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

e-Meeting, May 25th – June 5th, 2020

**Agenda Item: 8.3**

**Title: Email discussion for Study on support of reduced capability NR devices
(Appendix 3: Updated proposals)**

**Source: Rapporteur (Ericsson)**

**Document for: Discussion, Decision**

Contents

[Contents 1](#_Toc42236877)

[1 Introduction 2](#_Toc42236878)

[5 Requirements 2](#_Toc42236879)

[6 Evaluation methodology 2](#_Toc42236880)

[6.1 Evaluation methodology for UE complexity reduction 2](#_Toc42236881)

[6.2 Evaluation methodology for UE power saving 3](#_Toc42236882)

[6.3 Evaluation methodology for coverage recovery 3](#_Toc42236883)

[6.4 Evaluation methodology for other performance impacts 5](#_Toc42236884)

[7 UE complexity reduction features 5](#_Toc42236885)

[7.2 Reduced number of UE Rx/Tx antennas 5](#_Toc42236886)

[7.3 UE bandwidth reduction 5](#_Toc42236887)

[7.4 Half-duplex FDD operation 6](#_Toc42236888)

[7.5 Relaxed UE processing time 6](#_Toc42236889)

[7.6 Relaxed UE processing capability 6](#_Toc42236890)

[7.7 Combinations of UE complexity reduction features 6](#_Toc42236891)

[8 UE power saving and battery lifetime enhancement 6](#_Toc42236892)

[8.1 Reduced PDCCH monitoring 6](#_Toc42236893)

[9 Comments 6](#_Toc42236894)

[References 7](#_Toc42236895)

# 1 Introduction

An email discussion [101-e-NR-RedCap-01] was held during RAN1#101e for the study item “Study on support of reduced capability NR devices” [1]. The email discussion focusses on high-level topics and evaluation assumptions necessary to facilitate next step’s more concrete analysis and evaluations.

The contribution consists of the following documents:

1. ’Appendix 1: Questionnaire’ from the Rapporteur with received company comments
2. ’Appendix 2: Initial proposals’ from the Rapporteur with received company comments
3. ’Appendix 3: Updated proposals’ from the Rapporteur
4. A main document

This document is the ‘Appendix 3: Updated proposals’ document which contains updated proposals from the Rapporteur based on the comments received during the first and second steps in the email discussion which are documents in ’Appendix 1: Questionnaire’ and ’Appendix 2: Initial proposals’.

The section numbering in this document follows the proposed TR skeleton [2]. The TR skeleton itself was discussed separately in email discussion [101-e-NR-RedCap-Skeleton].

# 5 Requirements

Proposal 0: The peak bit rate requirements for industrial wireless sensors are assumed to correspond to LTE Cat-1bis (e.g. 10 Mbps peak bit rate in DL and UL).

Proposal 1: Reference bit rate is not assumed to correspond to cell-edge bit rate.

Proposal 3: The bit rates requirements indicated for smart wearable applications are assumed to correspond to high-end applications.

Proposal 4: For safety related sensors, latency requirements apply to traffic initiated from RRC\_CONNECTED.

# 6 Evaluation methodology

## 6.1 Evaluation methodology for UE complexity reduction

Proposal 5: Use the TR 36.888 methodology for UE cost/complexity evaluation as a starting point and determine what major updates are needed.

Proposal 6: Since there is no specific cost reduction target, cost/complexity estimation for the combinations of different complexity reduction techniques is down prioritized for this meeting.

Proposal 7: Cost/complexity breakdowns can be separate for FR1 and FR2.

Proposal 8: Include antenna parts at least in the cost/complexity breakdown for FR2.

Proposal 9: The reference NR device 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
	+ 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
* Access: Direct DL/UL access between UE and gNB

Proposal 10: Potential benefits in terms of reduced device size can be mentioned where applicable in the TR (e.g. in the section on reduced number of antennas), but the SI will not aim to quantify such benefits.

