the FFS on multiband support. As commented earlier, we should note in the TR where a technique provides gains that aggregate over multiple bands, or not, which can then be taken into account for the final recommendations.No need to include the MCS tables supported. Support or not has no real impact on cost/complexity, and the reference is for evaluation of cost/complexity. In general, when we look at power savings and coverage compensation, existing features should be used before new features developed.Disagree with Vivo comment on not including all mandatory features. Rather than repeating their comment, they should explain a feature they do not want to see included and why it makes a big difference in cost. |
| Nokia, NSB | We are fine with the proposal |
| InterDigital | We are fine with the proposal. |
| SONY | We really need to have a single reference device. How many complexity analyses are we going to have? If we have 8 different reference devices (TDD / FDD, 2RX / 4RX, single band / multiple band) and we have 8 different complexity reduction schemes (1 RX, 10MHz BW, 20MHz BW, xxx peak rate, yyy peak etc. etc.), then are we really going to document 64 different complexity analyses? No.One the specific proposal, we think the following should be changed:* Duplex mode: no need to study TDD in FR1. TDD complexity should be a subset of FDD complexity in any case (no need for duplexer)
* MCS table: delete. The complexity analysis shouldn’t be considering this level of detail. Having such a detailed reference UE specification will down the road lead to time-consuming detailed and mainly irrelevant discussion of specific aspects of these MCS tables.

Additional comments:* Multiple bands. If we consider a reference device with multiple bands, then we should assume that the cost-reduced UE supports the same multiple bands (hence removal of some bands is not a cost / complexity reduction in itself)

Mandatory Rel-15 features. We are OK to remove “(with or without capability signaling)”: that still means that any feature that is “mandatory” in any sense is part of the reference UE. We shouldn’t be considering features on a case-by-case basis (we think there is neither time for this or value in it). |
| Apple | We are fine with this proposal.  |
| CMCC | TDD for FR1 should be included in the reference NR device. Both TDD and FDD are considered as the reference LTE modem in TR 36.888. In addition, TDD bands for FR1 have been extensively deployed by operators. Therefore, TDD for FR1 can not be removed. |
| China Telecom | Fine with this proposal. And we also consider the TDD for FR1 can not be removed. |
| Spreadtrum  | We share the similar view with Sierra Wireless. |

# 7 UE complexity reduction features

## 7.2 Reduced number of UE Rx/Tx antennas

It seems from the concerns expressed in Section 9 in [3] that not all companies are comfortable giving different priorities to different antenna configurations, and that there may be a wish to align the wording in Proposals 22 and 23. Proposal 23 has been updated to take this into account.

**Proposal 22:** For FR1, study two antenna configurations for RedCap UEs, namely 1Rx/1Tx and 2Rx/1Tx.

**Proposal 23:** For FR2, study two antenna configurations for RedCap Ues, namely 1Rx/1Tx and 2Rx/1Tx.

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| **Company** | **Comments** |
| Qualcomm | Proposals 22 and 23 look good to us. |
| Ericsson | Support proposal 22.Support proposal 23 (with or without revision). |
| ZTE,Sanechips | Support both. |
| Intel | Fine with the proposals. |
| Sierra Wireless | Agree with proposal |
| vivo | Fine with the proposal |
| Huawei, HiSilicon | Fine |
| CATT | Fine with the proposal |
| Samsung | Although our preference is to prioritize the study on 2Rx/1Tx for FR2, we can live with the update proposals for the sake of progress.  |
| DOCOMO | Agree with the proposal |
| Lenovo, Motorola Mobility | Fine with the proposal |
| Panasonic | OK  |
| OPPO | No restriction for FR2 is better, ok. |
| LG | Support the proposal. |
| Sequans | We are fine with the proposal. We prefer prioritizing 2Rx/1Tx to focus on the most Cat1-alike case but we can move on. |
| MediaTek | Fine with the proposals. |
| FUTUREWEI | OK with or without revision |
| Nokia, NSB | We are fine with the proposal with or without revision |
| InterDigital | We are fine with the proposal. |
| SONY | Agree with proposal |
| Apple | Agree with proposal |
| CMCC | Fine with the proposal, in addition, we think 2Rx/1Tx can be with high priority in FR1. |
| China Telecom | Fine with the proposal, and we think the 2Rx/1Tx for FR2 has a higher priority. |
| Spreadtrum | Agree with proposal. |

For Proposal 22a, some comments in Section 9 in [3] preferred to revert the wording to an earlier version of the proposal, and some comments suggested that there needs to be some limit to how large the reduced antenna efficiency can be allowed to be. The proposal has been updated to take this into account. Other comments proposed other wordings or argued that the proposal is out of the RedCap SI scope and that it e.g. better handled in the Cov. Enh. SI.

