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 3)**

**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 both categories of *Medium propriety* proposals listed above 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.

The agreements quoted in this document are from *‘Chairman's Notes RAN1#101-e v030’*. The SI CE agreements are listed in the appendix in the end of this document, and they have been tagged with *CE01*, *CE02*, etc. so that they can be referred to from other sections in this document.

# 6 Evaluation methodology

## 6.1 Evaluation methodology for UE complexity reduction

Regarding Proposal 9, in the email discussion [101-e-Post-NR-RedCap], the comments concern the band and duplex support for the reference NR device. The proposal below has been updated to reflect that the reference NR device is only expected to operate in a single band at a time, and that for each complexity reduction technique, the study includes whether the complexity reduction accumulates across RF bands.

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: Operation in a single FDD band or a single TDD band at a time
  + FR2: Operation in a single TDD band at a time
* 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

Note: For each complexity reduction technique, the study includes whether the complexity reduction accumulates across RF bands.

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| **Company** | **OK with Proposal 9 (Y/N)** | **Comments** |
| FUTUREWEI | Y | The Note is important. |
| Sierra Wireless | Y | Proposal looks good, the note is important to us. |
| Ericsson | Y |  |
| SONY | Y | The intention of the “band and duplex mode support” is not exactly clear. It seems to say two things:   * FR1 supports FDD and TDD; FR2 supports TDD * Inter-band carrier aggregation is not supported   It doesn’t really say anything about whether a UE supports multiple bands and any multi-band analysis is left to the note.  If this is the meaning, we are OK with it.  It is also not clear what “2RX antennas” means for FR2. Does it mean there is one antenna panel with 2 elements? Does it mean that there are two antenna panels? Does the number of FR2 antennas indicate something about the number of antenna ports? |
| ZTE,Sanechips | Y with wording change for the note | Prefer to change the note to : The study will consider impacts from multiple RF bands on the cost/complexity reduction technique. |
| Qualcomm | Y |  |
| Nokia, NSB | Y |  |
| Rapporteur |  | Regarding Sony’s comments above:  For FR1, it is correct that the proposal does not say anything about whether the UE supports multiple bands and any multi-band analysis is left to the note.  For FR2, “2Rx antennas” means 2 Rx branches, without saying anything explicitly about how the antennas are implemented. |
| China Telecom | Y |  |
| DOCOMO | Y |  |
| OPPO | Y | The note for complexity accumulating among band is good to us, except it should be “In a frequency range”. We don’t see the possibility of RF sharing among FR1/FR2. |
| Samsung |  | Clarification question on the assumption on FR1: since antennas assumption is different, with current proposal, the reference UE needs to be able to support both FDD and TDD band but only required to operate in one band at a time. So, minimal requirement is 4Rx for hardware cost break down, is this correct?  For the understanding on the note, we share the same understanding from ZTE and Sony, which is different from Sierra wireless. But we can figure out how to capture it on TR later. |

## 6.2 Evaluation methodology for UE power saving

The following proposals have been agreed:

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| Proposal 14: For wearables, 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. Values are FFS.  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 UL message (plus headers, e.g. MAC, RLC, etc.) transmitted periodically with a periodicity [100 ms] should be considered (other values are not precluded). |

For the FFS in the agreed Proposal 14, some related aspects are treated in the previous section on coverage evaluation, and further discussion and agreements can take place in the next RAN1 meeting.

For the square brackets in the agreed Proposal 15, in the email discussion [101-e-Post-NR-RedCap], one comment proposed to encourage study of periodicities in the range 50 ms to 500 ms.

Proposal 15a: Replace the agreement corresponding to Proposal 15 with the following: 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 UL message (plus headers, e.g. MAC, RLC, etc.) transmitted periodically with a periodicity 100 ms should be considered (other values between 50 ms and 500 ms are encouraged).

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| **Company** | **OK with Proposal 15a (Y/N)** | **Comments** |
| FUTUREWEI | Y | Not so important to make the agreement, but OK |
| Sierra Wireless | Y |  |
| Ericsson | Y | We are fine with removing the brackets. We are fine with or without the update in the parentheses. |
| SONY | Y | As an aside, we had understood that proposals 14 and 15 applied just to the evaluation methodology for UE power saving. However the chairman’s notes don’t have a restriction to the UE power saving evaluation methodology and hence proposal 14 and 15 seem to be applicable to the whole RedCap study. This seems unfortunate. |
| ZTE,Sanechips | Y |  |
| Qualcomm |  | We are fine with or without the update in Proposal 15a. In addition, 5-10 ms should also be included, as mentioned in the SID. |
| Nokia, NSB | Y |  |
| Rapporteur |  | Regarding Sony’s comment above:  Yes, indeed these proposals were intended to concern evaluation methodology for UE power saving, and perhaps it would be a good idea to clarify that. I can bring it up in the next round of potential proposals for endorsement in the email thread. I’ll try to check whether there is a similar issue for other agreements, i.e. that the context for the agreement might be unclear in the session notes. |
| China Telecom | Y |  |
| DOCOMO | Y |  |
| OPPO | Y |  |
| Samsung | Y |  |

## 6.3 Evaluation methodology for coverage recovery

Proposal 16 in [3] concerned overall coverage evaluation methodology. Related to overall coverage evaluation methodology, the CI SE has made agreements CE03 and CE11 (see appendix).

