**3GPP TSG RAN meeting #89e RP-20xxxx**

**Electronic Meeting, September 14 - 18, 2020**

## Status Report to TSG

**Agenda item:** 9.7.5

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| **WI / SI Name** | Study on support of reduced capability NR devices |
| included in this status report | Study Item: Yes | Core part: No | Performance part:No | Testing part:No |
| **Acronym** | FS\_NR\_redcap |
| **Unique ID** | 860035 |
| **TSG Tdoc of latest approved WI/SI description (if any)** | [RP-201386](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_88e/Docs/RP-201386.zip) |
| **Target Completion Date****(indicate if changed)** | Study Item: 12/2020 | Core part:  | Performance part:  | Testing part:  |
| **Overall Completion level** | Study Item: 45% | Core part:  | Performance Part:  | Testing part:  |

**Source:**

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| **Leading WG** | RAN1 |
| **Rapporteur** | **Name** | Johan BERGMAN |
| **Company** | Ericsson |
| **Email** | johan.bergman@ericsson.com |

## 1 Work plan related evaluation

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| **Do you want to modify the time budget for this WI/SI compared to what was endorsed at the last RAN meeting?** | Yes |

**Additional explanations/motivations for the time budget changes in the attached Excel table:**The only update is to postpone the start from February to May and the completion date from June to December.

## 2. Detailed progress in RAN WGs

For convenience, to collect all agreements in one place, the RAN1#101-e agreements from May 2020 are also included below.

## 2.1 RAN1

#### 2.1.1 Agreements

**RAN1#101-e (May 2020)**

To this meeting, 103 contributions were submitted (for details see agenda item 8.3 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/TDoc_List_Meeting_RAN1%23101-e.xlsx)).

An initial TR 38.875 skeleton was provided in [R1-2003288](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/R1-2003288.zip) and endorsed as V0.0.1 in [R1-2004962](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/R1-2004962.zip).

RAN1 carried out online (GTW) discussions and the following offline email discussions:

* [101-e-NR-RedCap-Skeleton] on the skeleton for TR 38.875
	+ Summarized in [R1-2004993](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/R1-2004993.zip)
* [101-e-NR-RedCap-01] on high-level topics and evaluation assumptions
	+ Summarized in [R1-2004731](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/R1-2004731.zip) and [R1-2005048](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/R1-2005048.zip)
* [101-e-Post-NR-RedCap] on high-level topics and evaluation assumptions
	+ Summarized in [R1-2005114](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/R1-2005114.zip)

RAN1 made the following agreements related to **use case requirements**:

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| Agreements:* For safety related sensors, latency requirements apply to traffic initiated from RRC\_CONNECTED.
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RAN1 made the following agreements related to **study of UE complexity reduction**:

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| 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

Agreements:* For FR1, study two antenna configurations for RedCap UEs, namely 1Rx/1Tx and 2Rx/1Tx.
* For FR2, study two antenna configurations for RedCap UEs, namely 1Rx/1Tx and 2Rx/1Tx.

Agreements:* Study HD-FDD operation Type A and Type B (as defined in LTE) in RAN1, where study of Type A is prioritized.

Agreements:* For UE complexity reduction through relaxed UE processing time, study a more relaxed UE processing time in terms of N1/N2 compared to capability #1.

Agreements:* Use the TR 36.888 methodology for UE cost/complexity evaluation as a starting point and determine what major updates are needed.
* Cost/complexity breakdowns can be separate for FR1 and FR2 if found beneficial.
* Include antenna parts at least in the cost/complexity breakdown for FR2.
* 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.

Agreements: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
* Operation in a single 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: The study will consider impacts on the cost/complexity reduction from support of multiple RF bands within FR1 or FR2. |

RAN1 made the following agreements related to **study of UE power saving**:

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| Agreements:* 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).

Agreements:* 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.
* For evaluation of UE power saving, 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.
* For evaluation of UE power saving, 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 encouraged).
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RAN1 made the following agreements related to **study of coverage loss/recovery**:

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| Agreements:* If/when coverage evaluations outside the CE SI are needed,
	+ 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 for FR2 is the same as FR1.