## 6.2 Evaluation methodology for UE power saving

Proposal 11: Reuse the power consumption models and scaling factors for FR1 and FR2 provided in TR 38.840 (sections 8.1.1, 8.1.2, 8.1.3) as appropriate.

Proposal 12: The reference UE in the power saving evaluation is a RedCap UE. Potential configuration of legacy power saving features is FFS.

Proposal 13: The power saving evaluation in RAN1 focuses on the power saving from relaxed PDCCH monitoring (whereas the power saving for the SI objectives on Extended DRX and RRM relaxation is expected to be evaluated in RAN2, and the evaluation of the power saving from other features has lower priority).

Proposal 14: For wearables, use the traffic model from TR 38.840 with proper modification of at least packet size and mean inter-arrival time for RedCap use cases. Values are FFS.

Proposal 14a: For wearables, use FTP model 3 and VoIP to characterize the RedCap service types including IM, VoIP, heartbeat, etc.

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

## 6.3 Evaluation methodology for coverage recovery

Proposal 16: Base the coverage analysis on the IMT-2020 self-evaluation methodology.

Proposal 17: For coverage analysis, down select between the following options:

1. Align with the CE SI and perform the coverage analysis on the set of signals, channels and messages agreed to be within the scope of the CE SI.
2. Use a link budget approach taking all relevant DL and UL channels into account; including PSS/SSS, PBCH, PDCCH, PDSCH, PRACH, PUCCH, PUSCH, SIB1, Paging, RAR, Message-3, Message-4, and Message-5.

Proposal 18: Await agreements in the CE SI regarding simulation assumptions, quality targets and performance metrics before proceeding with proposals in the RedCap SI.

Proposal 19: The RedCap SI determines the “Hardware link budget” following the IMT-2020 self-evaluation methodology according to the below template, where items related to the “Maximum range” have been deleted (using track changes for traceability) and the table has been adapted to support any studied signal, channel or message (not necessarily only data and control channels).

|  |  |
| --- | --- |
| **Parameter** | **Values** |
| Scenario |  |
| Frame structure |  |
| Carrier frequency (Hz) |  |
|  |  |
|  |  |
|  |  |  |  |
|  |  |  |  |
| Transmission bit rate (bit/s) |  |  |  |
|  |  |  |  |
| Target packet error rate for the required SNR in item (19a)  |  |  |  |
|  |  |  |  |
| Spectral efficiency (bit/s/Hz) |  |  |  |
|  |  |  |  |
| UE speed (km/h) |  |  |  |
| Feeder loss (dB) |  |  |  |
| **Transmitter** |  |  |
| (1) Number of transmit antennas. (The number shall be within the indicated range in § 8.4 of Report ITU-R M.2412-0) |  |  |  |
| (1bis) Number of transmit antenna ports |  |
| (2) Maximal transmit power per antenna (dBm) |  |
| (3) Total transmit power = function of (1) and (2) (dBm) (The value shall not exceed the indicated value in § 8.4 of Report ITU-R M.2412-0) |  |
| (4) Transmitter antenna gain (dBi) |  |  |
| (5) Transmitter array gain (depends on transmitter array configurations and technologies such as adaptive beam forming, CDD (cyclic delay diversity), etc.) (dB) |  |  |
| (6) Channel power boosting gain or loss (dB) |  |  |
|  |  |  |
| (8) Cable, connector, combiner, body losses, etc. (enumerate sources) (dB) (feeder loss must be included for and only for downlink) |  |  |
| (9a) EIRP = (3) + (4) + (5) + (6) – (8) dBm |  |  |
|  |  |  |
| **Receiver** |  |
| (10) Number of receive antennas (The number shall be within the indicated range in § 8.4 of Report ITU-R M.2412-0) |  |  |
| (10bis) Number of receive antenna ports |  |  |
| (11) Receiver antenna gain (dBi) |  |  |
| (11bis) Receiver array gain (depends on transmitter array configurations and technologies such as adaptive beam forming, etc.) (dB) |  |  |
| (12) Cable, connector, combiner, body losses, etc. (enumerate sources) (dB) (feeder loss must be included for and only for uplink) |  |  |
| (13) Receiver noise figure (dB) |  |  |
| (14) Thermal noise density (dBm/Hz) |  |  |
| (15a) Receiver interference density (dBm/Hz)  |  |  |
|  |  |  |  |  |
| (16a) Total noise plus interference density = 10 log (10^(((13) + (14))/10) + 10^((15a)/10)) dBm/Hz  |  |  |  |  |
|  |  |  |  |  |
| (17a) Occupied channel bandwidth (for meeting the requirements of the traffic type) (Hz) |  |  |  |  |
|  |  |  |  |
| (18a) Effective noise power = (16a) + 10 log((17a)) dBm |  |  |  |
|  |  |  |  |
| (19a) Required SNR (dB)  |  |  |  |
|  |  |  |  |
| (20) Receiver implementation margin (dB) |  |  |  |
| (21a) H-ARQ gain (dB) |  |  |  |
|  |  |  |  |
| (22a) Receiver sensitivity = (18a) + (19a) + (20) – (21a) dBm |  |  |  |
|  |  |  |  |
| (23a) Hardware link budget = (9a) + (11) + (11bis) – (22a) dB |  |  |  |  |
| – |  |  |  |  |
|  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |
|  |  |
|  |  |  |
|  |  |  |