**Question 16: Should the RedCap SI adopt CE SI agreements CE03 and CE11 regarding overall coverage evaluation methodology?**

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| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | Y if modified | The questions seem to assume that we are going to replicate the entire cov enh study in redcap, checking whether we “adopt” or not each and every agreement they make, then running all of the full evaluations for all of the redcap applications. It may be a bit much to start down this path during this endless e-meeting, it may be better to agree to high level principles first.  In our view, we can wait and let the CE study progress, and then see what we can learn in the context of that study (about e.g. limiting channels). We may also be able to see what happens if everything else was the same as in the CE SI with the only change being e.g. 20MHz BW or reduced number of antennas at the UE. Then we can decide if we need or should do full blown redcap specific evaluations to duplicate the CE SI for all the redcap applications.  We may be able to easily reevaluate or estimate based on the initial results from CE SI. The modification to the question 16 is to add “If evaluations outside the CE SI are needed, …” |
| Sierra Wireless | Y if modified | Agree with Futurewei, we should not replicate the entire CE SI in RedCap. We can wait for both the CE SI and the RedCap SI to progress before determining if and what is needed. CE SI has 20MHz as part of the evaluation, perhaps CE SI can add 1Rx, can minimize RedCap work.  We are Ok with Futurewei suggestion. |
| Ericsson | Y | It is good to align the baseline CE methodology as much as possible so that we can reuse the findings from the CE study when applicable. However, we expect RedCap specific evaluations are needed. The same methodology as described in CE03 and CE11 can be adopted. So we propose the following revision – adding “If and when evaluations outside the CE SI are needed, …” |
| SONY | Y | The basic CE SI methodology (CE03) to determine coverage is to use a link budget with a required SINR that is determined by LLS. This seems to be a standard way of determining coverage and we don’t see why or how we would deviate from this in RedCap |
| ZTE,Sanechips | Modify | * The basic evaluation methodology is based on link-level simulation for FR1.   + Step 1: Obtain the required SINR for the physical channels under target scenarios and service/reliability requirements.   + Step 2: Obtain the baseline performance based on required SINR and link budget template.   + Note: aspects related to identifying target performance and coverage bottlenecks based on target performance metric is to be handled separately * ~~The evaluation methodology based on system-level simulation is optional for FR1.~~   + ~~Note: The simulation assumptions for SLS are up to companies’ reports.~~ * The evaluation methodology for FR2 is the same as FR1.   In general we think this very high level of coverage evaluation methodology can be used . But we don’t think SLS is needed , especially considering the available time left. Ok with other parts.  More importantly we need to examine the techniques used for cost/complexity reduction (this implied we have reached some minestrone in that aspects )  Remember the difference for RedCap SI is here coverage recovery is based on the loss from the cost/complexity reduction, therefore we need to fist have a clear picture of what is the loss. |
| Qualcomm | Y |  |
| Nokia, NSB | Y |  |
| China Telecom | Y | Agree with Ericsson. |
| DOCOMO | Y | We think it is beneficial to align the evaluation methodology with CE SI to use/refer their result for RedCap. It is also fine to add texts proposed by FUTUREWEI and Ericsson. |
| OPPO | Y | The coverage evaluation methodology is commonly used. Good to be agreed on to make evaluation. Other change can be considered later. |
| Samsung | Y | Although we agree to adopt the methodology used in CE SI and adopt the agreements CE03 and CE11 in the RedCap SI, this does not mean that we agree to evaluate all channels that will be evaluated in CE SI.  We also fine with adding “If and when evaluations outside the CE SI are needed, …” |

Proposal 17 in [3] concerned what signals, channels and messages to include in the coverage evaluation. The CE SI agreements (see appendix) concern evaluation of at least PDSCH, PUCCH, PUSCH and Msg3. Since the RedCap SI includes study of techniques such as reduced UE bandwidth, it may be useful to additionally include PDCCH, PBCH, SIB1, Msg2 and Msg4 in the RedCap coverage evaluation.

**Question 17: Should the RedCap SI coverage evaluation include PDSCH, PUCCH, PUSCH and Msg3 and in addition include PDCCH, PBCH, SIB1, Msg2 and Msg4?**

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| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | N | Again reuse as much as possible from the CE SI, close coordination is required; CE SI already includes Msg3, expanding beyond is not essential. |
| Sierra Wireless | N | Need to wait for CE SI to progress and the RedCap SI to decide on the techniques. The CE SI may not focus the channels that RedCap would need to do, but perhaps CE SI can be asked to add these channels to the CE evaluations, can minimize RedCap work. |
| Ericsson | Y | In general, evaluating DL performance is important for RedCap considering that reducing number of UE antennas is a cost/complexity reduction technique to be studied. So, we think there is a value in including PDCCH, PBCH, SIB1, Msg2 and Msg4, in addition to PDSCH, which is already considered in the CE study. In FR2, it is important to assess the performance loss in PBCH and PDCCH when the UE maximum bandwidth is 50 MHz.  There are ongoing discussions in the CE study on the simulation assumptions for SSB, PDCCH, Msg-2, Msg-4, and PRACH. |
| SONY | Y | The channels that are evaluated can depend on the complexity reduction technique. E.g. for a complexity reduction technique that affects the UL (e.g. lower TX power), the DL channels would not need to be evaluated.  If RedCap refers to results in the CE SI, we would still consider those results to have been evaluated in RedCap (just be reference in this case). |
| ZTE,Sanechips | FFS | This two study items have two different targets, while the CE SI is trying to enhance the coverage, in RedCap SI the target is to recover the coverage due to cost/complexity reduction. Therefore FFS is needed to see if PDCCH, PBCH, SIB1, Msg2 and Msg4 need to be included. |
| Qualcomm | Partially Y | The UE complexity reduction impacts downlink coverage more than uplink. On the other hand, both the DL and UL coverage of wearable device may be impacted by reduced antenna efficiency incurred by small form factor.  Therefore, we support the evaluation planned for PDSCH, PUCCH, PUSCH, msg3, PDCCH, SIB1, msg2 and msg4. We don’t think the evaluation for PBCH is needed, if RedCap UE reuses the R15 SSB design. |
| Nokia, NSB | Y | We think at least PDCCH and PBCH need to be included. SIB1 may also be needed as the size could be large and thus impacted by bandwidth limitation. |
| China Telecom | Y | As ZTE’s comments, the two study have two different targets, due to the cost/complexity reduction, we need to consider more evaluaition. |
| DOCOMO | Y | Including the CHs outside CE SI scope is necessary for RedCap as it is not clear which CH is the bottleneck in RedCap. |
| OPPO | Y | We see some independent evaluation is needed for the SI dealing with complexity reduction. |
| Samsung | N | We should first identify which channel may be impacted by the cost reduction techniques, then decide whether to evaluate it or not. |