Agreements:* If/when link-level coverage evaluations outside the CE SI are needed,
	+ The CE SI link-level simulation assumptions can be used as a starting point.
	+ For calibration purposes, the following settings can be used:

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| **Parameters** | **FR1 values** | **FR2 values** |
| Scenario and frequency | Urban:2.6 GHz (TDD) (primary choice)4 GHz (TDD) (secondary choice)Rural:700 MHz (FDD) | Indoor: 28 GHz (TDD) |
| Frame structure for TDD | For 2.6 GHz:DDDDDDDSUU (S: 6D:4G:4U)For 4 GHz:DDDSUDDSUU(S: 10D:2G:2U) | DDDSU(S: 10D:2G:2U) |
| Channel model | TDL-C | TDL-A |
| UE velocity | 3 km/h | 3 km/h |

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RAN1 made the following agreements related to **study of performance impacts**:

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| Agreements:* The evaluation of performance impacts includes at least peak data rate, latency and reliability (as needed for the use cases). 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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**RAN1#102-e (August 2020)**

To this meeting, 139 contributions were submitted (for details see agenda item 8.6 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/TDoc_List_Meeting_RAN1%23102-e.xlsx)).

An updated TR 38.875 skeleton was provided in [R1-2005233](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/R1-2005233.zip). The updates in Sections 4 and 5 were endorsed in RAN1 (and the other updates were endorsed in RAN2).

RAN1 carried out online (GTW) discussions and the following offline email discussions:

* [102-e-NR-RedCap-01] on UE complexity reduction features
	+ Summarized in [R1-2007090](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/R1-2007090.zip), [R1-2007177](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/R1-2007177.zip), [R1-2007269](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/R1-2007269.zip), [R1-2007302](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/R1-2007302.zip) and [R1-2007331](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/R1-2007331.zip)
* [102-e-NR-RedCap-02] on PDCCH monitoring relaxation
	+ Summarized in [R1-2007030](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007030.zip), [R1-2007184](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007184.zip), [R1-2007284](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007284.zip), [R1-2007344](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007344.zip) and [R1-2007426](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007426.zip)
* [102-e-NR-RedCap-03] on coverage recovery and capacity impact
	+ Summarized in [R1-2007091](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007091.zip), [R1-2007153](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007153.zip) and [R1-2007312](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007312.zip)
* [102-e-NR-RedCap-04] on reduced capability signaling framework
	+ Summarized in [R1-2007330](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007330.zip)
* [102-e-NR-RedCap-05] on identification and access restriction
	+ Summarized in [R1-2007283](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007283.zip)

RAN1 made the following agreements related to **study of UE complexity reduction**:

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| Agreements:* For cost/complexity reduction analysis, the RF-to-baseband cost ratio for an FR1 UE is assumed to be 40:60.
* For cost/complexity reduction analysis, the RF-to-baseband cost ratio for an FR2 UE is assumed to be approximately 50:50.

Agreements:* Assume the detailed cost breakdown for FR1 FDD/TDD and FR2 in the table below:

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| **Functional block** | **FR1 FDD (2Rx)** | **FR1 TDD (4Rx)** | **FR2** |
| **RF** |
| Antenna array for FR2 |  |  | ~33% |
| Power amplifier  | ~25% | ~25%  | ~18% |
| Filters | ~10% | ~15% | ~8%  |
| RF transceiver(including LNAs, mixer, and local oscillator) | ~45%  | ~55% | ~41% |
| Duplexer / Switch | ~20% | ~5% | ~0% |
| **Baseband** |
| ADC / DAC | ~10% | ~9% | ~4% |
| FFT/IFFT | ~4% | ~4% | ~4% |
| Post-FFT data buffering | ~10% | ~10% | ~11% |
| Receiver processing block | ~24% | ~29% | ~24% |
| LDPC decoding | ~10% | ~9% | ~9% |
| HARQ buffer | ~14% | ~12% | ~11% |
| DL control processing & decoder | ~5% | ~4% | ~5% |
| Synchronization / cell search block | ~9% | ~9% | ~7% |
| UL processing block | ~5% | ~5% | ~7% |
| MIMO specific processing blocks | ~9% | ~9% | ~18% |

Agreements:* In potential cost evaluations for a UE, it is assumed that the multi-band support affects the RF cost but not the baseband cost significantly.
* In the TR, at least include a qualitative statement; relevant numerical results can also be considered.

**Conclusion**:* The study of reduced number of UE (physical) antenna elements and panels in FR2 is not prioritized in the RedCap study item.

