**3GPP TSG RAN meeting #91e RP-21xxxx**

**Electronic Meeting, March 16-26, 2021**

## Status Report to TSG

**Agenda item:** 9.6.4

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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-202704](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_90e/Docs/RP-202704.zip) |
| **Target Completion Date****(indicate if changed)** | Study Item: RAN1: 12/2020RAN2: 03/2021 | Core part:  | Performance part:  | Testing part:  |
| **Overall Completion level** | Study Item: 100% | 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?** | No |

## 2. Detailed progress in RAN WGs

For convenience, to collect all agreements in one place, the agreements from 2020 are also included below.

## 2.1 RAN1

#### 2.1.1 Agreements

##### 2.1.1.1 RAN1#101e

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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##### 2.1.1.2 RAN1#102e

To this meeting, 144 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)
* [102-e-Post-NR-RedCap-01] on evaluation results (templates and initial results)
	+ Summary of template discussion: [R1-2007476](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007476.zip), [R1-2007477](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007477.zip), [R1-2007478](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007478.zip), and [R1-2007481](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007481.zip)
	+ Summary of initial results: [R1-2007482](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2007482.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) |

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

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| 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**:

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| 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
 |

##### 2.1.1.3 RAN1#103e

To this meeting, 187 contributions were submitted (for details see agenda item 8.6 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_103-e/Docs/TDoc_List_Meeting_RAN1%23103-e.xlsx))

An updated TR 38.875 skeleton was endorsed in [R1-2009490](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/R1-2009490.zip) and TR 38.875 V0.1.0 was endorsed in [R1-2009850](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_102-e/Docs/R1-2009850.zip).

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

* [103-e-NR-RedCap-EvaluationResults] on evaluation results
	+ Summarized in [R1-2009293](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_103-e/Docs/R1-2009293.zip)
* [103-e-NR-RedCap-01] on TR38.875 updates
	+ Summarized in [R1-2009843](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_103-e/Docs/R1-2009843.zip) and [R1-2009844](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_103-e/Docs/R1-2009844.zip)
* [103-e-NR-RedCap-02] on UE complexity reduction features
	+ Summarized in [R1-2008869](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2008869.zip), [R1-2009391](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009391.zip), [R1-2009393](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009393.zip), [R1-2009394](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009394.zip), [R1-2009651](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009651.zip), [R1-2009652](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009652.zip), [R1-2009795](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009795.zip) and [R1-2009803](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009803.zip)
* [103-e-NR-RedCap-03] on PDCCH monitoring relaxation
	+ Summarized in [R1-2008471](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2008471.zip), [R1-2009370](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009370.zip), [R1-2009411](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009411.zip), [R1-2009493](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009493.zip), [R1-2009571](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009571.zip), [R1-2009659](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009659.zip), [R1-2009720](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009720.zip), [R1-2009766](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009766.zip), [R1-2009783](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009783.zip), [R1-2009813](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009813.zip) and [R1-2009839](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009839.zip)
* [103-e-NR-RedCap-04] on coverage recovery and capacity impact
	+ Summarized in [R1-2009311](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009311.zip), [R1-2009365](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009365.zip), [R1-2009479](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009479.zip), [R1-2009580](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009580.zip), [R1-2009660](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009660.zip), [R1-2009721](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009721.zip), [R1-2009722](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009722.zip), [R1-2009796](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009796.zip) and [R1-2009817](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009817.zip)
* [103-e-NR-RedCap-05] on reduced capability signaling framework
	+ Summarized in [R1-2008555](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2008555.zip), [R1-2009381](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009381.zip), [R1-2009534](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009534.zip) and [R1-2009732](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009732.zip)
* [103-e-NR-RedCap-06] on identification and access restriction
	+ Summarized in [R1-2009317](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009317.zip), [R1-2009404](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009404.zip), [R1-2009608](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009608.zip), [R1-2009735](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009735.zip), [R1-2009771](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009771.zip) and [R1-2009780](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_103-e/Docs/R1-2009780.zip)

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

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| Agreements:For evaluating complexity reduction, to come up with a set of combinations of techniques:* For each case (FR1 FDD, FR1 TDD, & FR2), target up to 6 to 8 combinations
	+ Detailed combinations are FFS