Proposal 18 in [3] concerned simulation assumptions, quality targets and performance metrics. Related to quality targets, the CE SI has made agreements CE01, CE14 (*‘BLER for PUSCH’* field) and CE15 (*‘BLER for PUCCH’* field) for FR1 and CE17 for FR2 (see appendix).

**Question 18a: Should the RedCap SI adopt CE SI agreements** **CE01, CE14 (*‘BLER for PUSCH’* field) and CE15 (*‘BLER for PUCCH’* field) for FR1 and CE17 for FR2 regarding quality targets?**

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| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | wait | See Q16, may not want to go this route. If eval outside CE is needed, reuse as much as possible from the CE SI including the BLER |
| Sierra Wireless |  | Wait for RedCap SI to progress further to see if it is needed. |
| Ericsson | Y/N | N: CE01, CE17  The target data rates are fine for reference UEs. But target data rates should be lower for RedCap UEs. Cell edge data rate is determined by the spectral efficiency achievable at cell edge. We think the same cell-edge spectral efficiency can be assumed for RedCap. However, for cell-edge data rates, adjustments shall be made to account for RedCap UEs having reduced bandwidth. Also if RedCap UEs have reduced number of Rx antennas, it cannot be expected that the RedCap UEs will have the same spectral efficiency as the reference UE.  Furthermore, the CE agreements include several scenarios. For FR1, the RedCap study can focus on Urban and Rural scenarios. For FR2, the RedCap study can focus on Indoor and Urban scenarios.  Y: CE14 (‘BLER for PUSCH’ field) and CE15 (‘BLER for PUCCH’ field) |
| SONY | Y | CE01: Although the CE01 data rates are different to the “reference bits rates” in the Redcap SID, we are OK studying the data rates at CE01 (assuming that the coverage recovery needed at the CE01 data rates is similar to that required at the reference bit rates from the RedCap SID).  CE14: We are OK evaluating PUSCH at an iBLER of 10% but think that a higher iBLER could be a more optimal operating point in a coverage limited situation. As long as “before” and “after” coverage recovery are simulated at the same iBLER, we think that the coverage recovery conclusions should be valid. |
| ZTE,Sanechips | N | This two study items has two different targets, different use case (eMBB+ VoIP vs Industrial wireless sensors+ Video Surveillance + Wearable )  For CE1 , we think first discuss the scenario for the RedCap use cases, then we can discuss the target data rates.  For scenario, our proposal is the following:    CE14 and CE15 target different scenario and data rate , as compare with RedCap SI. We may adopt some of the parameter in the agreement, but certain some very important parameter, for example , reference data rates etc , will be different. FFS if eMBB/VoIP are used as two targeted traffic types. |
| Qualcomm | Y | The target data rates for evaluation shall consider the use cases of NR RedCap, and thus can be different from that assumed in the CE study.  It is okay to use BLER as a performance metric for PUSCH, PUCCH, PDSCH and PDCCH.  For FR1, it is fine to re-use the assumption in CE01.  For FR2, data rates in CE17 agreement are only representative of one use case (wearables), while the other two use cases are not covered. We propose to consider the other use cases and add them to the target data rates. |
| Nokia, NSB |  | No on CE01 and CE17 as we think these may not be typical cell edge data rates for RedCap.  We don’t have a strong view on CE14 and CE15. |
| China Telecom | Y | But target data rates can not meet all our use case. |
| DOCOMO | N | As we don’t have any agreement on the evaluation scenarios for RedCap coverage recovery, we think it should be discussed at first whether or not the evaluation scenarios for CE SI (Urban/Rural for FR1 and Indoor/Urban/Suburban for FR2, eMBB and VoIP traffic) can be assumed for RedCap as well.  CE01: If the evaluation scenarios are agreed to be same as CE SI, we are fine to adopt CE01 for RedCap.  CE14: If the evaluation scenarios are agreed to be same as CE SI, we are fine to adopt 2% rBLER.  CE15: We are fine to adopt BLER for PUCCH formats 1/3 in CE15 for FR1. BLER for PUCCH for FR2 should be further discussed considering beam-based operation and PUCCH formats 0/2.  CE17: The target data rate is not necessarily higher than the reference bitrate (2-4 Mbps for video surveillance, 10-50 Mbps in DL and minimum 5 Mbps in UL for wearables), DL 10 Mbps and UL 2 Mbps would be enough in the cell edge for FR2. |
| OPPO | N | No for CE01&17, others may need some modification. The scenarios are different. |
| Samsung | N | First of all, we need to understand whether any cost reduction technique will have impact on PUSCH and PUCCH.  If the impact is agreed, the target data rate of PUSCH should be much lower than in the agreement of CE01 and CE17. In Redcap SI we should use the parameter values of the Redcap use cases.  If some channels with the set up that would have been used in Redcap study have already been evaluated in CE SI, we should leverage such evaluation and don’t duplicate the work in Redcap SI. |

Related to common PUSCH/PUCCH link-level simulation assumptions for FR1, the CE SI has made agreements CE04 and CE16 (see appendix).