Agreements:* For RedCap UEs in FR1,
	+ The baseline UE bandwidth capability is 20 MHz, which can be assumed during the initial access procedure.
	+ Discuss further by email whether there is an issue or a necessity in achieving up to 150Mbps assuming a 20MHz and rank 1 transmission.

Agreements:* For the baseline UE bandwidth capability of RedCap UEs, the same maximum UE bandwidth in a band applies to both RF and baseband.
	+ This maximum UE bandwidth applies to both data and control channels.
	+ This maximum UE bandwidth is assumed for both DL and UL.
	+ Complexity analyses with other mixes of bandwidths are not precluded.

Agreements:* For the purpose of evaluation, the UE processing time in terms of N1/N2 can be assumed to be doubled compared to those of capability #1, i.e.,
	+ N1 = 16, 20, 34, and 40 symbols for 15, 30, 60, and 120 kHz SCS (assuming only front-loaded DMRS)
	+ N2 = 20, 24, 46, and 72 symbols for 15, 30, 60, and 120 kHz SCS

Agreements:* Study of relaxed UE processing time related to CSI computation is not prioritized in the RedCap study item.

Agreements:* For FR1 DL, study relaxation of maximum mandatory modulation to 64QAM instead of 256QAM.
* For FR1 UL, study relaxation of maximum mandatory modulation to 16QAM instead of 64QAM.
* For FR2 DL, study relaxation of maximum mandatory modulation to 16QAM instead of 64QAM.
* For FR2 UL, study relaxation of maximum mandatory modulation to 16QAM instead of 64QAM.
* Restriction to 1 or 2 MIMO layers in DL can be studied.
* No TBS restriction is considered in this SI beyond the implicit TBS restrictions resulting from reduced UE bandwidth or reduced number of MIMO layers.
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RAN1 made the following agreements related to **study of UE power saving**:

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| Agreements:* Use the VoIP traffic model from TR 38.840 as baseline. Other VoIP traffic models are not precluded and companies to report if other VoIP traffic models are assumed in evaluation.

Agreements:For power saving evaluation of RedCap UEs:* Reuse the Instant message traffic model from TR 38.840 as baseline. Other traffic models based on FTP model 3 are not precluded and companies to report the mean inter-arrival time and packet size if other traffic models are assumed in evaluation.
* FFS: ‘heartbeat’ traffic model

Agreements: * The scaling factor ‘0.7’ is used for 2 Rx to 1Rx power scaling for power reduction related evaluation.
* For evaluation, the power scaling for PDCCH candidate reduction defined in TR 38.840 is reused for Redcap UEs.
* For power consumption evaluation, the DRX configurations of Instant message and VoIP in TR 38.840 are reused.
* Discussion on reduced maximum number of configurable CORESET technique for power saving is deprioritized in the Redcap power saving sub-agenda
* For power consumption evaluation, use FTP-3 model with 100 Bytes packet size and 60s mean inter-arrival time as baseline for ‘heartbeat’ traffic.
* For power consumption evaluation, reuse the following DRX configuration defined in TS 38.840 for ‘heartbeat’ traffic model:
	+ C-DRX cycle 640 msec, inactivity timer {200, 80} msec
	+ FR1 On duration: 10 msec
	+ FR2 On duration: 5 msec

Agreements: For the PDCCH blocking rate evaluation, at least the following parameters are assumed as baseline:

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| **Parameters** | **Assumptions** |
| Number of candidates for each AL | Each company to report. |
| SCS/BW   | FR1: 30KHz/20MHz* 15kHz/20MHz is optional

FR2: 120KHz/[100]MHz |
| CORESET duration  | 2 symbols, with 3 symbols optional |
| Delay toleration (Slot) | 1 (1: implies that PDCCH is blocked if it can’t be scheduled in the given slot), with 2 optional |
| Aggregation level Distribution  | Companies to report (including the necessary UE channel conditions and deployment scenario(s) for the aggregation level distribution) |