**Proposal 22a:** For FR1, potential reduced antenna efficiency due to device size limitations for wearables is assumed to be limited to [x] dB (where x is FFS) and can be reflected as part of the antenna gains in the coverage analysis.

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| **Company** | **Comments** |
| Qualcomm | We are fine with this proposal. |
| Ericsson | We are fine with the revised proposal. We prefer “antenna efficiency” to “antenna radiation efficiency” because the former term covers additional aspects beyond radiation efficiency and covers both TX and RX aspects, as pointed out by Sony in [3]. |
| ZTE,Sanechips | OK with the revised proposal. Assume separate value of x for TX / RX. |
| Intel | Fine with the revised proposal. |
| Sierra Wireless | Agree with proposal |
| vivo | Fine with the proposal |
| Huawei, HiSilicon | As commented before, the antenna efficiency is a bit too general resulting in unclear scope of study. Antenna radiation efficiency is defined and applied to both transmission and reception in evaluations so can be kept with clarification (e.g. add “UE transmitter and/or receiver”). Regarding “reflected” or “reported, the intention is for companies to clearly report how much antenna radiation efficiency is assumed in the evaluations, otherwise its impact on coverage reduction is not accurately evaluated. The wording “reflected” implies that single value of antenna gain is reported for a mix of antenna radiation efficiency [x] dB and nominal UE antenna gain. We don’t prefer this mix, but could be OK with a further note:For FR1, potential reduced antenna radiation efficiency due to device size limitations for wearables is assumed to be limited to [x] dB (where x is FFS, e.g. can be 0) and can be reflected as part of the antenna gains of UE transmitter and/or receiver in the coverage analysis.* Note: Nominal UE antenna gain is assumed as 0 dBi when antenna radiation efficiency is reflected in the reported antenna gain.
 |
| CATT | Fine with the proposal. |
| Samsung | ok |
| DOCOMO | Agree with the proposal |
| Lenovo, Motorola Mobility | Fine with the proposal |
| Panasonic | We are not sure whether RAN1 needs to discuss antenna gain loss caused by the device size limitation. If x is coming from RAN4, we are ok. |
| OPPO | Antenna efficiency is good term. It is general enough and should not be very accurately stated as companies may have some reasonable difference. We support this proposal. We understand this also encourage companies converge on the number of dBs. |
| LG | Okay with the proposal. For now for evaluation purposes, the potential reduced antenna efficiency due to compact form factor with the limits on the maximum loss as suggested by the proposal seems enough. Regarding the additional aspects or mechanisms causing the antenna efficiency and not clear yet, we may leave them for further study.  |
| Sequans | We are fine with the proposal as it is. |
| MediaTek | We are not supportive of the proposal.* It is not clear what would be the expected outcome for considering antenna loss caused by the small form-factor. Is the plan to compensate for such antennal loss?