**Question 18b: Should the RedCap SI adopt CE SI agreement CE04 and CE16 regarding common PUSCH/PUCCH link-level simulation assumptions for FR1?**

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| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | wait | See Q16, may not want to go this route. Reuse as much as possible CE SI, the assumptions for the common control seem to be reasonable for redcap too. If further evaluations are needed this could be done after examining the outcome of the CE SI |
| Sierra Wireless |  | Wait for RedCap SI to progress further to see if it is needed. |
| Ericsson | Y (w/comments) | Yes, but some RedCap specific focus is beneficial.   * BWP should be 20 MHz in all cases regardless of the band * “UE velocity”: focus on 3 km/h regardless of the scenario   Additionally, to make the work more manageable we suggest   * “Frame structure for TDD“: Among the two TDD patterns for 4 GHz, focus on DDDSUDDSUU (S: 10D:2G:2U). The other TDD pattern has a similar DL-to-UL ratio as the pattern chosen for 2.6 GHz and in our view does not add much further insight. * “Channel model for link-level simulation”: focus on TDL channel models * “Scenario and frequency”: it is not necessary to study all the frequency bands listed in the CE agreement for each scenario. We propose to priority the 4 GHz (TDD) option for the Urban scenario and 700 MHz (FDD) option for the Rural scenario. * “PRBs/MCS for VoIP for PUSCH”: focus on QPSK |
| SONY | N | There are many permutations and combinations in CE04 and CE16. The RedCap study is about complexity reduction, where one aspect is coverage recovery. Hence we should not aim to overcomplicate the coverage recovery evaluation.  We should aim for one scenario, one frame structure, one pathloss model etc. |
| ZTE,Sanechips | N | CE4 and CE15 target different scenario and data rate , as compare with RedCap SI. We may adopt some of the parameter in the agreement, but certain some very important parameter, for example , reference data rates etc , will be different.  We think indoor/indoor hotspot scenarios need to be included in the current CE4 agreement for RedCap. Some of the parameter can be simplified.  BWP/SCS and other details parameter need to discussed further, maybe depend on the discussion result from step 1 and step 2. |
| Qualcomm | Y | For CE04, the BWP bandwidth needs to be adjusted for RedCap, e.g. changed from 100MHz to 20MHz. |
| Nokia, NSB | N | I think there are too many scenarios and we don’t need to evaluate them all. Potentially we can focus on perhaps only 1 or 2 of the options from CE04 and CE16. |
| China Telecom | Y | We don’t need to reuse the agreement completely, we need to discuss which parameters can be adopted for our use case. |
| DOCOMO | N | As we don’t have any agreement on the evaluation scenarios for RedCap coverage recovery, we think it should be discussed at first whether or not the evaluation scenarios for CE SI (Urban/Rural for FR1 and Indoor/Urban/Suburban for FR2, eMBB and VoIP traffic) can be assumed for RedCap as well.  If (some parts of) same evaluation scenarios are agreed for RedCap, we can follow the corresponding parameters, except for 100 MHz BWP for 2.6/4 GHz which would be applicable to reference UE but not to RedCap UE. |
| OPPO | N | We need to down size the parameters. BW and others are higher in CE. |
| Samsung | N | Same as comments above, we need to understand whether any cost reduction technique will have impact on PUSCH and PUCCH.  For CE16, since the target bit rate may be different, the occupied BW should be different.  For CE04, at least the FH need to be reviewed, as well as bandwidth of BWP. |

Related to PUSCH-specific link-level simulation assumptions for FR1, the CE SI has made agreement CE14 (see appendix).

**Question 18c: Should the RedCap SI adopt CE SI agreement CE14 (except the *‘BLER for PUSCH’* field which is treated in Question 18a) regarding PUSCH-specific link-level simulation assumptions for FR1?**

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| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | wait |  |
| Ericsson | Y | To make the work more manageable we suggest   * “Number of UE transmit chains for PUSCH”: focus on 1 UE transmit chain * “DMRS configuration for PUSCH”: focus on the configuration corresponding to 3 km/h. * “Repetitions for PUSCH”: in the eMBB case, focus on “w/o repetition as baseline”. |
| SONY | N | Reduce number permutations from CE SI. |
| ZTE,Sanechips |  | Similar to answers in 18b/a |
| Qualcomm | Y |  |
| Nokia, NSB | N | There are too many scenarios here and we prefer to focus only on 1 or 2 configurations to evaluate. |
| China Telecom | Y |  |
| DOCOMO | N | As we don’t have any agreement on the evaluation scenarios for RedCap coverage recovery, we think it should be discussed at first whether or not the evaluation scenarios for CE SI (Urban/Rural for FR1 and Indoor/Urban/Suburban for FR2, eMBB and VoIP traffic) can be assumed for RedCap as well.  If (some parts of) same evaluation scenarios are agreed for RedCap, we can follow the corresponding parameters, except for 2Tx (optional) which is not applicable to reference UE or RedCap UE. |
| OPPO | Further discussion |  |
| Samsung | N | Same as comments above, we need to understand whether any cost reduction technique will have impact on PUSCH. |

Related to PUCCH-specific link-level simulation assumptions for FR1, the CE SI has made agreement CE15 (see appendix).