Agreements: For Redcap power consumption evaluation:* Note that 2RX is assumed

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| Power State | Alt.4a  |
| Deep Sleep (PDS) | 0.8 |
| Light Sleep (PLS) | 18 |
| Micro sleep (PMS) | 31 |
| PDCCH-only (PPDCCH) | 50 for same-slot scheduling, 40 for cross-slot scheduling |
| PDCCH + PDSCH (PPDCCH+PDSCH) | 120 |
| PDSCH-only (PPDSCH) | 112 |
| SSB/CSI-RS proc. (PSSB) | 50 |
| Intra-frequency RRM measurement (Pintra) | [60] Note4 (synchronous case, N=8, measurement only)[80]Note4 (combined measurement and search) |
| Inter-frequency RRM measurement (Pinter) | [60]Note4 (neighbor cell search power per freq. layer)[80] Note4 (measurement only per freq. layer)Micro sleep power assumed for switch in/out a freq. layer |

Working assumption:Adopting the following rule for power determination* Rule 1: ‘Micro sleep’ power of 1 Rx is [0.8]x2 Rx ‘Micro sleep’ power
* Rule 2: For both 1 Rx and 2 Rx configuration,
* P(α) = max (Micro-sleep, α ∙ Pt + (1 – α) ∙ 0.7Pt))
* Pt is the PDCCH-only power for same slot and cross-slot scheduling cases.

**Conclusion**: It is up to each company to report the power consumption modeling for 3-symbols CORESET configuration and reduced number of non-overlapped CCEs.**Conclusion:*** RAN1 to defer to RAN2 for further progress on studies regarding RRM relaxations and E-DRx for RedCap UEs to facilitate reduced UE power consumption.
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RAN1 made the following agreements related to **study of coverage loss/recovery**:

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| Agreements:For the channel(s) affected by complexity reduction, the following methodology can be used to determine the target performance for coverage recovery* Step 1: Obtain the link budget performance of the channel based on link budget evaluation
* Step 2: Obtain the target performance requirement for RedCap UEs within a deployment scenario
* FFS on the target performance requirement
* Step 3: Find the coverage recovery value for the channel if the link budget performance is worse than the target performance requirement

Agreements:* Link budget evaluation for RedCap should include at least PDCCH/PDSCH and PUCCH/PUSCH

Agreements:* For initial access related channels, at least Msg2, Msg3, Msg4 and PDCCH scheduling Msg2/4 are included for link budget evaluation
	+ Other initial access related channels are not precluded

Agreements:* The impact of small form factor is considered for all the uplink and downlink channels
	+ A 3dB loss of antenna gain is included in link budget calculation for FR1
		- FFS on the application to both FDD and TDD bands or only FDD bands [revised, see below]

Agreements:* For link budget evaluation, the antenna gain loss due to the small form factor can be applied to all the FR1 bands
* For RedCap coverage analysis, the agreements in the Rel-17 CE SI regarding link budget template and antenna array gain are reused.
	+ Continue to discuss and decide the performance metric in RAN1-103 e-meeting

Agreements: Down-selection on the following options for the target performance requirement for RedCap UEs in RAN1#103-e (aim for early in the e-meeting):* Option 1: The target performance requirement for each channel is identified by a target MCL or MIL or MPL within a reasonable deployment
* Option 3: The target performance requirement for each channel is identified by the link budget of the bottleneck channel(s) for the reference NR UE within the same deployment scenario
	+ Note: The “bottleneck channel(s)” are the physical channel(s) that have the lowest MCL or MIL or MPL
* The details for the target performance requirement are FFS

Agreements: For RedCap UE, adopt the following target data rates for link budget evaluation for FR1 Rural.* 1 Mbps on DL and 100kbps in UL

Agreements: For RedCap UE, adopt the following target data rates for link budget evaluation for FR1 Urban.* 2 Mbps on DL and 1Mbps in UL

Note: The 2Mbps target data rate in downlink is the scaled value of the 10Mbps in the CE SI by a factor of 0.2Agreements: For RedCap UEs, the target data rates for link budget evaluation for FR2 are as follows:* 25Mbps for BW 50MHz/100MHz on DL and 5Mbps in UL
	+ Optionally, 12.5Mbps for BW 50MHz as the target data rate for DL, assuming the same DL PSD as that of BW 100MHz
	+ Note: in case of 50MHz BW, the maximum supported DL data rate is half that of the 100MHz BW in DL

Agreements:* For RedCap coverage evaluation, the Rel-17 CE SI agreements on gNB antenna configuration, # gNB Tx/Rx chains, channel model and delay spread are reused with the following revision and/or addition

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| **Parameters** | **FR1 values** | **FR2 values** |
| Channel model | TDL-C | TDL-ACDL-A(optional) |
| Delay spread | 300ns | 30ns |
| UE velocity | 3 km/h | 3 km/h |
| Antenna correlation | Low | Low |
| # gNB Tx chains | 2 or 4 | 2 |
| # gNB Rx chains | 2 or 4 | 2 |

* For RedCap coverage evaluation, adopt the following table for the reference NR UE.