Agreements:* Adopt the TP in R1-2009393 as baseline text for TR clause 7.2.1.
* Adopt the TP in R1-2009393 for TR clause 7.3.1.
* Adopt the TP in R1-2009393 as baseline text for TR clause 7.3.2.
	+ Companies are invited to double-check their entries in the cost reduction spreadsheet with respect to the above comments (and to catch potential typos).
	+ The table will be further updated with potential updated cost estimates.
* Capture the recommendation that maximum bandwidth of an FR1 RedCap UE is 20 MHz during and after initial access.
	+ FFS: Whether an FR1 RedCap UE can optionally support a maximum bandwidth larger than 20 MHz after initial access
* Adopt the TP in R1-2009393 as baseline text for TR clause 7.4.1.
* Adopt the updated TP in R1-2009393 as baseline text for TR clause 7.6.1
* Adopt the updated TP in R1-2009393 as baseline text for TR clause 7.6.2.
* Adopt the TP in R1-2009393 as baseline text for TR clause 7.7.2.
	+ Companies are invited to double-check their entries in the cost reduction spreadsheet with respect to the above comments (and to catch potential typos).
	+ The table will be further updated with potential updated cost estimates.

Working assumption: Support that the maximum bandwidth of an FR2 RedCap UE is 100 MHz during initial access and 100MHz after initial access.Agreements:For TR section 7.2.2 (on reduced number of Rx antennas), the following combinations of complexity reduction techniques are evaluated.1. FR1 FDD: 1 layer, 1 Rx
2. FR1 TDD: 1 layer, 1 Rx
3. FR1 TDD: 2 layers, 2 Rx
4. FR2: 1 layer, 1 Rx

Agreements: For FR1 FDD, the following combinations of complexity reduction techniques are evaluated:1. 1 layer, 1 Rx, 20 MHz
2. 1 layer, 1 Rx, 20 MHz, HD-FDD type A
3. 1 layer, 1 Rx, 20 MHz, relaxed modulations for DL & UL
4. 1 layer, 1 Rx, 20 MHz, doubled processing time for N1 & N2 only
5. 1 layer, 1 Rx, 20 MHz, relaxed modulations for DL & UL, doubled processing time for N1 & N2 only
6. 1 layer, 1 Rx, 20 MHz, relaxed modulations for DL & UL, HD-FDD type A, doubled processing time for N1 & N2 only
7. 2 layers, 2 Rx, 20 MHz, HD-FDD type A
8. 2 layers, 2 Rx, 20 MHz, doubled processing time for N1 & N2 only

**Agreements:** For FR1 TDD, the following combinations of complexity reduction techniques are evaluated:1. 1 layer, 1 Rx, 20 MHz
2. 1 layer, 1 Rx, 20 MHz, relaxed modulations for DL & UL
3. 1 layer, 1 Rx, 20 MHz, doubled processing time for N1 & N2 only
4. 1 layer, 1 Rx, 20 MHz, relaxed modulations for DL & UL, doubled processing time for N1 & N2 only
5. 2 layers, 2 Rx, 20 MHz
6. 2 layers, 2 Rx, 20 MHz, relaxed modulations for DL & UL
7. 2 layers, 2 Rx, 20 MHz, doubled processing time for N1 & N2 only
8. 2 layers, 2 Rx, 20 MHz, relaxed modulations for DL & UL, doubled processing time for N1 & N2 only

**Agreements:** For FR2, the following combinations of complexity reduction techniques are evaluated:1. 1 layer, 1 Rx, 100 MHz
2. 1 layer, 1 Rx, 100 MHz, relaxed modulations DL & UL
3. 1 layer, 1 Rx, 100 MHz, doubled processing time for N1 & N2 only
4. 1 layer, 1 Rx, 100 MHz, relaxed modulations DL & UL, doubled processing time for N1 & N2 only
5. 2 layers, 2 Rx, 100 MHz, relaxed modulations DL & UL
6. 2 layers, 2 Rx, 100 MHz, doubled processing time for N1 & N2 only
7. 2 layers, 2 Rx, 100 MHz, relaxed modulations DL & UL, doubled processing time for N1 & N2 only