**Question 18d: Should the RedCap SI adopt CE SI agreement CE15 (except the *‘BLER for PUCCH’* field which is treated in Question 18a) regarding PUCCH-specific link-level simulation assumptions for FR1?**

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| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | wait |  |
| Ericsson | Y | But, only focus on the mandatory cases chosen in the CE agreements, i.e., focus on the no repetition case. |
| SONY | N | Reduce number permutations from CE SI. |
| ZTE,Sanechips |  | Similar to answers in 18b/a |
| Qualcomm | Y |  |
| Nokia, NSB | N | There are too many scenarios here and we prefer to focus only on 1 or 2 configurations to evaluate. |
| China Telecom | Y |  |
| DOCOMO | Y |  |
| OPPO | Y |  |
| Samsung | N | Same as comments above, we need to understand whether any cost reduction technique will have impact on PUCCH. |

Related to Msg3-specific PUSCH link-level simulation assumptions, the CE SI has made agreements CE08 and CE10 (see appendix).

**Question 18e: Should the RedCap SI adopt CE SI agreement CE08 and CE10 regarding Msg3-specific PUSCH link-level simulation assumptions?**

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| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | wait | Recommendation is to look at the outcome of the CE SI and decide later if any further evaluation and/or modifications related to redcap are necessary |
| Ericsson | Y |  |
| SONY | Y |  |
| ZTE,Sanechips | FFS | Need to take into account the discussion result from step1/2 |
| Qualcomm | Y |  |
| Nokia, NSB | Y |  |
| China Telecom | Y |  |
| DOCOMO | Y |  |
| OPPO | Y |  |
| Samsung | N | Same as comments above, we need to understand whether any cost reduction technique will have impact on PUSCH with Msg3. |

Related to VoIP-specific link-level simulation assumptions, the CE SI has made agreements CE02 and CE09 (see appendix).

**Question 18f: Should the RedCap SI adopt CE SI agreement CE02 and CE09 regarding VoIP-specific link-level simulation assumptions?**

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| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | wait | Recommendation is to look at the outcome of the CE SI and decide later if any further evaluation and/or modifications related to redcap are necessary |
| Ericsson | Y |  |
| SONY | N | We can draw conclusions from eMBM performance in RedCap and do not need to additionally consider VoIP. |
| ZTE,Sanechips | FFS | Need to discuss if VoIP is one required service type for RedCap UE. |
| Qualcomm | Y |  |
| Nokia, NSB | FFS | We don’t think VoIP evaluation is necessary but it can be further discussed. |
| China Telecom | Y |  |
| DOCOMO | N | As we don’t have any agreement on the evaluation scenarios for RedCap coverage recovery, we think it should be discussed at first whether or not the evaluation scenarios for CE SI (Urban/Rural for FR1 and Indoor/Urban/Suburban for FR2, eMBB and VoIP traffic) can be assumed for RedCap as well.  If VoIP traffic is adopted for one of the evaluation scenarios for RedCap, we can follow the corresponding parameter. |
| OPPO | Y |  |
| Samsung | N | We need to first discuss whether or not, and which case need to support VoIP.  In addition, same as comments above, we need to understand whether any cost reduction technique will have impact on PUSCH. |

Related to PDSCH-specific link-level simulation assumptions for FR1, the CE SI has made agreement CE07 (see appendix).

**Question 18g: Should the RedCap SI adopt CE SI agreement CE07 regarding PDSCH-specific link-level simulation assumptions for FR1?**

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| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | wait | Recommendation is to look at the outcome of the CE SI and decide later if any further evaluation and/or modifications related to redcap are necessary |
| Ericsson | Y | What has been captured in this agreement looks fine. However, there are more details needed. More proposals on PDSCH simulation assumptions are currently being discussed in the CE email discussion. |
| SONY | Wait | Depends on what is included in the FFS of CE07. Apart from the FFS, the other aspects of CE07 seem OK for RedCap |
| ZTE,Sanechips | FFS |  |
| Qualcomm | Y | The simulation assumptions for PDCCH and msg2 should also be addressed. |
| Nokia, NSB | Y |  |
| China Telecom | Y |  |
| DOCOMO | Y |  |
| OPPO | Y |  |
| Samsung | N | Same as comments above, we need to understand whether any cost reduction technique will have impact on PDSCH.  If PDSCH is agreed to be evaluated, CE07 is ok to be adopted. |

Related to common PUSCH/PDSCH link-level simulation assumptions for FR2, the CE SI has made agreement CE13 (see appendix).