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| **Parameters** | **FR1 values** | **FR2 values** |
| # UE Tx chains | 1 | 1 |
| # UE Rx chains | Urban: 4 and Rural: 2 | 2 |
| UE BW | Urban: 100 MHz (273 PRBs)Rural: 20 MHz (106 PRBs) | 100 MHz (66 PRBs) |

* For RedCap coverage evaluation, adopt the following table for the RedCap UE.
	+ Other UE BWs are not precluded

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| **Parameters** | **FR1 values** | **FR2 values** |
| # UE Tx chains | 1 | 1 |
| # UE Rx chains | 1 or 2 | 1 or 2 |
| UE BW | Urban: 20 MHz (51 PRBs)Rural: 20 MHz (106 PRBs) | 50 MHz (32 PRBs) or 100 MHz (66 PRBs) |

Agreements:* For RedCap coverage evaluation, reuse the Rel-17 CE SI agreements on channel specific parameters with the following revision and/or addition
	+ TBS/PRB/MCS of PDSCH (except for Msg2)/PUSCH for the RedCap UE are based on the agreed target data rates or message sizes and reported by companies
	+ Adopt the following table for Msg2 evaluation
		- Note: the TBS scaling is not precluded in the table entry “PRBs/TBS/MCS”

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| **Parameters** | **Values** |
| PRBs/TBS/MCS | MCS is fixed to zero. Companies to report the used number of PRBs and corresponding TBS value |
| PDSCH duration | 12 OS |
| DMRS configuration | Type I, 3 DMRS symbol, no multiplexing with data |
| Waveform  | CP-OFDM |
| HARQ configuration  | No retransmission |

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RAN1 made the following agreements related to **study of capacity impact**:

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| Agreements:* For SLS based capacity evaluation, use the assumption in TR 38.802, Table A.2.1-1 as the baseline.
* For calibration purposes, the following settings can be used:

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| **Parameters** | **FR1 values** | **FR2 values** |
| Layout | Single layerMacro layer: Hex. Grid | Single layerIndoor floor: (12BSs per 120m x 50m)Candidate TRP numbers: 3, 6, 12 |
| Inter-BS distance | 500m | 20m |
| Scenario and frequency | Dense Urban:2.6 GHz (TDD) (primary choice) 4 GHz (TDD) (secondary choice)Other scenarios (e.g. Rural 700MHz) are not precluded. | Indoor: 28 GHz (TDD) |
| Frame structure for TDD | For 2.6 GHz: DDDDDDDSUU (S: 6D:4G:4U)For 4 GHz:DDDSUDDSUU (S: 10D:2G:2U) | DDDSU (S: 10D:2G:2U) |
| Channel model | 3Duma | 5GCM office |
| UE distribution | 20% Outdoor in cars: 30km/h,80% Indoor in houses: 3km/h | 100% Indoor: 3km/h  |
| Traffic model | Full buffer (Optional)Non-full buffer traffic, e.g. FTP traffic model 3 for the reference NR UEs and the IM traffic model from TR 38.840 for RedCap UEs  |
| Traffic load | Full buffer traffic (Optional):10 users per cell including both RedCap and reference NR UEsNon-full buffer traffic:Low (e.g. <30%) and medium (e.g. 30%-50%) loading (resource utilization)  |
| Percentage of RedCap UEs among total number of UEsNote: Other UEs are the reference NR UEs | Full buffer traffic (Optional):0, 20%, 50% (i.e. 0, 2 or 5 RedCap UEs per cell), 100% (as applicable)Non-full buffer traffic:0, 25%, 50%, 100% (optional, as applicable) |

  |

RAN1 made the following agreements related to **study of reduced capability signalling framework**:

|  |
| --- |
| Agreements:* Studying how to constrain RedCap devices to be used only for the intended use cases is deprioritized in RAN1

Agreements:* Discussion on whether to study CA case is deprioritized for reduced capability UEs in Rel. 17 SI and it will not start until maximum UE channel bandwidth is clear.
 |

