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** |
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## 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** |
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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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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** |
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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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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** |
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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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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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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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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** |
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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?**

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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?**

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## 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** |
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## 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.

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| **Company** | **OK with Proposal 21 (Y/N)** | **Comments** |
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# 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)

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| **Company** | **OK with Proposal 30 (Y/N)** | **Comments** |
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# 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.

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| --- | --- |
| **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](../../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.

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| --- | --- |
| **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.

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| **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.

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| **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.

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| **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.

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| **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)