**Question 18h: Should the RedCap SI adopt CE SI agreement CE13 regarding common PUSCH/PDSCH link-level simulation assumptions for FR2?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | wait | Seems to be reasonable |
| Ericsson | Y | To make the work more manageable we suggest   * “UE velocity”: prioritize 3 km/h * “Occupied channel bandwidth”: prioritize 100 MHz |
| SONY | N | Reduce number permutations from CE SI. |
| ZTE,Sanechips | FFS | It’s better to have different UE velocity based on the use case (in CE it is based on scenarios)  Occupied channel bandwidth need result from step1/2. |
| Qualcomm | Y | Change the BW to 50 and 100 MHz per the agreement made for RAN1#101e. |
| Nokia, NSB | N | There are too many scenarios here and we prefer to focus only on 1 or 2 configurations to evaluate. |
| China Telecom | Y | The occupied channel bandwidth is 100MHz, and we also need to consider 200MHz. |
| DOCOMO | N | As we don’t have any agreement on the evaluation scenarios for RedCap coverage recovery, we think it should be discussed at first whether or not the evaluation scenarios for CE SI (Urban/Rural for FR1 and Indoor/Urban/Suburban for FR2, eMBB and VoIP traffic) can be assumed for RedCap as well.  If (some parts of) same evaluation scenarios are agreed for RedCap, we can follow the corresponding parameters, except for [400 MHz] which is not applicable to reference UE or RedCap UE. |
| OPPO | N | Need discussion for RedCap configuration. |
| Samsung | N | Same as comments above, we need to understand whether any cost reduction technique will have impact on PDSCH/PUSCH  If PDSCH /PUSCH is agreed to be evaluated, CE03 is ok to be adopted except for the occupied BW. |

Proposals 19 and 20 in [3] concerned link budget methodology. Related to link budget methodology, the CE IS has made agreements CE05, CE06 and CE12 (see appendix).

**Question 19: Should the RedCap SI adopt CE SI agreements CE05, CE06 and CE12 regarding link budget methodology?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| FUTUREWEI | wait | General recommendation is to use the IMR 2020 self evaluation + the evaluations from the CE SI first before performing any link budget analysis. If there is any need for further evaluations this could be done after we examine the outcome of the CE SI |
| Ericsson | wait | We can wait for the CE study to down select among the 3 options in CE05. |
| SONY | N | There are too many FFS in CE05 / CE06 / CE12. How can we be sure that these agreements are appropriate for RedCap without having some indication of how the FFS will be resolved? |
| ZTE,Sanechips | FFS | More importantly we need to examine the techniques used for cost/complexity reduction (this implied we have reached some minestrone in that aspects )  Remember the difference for RedCap SI is here coverage recovery is based on the loss from the cost/complexity reduction, therefore we need to fist have a clear picture of what is the loss. |
| Qualcomm | Y |  |
| Nokia, NSB | wait |  |
| China Telecom | Y |  |
| DOCOMO | Y | But we can wait for CE SI down selection. |
| OPPO | Y |  |
| Samsung | - | We agree to adopt the link budget methodology from CE SI in general, but we think we need to further discuss the methodology based on the final option in next meeting instead. Agreeing to these several options now means to duplicate the discussions in the two SIs. |

## 6.4 Evaluation methodology for other performance impacts

Regarding Proposal 21, in the email discussion [101-e-Post-NR-RedCap], two comments proposed to add reliability with similar importance as latency.

Proposal 21: The evaluation of performance impacts includes at least peak data rate, latency and reliability. Other performance metrics such as power consumption, spectral efficiency and PDCCH blocking probability may also be considered if appropriate for a specific technique.

|  |  |  |
| --- | --- | --- |
| **Company** | **OK with Proposal 21 (Y/N)** | **Comments** |
| FUTUREWEI | Weak Y | Nothing against reliability, but getting a bit frustrated with this email discussion as it is not clear at all what criteria is being used to add things to the first list and the second list. Given the last minute addition perhaps the second list is more appropriate for reliability. Or just drop till the next meeting. |
| Sierra Wireless | Y | We would like to see that these are studied together, not individually, as they do have some interdependent tradeoffs. |
| Ericsson | Y |  |
| SONY | Y |  |
| ZTE,Sanechips | FFS | Need to understand how reliability is going to be used in the evaluation. Maybe it’s better to include it in the ‘other’ performance metric for now. |
| Qualcomm | Partially Y | We don’t think reliability needs to be evaluated for all use cases of RedCap UE, unless there is a consensus on the definition and requirement for“reliability. |
| Nokia, NSB | Y |  |
| China Telecom | Y |  |
| DOCOMO | Y |  |
| OPPO | Y |  |
| Samsung | Y |  |

# 7 UE complexity reduction features

## 7.6 Relaxed UE processing capability

Regarding Proposal 30, in the email discussion [101-e-Post-NR-RedCap], several replies expressed that they want to include reduction of number of HARQ processes in the bullet list, and some replies expressed that they also want to include reduction of max TBS, whereas one reply expressed that neither one of these two should be included. Based on this, the updated proposal below includes the two bullets but with an FFS, which should be interpreted as it is for further study whether the list of peak data rate relaxation techniques that the study should at least focus on includes these two techniques or not.

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

* Reducing the maximum number of MIMO layers
* Maximum modulation order restriction
* Reduced number of HARQ processes (FFS)
* Reduced max TBS (FFS)