RAN1 made the following agreements related to **study of identification and access restriction**:

|  |
| --- |
| Agreements:* Further study the options for identification of RedCap UEs, including the following indication methods:
	+ **Opt. 1**: During Msg1 transmission, e.g., via separate initial UL BWP, separate PRACH resource, or PRACH preamble partitioning.
	+ **Opt. 2**: During Msg3 transmission.
	+ **Opt. 3**: Post Msg4 acknowledgment.
		- E.g., during Msg5 transmission or part of UE capability reporting.
	+ **Opt. 4:** During MsgA transmission (subject to support of if 2-step RACH)
	+ Other options are not precluded.
	+ Note: This study intends to establish feasibility of, and pros and cons for the identified options from RAN1 perspective, without any intention of down-selection without guidance from RAN2.

**Conclusion:*** RAN1 to wait for further progress in RAN2 on the issues of temporary access barring and congestion control
 |

#### 2.1.2 Remaining Open issues

Identify and study potential UE complexity reduction features, including [RAN1, RAN2]:

* Reduced number of UE RX/TX antennas
* UE Bandwidth reduction
* Half-Duplex-FDD
* Relaxed UE processing time
* Relaxed UE processing capability

Study UE power saving and battery lifetime enhancement for reduced capability UEs in applicable use cases (e.g. delay tolerant) [RAN2, RAN1]:

* Reduced PDCCH monitoring by smaller numbers of blind decodes and CCE limits [RAN1].

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.

Support RAN2-led study objectives as needed (see section 2.2.2)

## 2.2 RAN2

#### 2.2.1 Agreements

**RAN2#111-e (August 2020)**

To this meeting, 61 contributions were submitted (for details see agenda item 8.12 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/TDoc_List_Meeting_RAN2%23111-e.xlsx)).

An updated TR 38.875 skeleton was provided in [R2-2007366](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_111-e/Docs/R2-2007366.zip). The updates in Sections 8, 10 and 11 were endorsed in RAN2 (and the other updates were endorsed in RAN1).

RAN2 carried out online (GTW) discussions and the following offline email discussions:

* [AT111e][108][REDCAP] on study scope and TR skeleton update
	+ Summarized in [R2-2008189](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/R2-2008189.zip)
* [AT111e][109][REDCAP] on reduced capability signaling framework
	+ Summarized in [R2-2008191](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/R2-2008191.zip)
* [AT111e][110][REDCAP] on identification and access restriction
	+ Summarized in [R2-2008192](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/R2-2008192.zip)
* [AT111-e][111][REDCAP] on UE power saving
	+ Summarized in [R2-2008193](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/R2-2008193.zip) and [R2-2008216](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/R2-2008216.zip)

RAN2 made the following agreements related to **organization and scope of the study**:

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| --- |
| Agreements:* RAN2 studies, and provides input to TR 38.875, on whether and how it can be ensured RedCap UEs are used only for intended use cases. This may require coordination with other WGs (e.g. RAN3 / SA / CT).
* RAN2 studies, and provides input to TR 38.875, on how and when to identify RedCap UEs and how to control RedCap UE access in RAN. Before concluding the identification discussion, further progress is needed in RAN1.

 Agreements:* For power saving, for now RAN2 studies extended DRX for idle and inactive modes and RRM relaxation for stationary RedCap devices, and input to be provided to TR 38.875.
* Depending on RAN1 input, discussion is expected at least on the following impacts on RAN2 procedures:

a.    Impact on cell (re)selectionb.    Impact on initial accessc.    Impact on other idle mode procedures (i.e. SI acquisition, paging) FFS:* Whether reduction of upper layer capabilities should be considered is FFS (in any case no email discussion until the next meeting on this)
 |

RAN2 made the following agreements related to **study of reduced capability signalling framework**:

|  |
| --- |
| Agreements:* At least for device type identification and access restriction (including initial access), the network needs to know whether the UE is RedCap UE or not. FFS on whether based on explicit or implicit signalling.
* The existing UE capabilities framework is used as baseline to indicate the capabilities of a RedCap UE (this does not imply anything on the reporting of the device type, if the need for a device type will be agreed)
* The number of device types should be minimised, to reduce market fragmentation, and introduced only where essential to control UE accesses and differentiate them from legacy R15/R16 and non-Redcap R17 UEs, (e.g. number of Tx/Rx antennas, maximum supportable BW, etc.). The exact composition of the set of L1 capabilities of the device type can be discussed by RAN1
* Discuss in normative phase on whether to signal (and in case how) a Device type and its associated capabilities (the reduced set of capabilities) is captured in specifications, and whether device type is indicated as part of UE capability;
 |