This is not aligned with the SI scope. The SID specifically describes that: *“Study functionality that will enable the performance degradation of such complexity reduction to be mitigated or limited, including [RAN1]:** *Coverage recovery to compensate for potential coverage reduction due to the device complexity reduction.”*
* We acknowledge that there could be some inefficacies for the antennas and the RF-front-end due to the small form factor. However, these inefficacies are not limited to wearables, and other 5G devices could have similar issues. Thus, this issue is not concerning only RedCap devices. Accordingly, any coverage compensations for the inefficacies of the antennas and RF-front-end could be addressed by CE SI if needed.
* Also, as highlighted by Panasonic, the antenna gain loss caused by size limitation should be discussed by RAN4.
 |
| FUTUREWEI | Nice to have but ok to wait if not agreed today and consider if this SI in RAN1 is the best place for it. Huawei’s revisions are ok. |
| Nokia, NSB | We do not agree with the proposal.We are not sure what is the purpose of including potential reduced antenna radiation efficiency for wearables in the coverage analysis. Coverage recovery study is intended to compensate for reduced complexity, not for device size limitations. Therefore, this does not seem to be in the SI scope. |
| InterDigital | We are fine with the proposal. |
| SONY | Agree with the proposal. We think that RAN1 should be considering aspects of smaller form factor in this study. The battery in a UE contributes to UE cost / complexity, as well as size. Reducing battery size would lead to a lower cost / complexity UE. The battery size is going to depend in part on UE antenna efficiency. The SI also has an objective on studying battery life enhancement, where we have goals of battery lifetimes in the justification section of the SID (several years for IWS, up to 1-2 weeks for wearables. We need to have some idea of antenna efficiency to estimate battery lifetime. Hence we think that UE antenna efficiency is very much one of the aspects that should be taken into consideration in the study and is in line with the SI justification and objectives.In terms of the coverage analysis itself, we would also be OK with the antenna efficiency being a separate term (separate from the antenna gain), but this isn’t a hugely important point as the impact on the link budget should be the same however the antenna efficiency is accounted for. |
| Apple | Agree with proposal We see it as a key design challenge for the wearable device category. It was also specifically emphasized in the SID “One characteristic for the use case is that the device is small in size.” |
| CMCC | Fine with the proposal. In addition, the reduced antenna efficiency [x] Db should be clarified to be included in LLS or in link budget. |
| China Telecom | Fine with the proposal. |
| Spreadtrum | Fine with the proposal. |

## 7.4 Half-duplex FDD operation

Based on some comments in Section 9 in [3], it seems that although some aspects of the guard times for HD-FDD operation should probably be discussed in RAN4, it should be possible for RAN1 to do some initial cost/complexity analysis, as was done in the LTE MTC SI for TR 36.888.

**Proposal 26:** Study HD-FDD operation Type A and Type B, where study of Type A is prioritized.

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| **Company** | **Comments** |
| Qualcomm | We think the HD-FDD operation for RedCap UE can be studied in RAN1, and RAN1 can assume specific DL-to-UL switching time and UL-to-DL switching time based on previous 3GPP studies for LTE HD-FDD.Therefore, we suggest the following changes to Proposals 26:**Proposal 26: Study HD-FDD operation Type A and Type B in RAN1, where study of Type A is prioritized.** |
| Ericsson | Support proposal 26. |
| ZTE,Sanechips | Support. |
| Intel | Fine with the proposal as is. |
| Sierra Wireless | Agree with proposal |
| vivo | Fine with the proposal |
| Huawei, HiSilicon | Fine with the proposal. But we don’t feel the switching time can be arbitrarily determined by RAN1 now. |
| CATT | Fine with the proposal |
| Samsung | Ok in general. Some clarifications on definition of Type A and Type B HD-FDD are suggested: **Proposal 26:** Study HD-FDD operation Type A and Type B as defined in LTE MTC, where study of Type A is prioritized. |
| DOCOMO | Agree with the proposal |
| Lenovo, Motorola Mobility | Fine with the proposal. One thing noticed is that as defined in 36.306, the LTE Cat.1bis UEs support type A operation type. Therefore, with this proposal 26, it comes to the question again how to interpret the SID note that RedCap UE capability shall be no less than Cat.1bis.  |
| Panasonic | OK |
| OPPO | Fine with the proposal. |
| LG | Okay with the proposal as it is. |
| Sequans | We are fine with the proposal. Also no problem to clarify study in RAN1 although we think that intro comment from Rapporteur is clarifying enough. |
| MediaTek | Support the proposal. |
| FUTUREWEI | Lenovo makes a good point. We can study “at least” type A, or type A with type B FFS. Type B will also be harder to use for the delay sensitive applications if we want to reduce number of devices. |
| Nokia, NSB | We are fine with the proposal |
| InterDigital | We are fine with the proposal. |
| SONY | Agree with the proposal. |
| CMCC | Fine with the proposal. |
| China Telecom | Fine with the proposal. |
| Spreadtrum  | Fine with the proposal. |

# 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)