|  |  |  |
| --- | --- | --- |
| **Company** | **OK with Proposal 30 (Y/N)** | **Comments** |
| FUTURWEI | Weak Y | Strong concern about this objective and workload, should not be a ‘blank check’. Preference is only the first bullet on max MIMO layers. Not preferred but can accept max modulation order restriction, though would be better to include exactly which currently mandatory modulations we are considering to make optional (e.g., 256QAM DL and 64QAM UL in FR1) to avoid to avoid arguing later about whether or not we should study all possible combinations including 16QAM, QPSK, or pi/2-BPSK only devices types. For the last two bullets, there will be a lot of effort to include these in the TR as they depend very much on defining exact data rates for all the applications. Not as simple as just including “1000” for LPWA in LTE MTC. Technically, the gains for these will be limited as BW reduction and antenna reduction will already reduce the “processing”, TBS sizes, and HARQ memory. These should only be considered time permitting and after the main techniques are completed.  OK also to drop the discussion till next meeting, we have enough more important things that we need to progress and there is a chance we could clarify this at RAN. |
| Sierra Wireless | Y with change | We agree with the FFS for the last two items. We assume that the FFS is for the entire line and not just FFS on the details. We would like the FFS to be clearer:   * FFS: Reduced number of HARQ processes * FFS: Reduced max TBS |
| Ericsson | Y | We support the new formulation. |
| SONY | Y but restructure proposal | The whole bulleted list should be studied with equal priority.  The bullet on “reduced number of HARQ processes” shouldn’t be a sub-bullet of peak data rate relaxation, it should be a standalone bullet. We understand that the peak data rate would be measured in a TTI and not across a suite of HARQ processes. Hence reduction of number of HARQ processes does not relax peak data rate.  We think it is important that RAN1 identifies and studies potential complexity reduction techniques, one technique of which is surely reduction of number of HARQ processes. “Identify and study” is the first objective in the SID. |
| ZTE,Sanechips | Y |  |
| Qualcomm | Y |  |
| Nokia, NSB | Y |  |
| China Telecom | Y |  |
| DOCOMO | Y | We are fine to put FFS for progress |
| OPPO | Y, But removed the FFS. | It is not clear for FFS some scheme. For the study item, even thing should be treat equally for study, as long as it is in the scope. The main bullet is study the list. Putting FFS, it is still mean study the things. |
| Samsung | Y |  |

# 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)

# Appendix: CE SI agreements

The CE SI agreements quoted in this appendix are from *‘Chairman's Notes RAN1#101-e v030’*. Change tracking such as red font colour has been removed for improved readability. The agreements have been tagged with *CE01*, *CE02*, etc. so that they can be referred to from other sections in this document.

Agreement CE01:

* Adopt the following target data rates for eMBB performance evaluation for FR1.
* Urban scenario: DL 10Mbps, UL 1Mbps
* Rural scenario: DL 1Mbps, UL 100kbps
* Rural with long distance scenario: DL 1Mbps, UL 100kbps, 30kbps (optional)

Agreement CE02:

* For VoIP performance evaluation based on link-level simulation for FR1.
* A packet size of [320] bits with 20ms data arriving interval is adopted.
* TBD: TBS for SIP invite message. Payload of 1500 bytes can be a starting point.

Agreement CE03:

* The basic evaluation methodology is based on link-level simulation for FR1.
* Step 1: Obtain the required SINR for the physical channels under target scenarios and service/reliability requirements.
* Step 2: Obtain the baseline performance based on required SINR and link budget template.
* Note: aspects related to identifying target performance and coverage bottlenecks based on target performance metric is to be handled separately
* The evaluation methodology based on system-level simulation is optional for FR1.
* Note: The simulation assumptions for SLS are up to companies’ reports.

Agreement CE04:

* For link level simulation, adopt the following table for PUSCH and PUCCH for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Scenario and frequency | Urban: 4GHz (TDD), 2.6GHz (TDD)  Rural: 4GHz (TDD), 2.6GHz (TDD), 2GHz (FDD), 700MHz (FDD)  Rural with long distance: 700MHz (FDD), 4GHz (TDD) |
| Frame structure for TDD | DDDSU (S: 10D:2G:2U) only for 4GHz  DDDSUDDSUU (S: 10D:2G:2U) only for 4GHz  DDDDDDDSUU (S: 6D:4G:4U) only for 2.6GHz  Other frame structures can be reported by companies. |
| Pathloss model (select from LoS or NLoS) | Urban: NLoS  Rural: NLoS and LoS |
| BWP | 100MHz for 4GHz and 2.6GHz.  20MHz for 2GHz (FDD  20MHz (optional for 10MHz) for 700MHz. (FDD) |
| SCS | 30kHz for TDD, 15kHz for FDD. |
| Channel model for link-level simulation | TDL-C for NLOS, TDL-D for LOS.  [CDL] |
| UE velocity | Urban: 3km/h for indoor  Rural: 3km/h for indoor, 120km/h (optional 30km/h) for outdoor |
| Frequency hopping | w/ or w/o frequency hopping for PUSCH  w/ frequency hopping for PUCCH. |

* FFS whether there are any additional simulation considerations for the extreme coverage scenarios (e.g., rural)

Agreement CE05:

* Down selection on the following options for the link budget template for FR1 in next meeting.
* Option 1: Adopt single link budget template based on IMT-2020 self-evaluation with necessary revisions, including adding/removing/revising some parameters.
  + FFS: The template provided by FL in Tdoc [R1-2005005](file:///C:\Users\Docs\R1-2005005.zip).
* Option 2: Adopt both templates, i.e. link budget template in IMT-2020 self-evaluation and link budget template in TR 36.824.
* Option 3: Adopt single link budget template in TR 36.824 with necessary revisions, including adding/revising some parameters.

Agreement CE06:

Down selection on the following options for antenna array gain for LLS based methodology for FR1 in next meeting.

* Option 1: Antenna array gain is included in the link budget template.
* FFS: array gain = 10 \* 1og10 (number of antenna elements/number of TxRUs)
* FFS: For TDL channel model
* FFS: Values reflective of realistic implementation and network operation.
* Option 2: Antenna array gain is included in LLS.
* FFS: For CDL channel model

Agreement CE07:

* For link level simulation, adopt the following table for PDSCH for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Waveform | CP-OFDM |
| PRBs/MCS/TBS | Reported by companies. |
| PDSCH duration | 12 OS |
| Other parameters | FFS |

Agreement CE08:

* For link level simulation, adopt following TBS for Msg3 for FR1
* 56 bits

Agreement CE09:

* For link level simulation, the packet size of VoIP for FR2 is the same as FR1.