RAN2 made the following agreements related to **study of identification and access restriction**:

|  |
| --- |
| Agreements:* An indication in system information is needed to indicate whether a REDCAP UE can camp on the cell. FFS whether the indication is explicit or implicit.
* UAC mechanism also apply to REDCAP UEs.
* System information indicates whether REDCAP operation is allowed/barred on a frequency. FFS reuse the legacy intraFreqReselection or introduce separate flag
* Further discuss enhancement of UAC for REDCAP UEs, including e.g.:

a. define new Access Identity for REDCAP UEsb. define new Access Categories for REDCAP UEs(for any final decision we need to check with SA1 and/or CT1) |

RAN2 made the following agreements related to **study of UE power saving**:

|  |
| --- |
| Agreements:* RAN2 study eDRX mechanism for both RRC\_IDLE and RRC\_INACTIVE in this SI. ‎
* For RRC\_INACTIVE, the DRX cycle is extended to 10.24s as baseline.

Agreements:* For RRC\_IDLE, the DRX cycle is at least extended to 10.24s. FFS on further extension ‎beyond 10.24s.
* For RRC\_IDLE and/or RRC\_INACTIVE, if the NR DRX cycle range is extended beyond 10.24s, the LTE ‎eDRX mechanism beyond 10.24s (e.g., PTW, PH, etc.) is used as baseline when NR eDRX cycle is configured beyond 10.24s.

FFS:* For RRC\_IDLE and/or RRC\_INACTIVE, FFS on baseline mechanism when the configured NR eDRX cycle is less or equal to 10.24s
 |

RAN2 agreed to hold the following post-meeting email discussion:

* [POST111e][XXX][REDCAP] TP for the TR (Ericsson)
	+ Scope: Draft a TP for the TR based on the meeting agreements
	+ Intended outcome: email discussion summary and draft TR
	+ Deadline:  Until next meeting
* [POST111e][XXX][REDCAP] Definition and constraining of reduced capabilities (Intel)
	+ Scope: Continue to discuss the UE capability framework, how to define and constrain reduced capabilities, addressing the open issues and discussing potential solutions
	+ Intended outcome: email discussion summary
	+ Deadline:  Until next meeting
* [POST111e][XXX][REDCAP] UE identification and access restrictions (Huawei)
	+ Scope: Discuss UE identification and access restrictions, addressing open issues from the meeting, taking into account possible RAN1 agreements and identifying possible solutions
	+ Intended outcome: email discussion summary
	+ Deadline:  Until next meeting
* [POST111e][XXX][REDCAP] UE power saving features (CATT)
	+ Scope: Discuss UE power saving features: eDRX in idle and inactive and RRM relaxation for stationary devices
	+ Intended outcome: email discussion summary

#### 2.2.2 Remaining Open issues

Study UE power saving and battery lifetime enhancement for reduced capability UEs in applicable use cases (e.g. delay tolerant) [RAN2, RAN1]:

* Extended DRX for RRC Inactive and/or Idle [RAN2]
* RRM relaxation for stationary devices [RAN2]

Study standardization framework and principles for how to define and constrain such reduced capabilities – considering definition of a limited set of one or more device types and considering how to ensure those device types are only used for the intended use cases [RAN2, RAN1].

Study functionality that will allow devices with reduced capabilities to be explicitly identifiable to networks and network operators, and allow operators to restrict their access, if desired [RAN2, RAN1].

Support RAN1-led study objectives as needed (see section 2.1.2)

## 4. References

**RAN1#101-e (May 2020)**

103 contributions (for details see agenda item 8.3 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_101-e/Docs/TDoc_List_Meeting_RAN1%23101-e.xlsx))

**RAN1#102-e (August 2020)**

139 contributions (for details see agenda item 8.6 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/TDoc_List_Meeting_RAN1%23102-e.xlsx))

**RAN2#111-e (August 2020)**

61 contributions (for details see agenda item 8.12 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_111-e/Docs/TDoc_List_Meeting_RAN2%23111-e.xlsx))