Proposal 20: Add one final row supporting the calculation of the maximum coupling loss (MCL), which is defined as the total transmitted power minus receiver sensitivity, as measured at the antenna connectors, i.e. = (3) + (6) - (22a).

## 6.4 Evaluation methodology for other performance impacts

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

# 7 UE complexity reduction features

## 7.2 Reduced number of UE Rx/Tx antennas

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

Proposal 22a: For FR1, potential reduced antenna radiation efficiency due to device size limitations for wearables can be reported as part of the antenna gains in the coverage analysis.

Proposal 23: For FR2, study two antenna configurations for RedCap UEs, namely 1Rx/1Tx and 2Rx/1Tx, where study of 2Rx/1Tx is prioritized.

## 7.3 UE bandwidth reduction

The following agreement was made in a RAN1#101e GTW online session:

|  |
| --- |
| Agreements: * For FR1, study at least 20MHz maximum UE bandwidth at least for initial access
	+ Other bandwidths FFS
* For FR2, study 50MHz and 100 MHz maximum UE bandwidth at least for initial access
	+ Other bandwidths FFS
 |

Proposal 24a: For FR1, study potential issues with supporting FDMed ROs spanning a larger bandwidth than the UE bandwidth.

Proposal 25a: For FR2, study potential issues with supporting SSB/CORESET#0 multiplexing patterns spanning a larger bandwidth than the UE bandwidth.

## 7.4 Half-duplex FDD operation

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

Proposal 27: Let RAN4 determine the values of DL-to-UL and UL-to-DL guard periods, if needed.

## 7.5 Relaxed UE processing time

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

Proposal 29: Study relaxed CSI computation time as a complexity reduction technique through relaxed UE processing time with low priority.

## 7.6 Relaxed UE processing capability

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

* Maximum modulation order restriction
* Reducing the maximum number of MIMO layers

## 7.7 Combinations of UE complexity reduction features

Proposal 32: Discussion on combinations of UE complexity reduction features is down prioritized till the next meeting.

# 8 UE power saving and battery lifetime enhancement

## 8.1 Reduced PDCCH monitoring

Proposal 33: Study the impact of BD and CCE limits reduction on power saving and PDCCH blocking probability (quantitatively) and impacts on latency and scheduling flexibility (at least qualitatively).

# 9 Comments

|  |  |  |
| --- | --- | --- |
| **Company** | **Proposal** | **Comments (major concerns)** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

# 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] [R1-2003288](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_101-e/Docs/R1-2003288.zip), “TR skeleton for Redcap”, Rapporteur (Ericsson)