Agreement CE10:

* For link level simulation, TBS of Msg3 for FR2 is the same as FR1.

Agreement CE11:

* The evaluation methodology for FR2 is the same as FR1.

Agreement CE12:

* The link budget template for FR2 is the same as FR1.

Agreement CE13:

* For link level simulation, adopt the following table for PUSCH and PDSCH for FR2.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Scenario and frequency | 28GHz |
| Frame structure for TDD | DDDSU (S: 10D:2G:2U)  DDSU (S: 11D:3G:0U)  Other frame structures can be reported by companies. |
| Subcarrier Space | 120kHz |
| UE velocity | Indoor scenario:3km/h  Urban scenario: 3km/h for indoor, 30km/h for outdoor.  Suburban scenario: 3km/h for indoor, 30km/h, (optional: 120km/h) for outdoor. |
| Occupied channel bandwidth for | 100MHz, [400MHz] |
| Frequency hopping for PUSCH | w/ or w/o frequency hopping |

Agreement CE14:

* For link level simulation, adopt the following table for PUSCH for eMBB data or VoIP for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| BLER for PUSCH | For eMBB,  w/ HARQ, 10% iBLER;  w/o HARQ, 10% iBLER.  For VoIP, 2% rBLER. |
| Number of UE transmit chains for PUSCH | 1，2 (optional) |
| DMRS configuration for PUSCH | For 120km/h, (Optional: 30km/h): Type I, 2 or 3 DMRS symbol, no multiplexing with data.  For frequency hopping: Type I, 1 or 2 DMRS symbol for each hop, no multiplexing with data.  PUSCH mapping Type and DMRS position are reported by companies.  Working assumption:  For 3km/h: Type I, 1 or 2 DMRS symbol, no multiplexing with data. |
| Waveform for PUSCH | DFT-s-OFDM,  CP-OFDM (optional) |
| Repetitions for PUSCH | For eMBB,  w/o repetition as baseline,  w/ repetition (optional).  For VoIP, w/ repetition.  The actual number of repetitions is reported by companies.  FFS: Repetition type B |
| HARQ configuration for PUSCH | For eMBB, whether HARQ is adopted is reported by companies.  For VoIP, w/ HARQ.  The maximum number of HARQ transmission (limited by frame structure and latency requirements) can be reported by companies. |
| Latency requirements for voice | 50ms/100ms |
| PUSCH duration | 14 OS |

Agreement CE15:

* For link level simulation, adopt the following table for PUCCH for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| PUCCH format type | Format 1, 2bits UCI.  Format 3, [4bits (3 bits A/N + 1 bit SR)]/11/22 bits UCI |
| BLER for PUCCH | For PUCCH format 1:  DTX to ACK probability: 1%. NACK to ACK probability: 0.1%.  ACK missed detection probability: 1%.  For PUCCH format 3:  BLER for Ack/Nack, SR: 1%  FFS: BLER for CSI (10% or 1%) |
| Number of PRBs for PUCCH | 1 PRB |
| Number of UE transmit chains for PUCCH | 1 |
| Number of repetitions for PUCCH | w/ repetition (optional), w/o repetition for PUCCH.  The maximum number of repetitions is 8. |
| PUCCH duration | 14 OS |
| DMRS configuration for PUCCH | FFS: number of DMRS symbols for PUCCH Format 3. |

Agreement CE16:

* For link level simulation, adopt the following table for eMBB data or VoIP on PUSCH and for PUCCH for FR1.

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Number of antenna elements for BS | Urban: 192 antenna elements for 4GHz and 2.6GHz,  (M,N,P,Mg,Ng) = (12,8,2,1,1)  (optional) 128 antenna elements for 4GHz,  (M,N,P,Mg,Ng) = (8,8,2,1,1)  Rural: 64 antenna elements for 4GHz and 2.6GHz  (M,N,P,Mg,Ng) = (8,4,2,1,1)  32 antenna elements for 2GHz  (M,N,P,Mg,Ng) = (8,2,2,1,1)  16 antenna elements for 700MHz  (M,N,P,Mg,Ng) = (4,2,2,1,1) |
| Number of TxRUs for BS | TBD |
| Delay spread | Urban: 300ns  Rural: 300ns  Rural with long distance: 30ns |
| PRBs/TBS/MCS for eMBB for PUSCH | Any value of PRBs, and corresponding MCS index, reported by companies will be considered in the discussion. Companies are encouraged to use 30 PRBs for 1Mbps, 4 PRBs for 100kbps, 1 PRB for 30kbps as a starting point.  TBS can be calculated based on e.g. the number of PRBs, target data rate, frame structure and overhead. |
| PRBs/MCS for VoIP for PUSCH | [4 PRBs] for VoIP as starting point.  Other values of PRBs can be reported by companies.  QPSK, pi/2 BPSK (optional) |

Note: For TDL models, companies report whether antenna array gain is included in LLS or link budget template. Array gain calculation method and how channel estimation is accounted for is reported by companies

Agreement CE17:

* Adopt the following target data rates for eMBB performance evaluation for FR2.
* Indoor: DL: 25Mbps, UL:5Mbps
* Urban: DL: 25Mbps, UL: 5Mbps
* Suburban: FFS: (DL: 1Mbps, UL: 50kbps)