Agreements:* Adopt the updated TP in x9394 for TR clause 7.7.1

Agreements: For averaging of cost estimates, take the average of all valuesAgreements (see R1-2009651 for the TPs)* Adopt the updated TP above for TR clause 6.1.
* Adopt the above description of the benefit of reduced number of UE Rx branches in terms of reducing the device size in FR1 as a baseline text for TR 38.875.
* Adopt the above description of the benefit of reduced number of UE Rx branches in terms of reducing the device size in FR2 as a baseline text for TR 38.875.
* Adopt the TP above as baseline text for TR clause 7.4.2.
* Adopt the above description of the benefit of HD-FDD operation in terms of reducing the device size in FR1 FDD as a baseline text for TR 38.875.
* Adopt the TP above as baseline text for TR clause 7.5.1.
* Adopt the TP above as baseline text regarding relaxed CSI computation, either in TR clause 7.5.1 or in a TR (sub)clause on relaxed CSI computation.
* Adopt the TP above as baseline text for TR clause 7.5.2.
* Confirm the working assumption: Support that the maximum bandwidth of an FR2 RedCap UE is 100 MHz during initial access and 100MHz after initial access.
* Adopt the TPs corresponding to Questions 7.2.3-2/3a/4a/5a/7a in R1-2009651
* Adopt the TPs corresponding to Questions 7.3.3-2/3a/5a/7a in R1-2009651
* Adopt the TPs corresponding to Questions 7.4.3-2a/3a/6/7a in R1-2009651
* Adopt the TP corresponding to Question 7.5.3-3a in R1-2009651
* Adopt the TPs corresponding to Questions 7.6.3-2/3a/4a/5a in R1-2009651
* Adopt the TPs corresponding to Questions 7.7.3-2/4a/5/6a in R1-2009651

**Agreements:*** For FR1 FDD bands where a non-RedCap UE is required to be equipped with a minimum of 2 Rx branches,
	+ The minimum number of Rx branches supported by specification for a RedCap UE is 1.
	+ Specification also supports of 2 Rx branches for a RedCap UE.

Agreements:* For FR1 TDD bands where a non-RedCap UE is required to be equipped with a minimum of 4 Rx branches, the minimum number of Rx branches supported by specification for a RedCap UE is *N*. To be down-selected during the WI phase or at RAN plenary:
	+ Alt 1: N=2
	+ Alt 2: N=1, where N=2 is also supported

Agreements:* For FR1 FDD bands where a non-RedCap UE is required to be equipped with a minimum of 2 Rx branches,
	+ For a RedCap UE with 1 Rx branch, the maximum number of DL MIMO layers is 1.
	+ For a RedCap UE with 2 Rx branches, the maximum number of DL MIMO layers is *M*. Down-select between the following during the WI phase or at RAN plenary
		- Option 1: *M*=1, where M=2 is also supported
		- Option 2: M=2

Agreements:* For FR1 TDD bands where a non-RedCap UE is required to be equipped with a minimum of 4 Rx branches,
	+ For a RedCap UE with 1 Rx branch (if supported), the maximum number of DL MIMO layers is 1.
	+ For a RedCap UE with 2 Rx branches, the maximum number of DL MIMO layers is *M*. Down-select between the following optionsduring the WI phase or at RAN plenary
		- Option 1: *M*=1, where M=2 is also supported
		- Option 2: *M*=2

Agreements**:*** For FR2 bands where a non-RedCap UE is required to be equipped with a minimum of 2 Rx branches,
	+ For a RedCap UE with 1 Rx branch (if supported), the maximum number of DL MIMO layers is 1.
	+ For a RedCap UE with 2 Rx branches (if supported), the maximum number of DL MIMO layers is *M*. Down-select between the following options during the WI phase or at RAN plenary:
		- Option 1: *M*=1, where M=2 is also supported
		- Option 2: *M*=2

Agreements:* Recommend that HD-FDD type B is not supported for RedCap FR1 FDD UEs in Rel-17.
* Decide at RAN plenary whether to have support FD-FDD or HD-FDD type A or both by specification for an FR1 FDD RedCap UE

Agreements**:** Decide at RAN plenary whether to support relaxed UE processing time in terms of N1/N2 by specification for a RedCap UE.Agreements:* Recommend that support of 256QAM in DL is optional (instead of mandatory) for a FR1 RedCap UE.
* Recommend that relaxed maximum mandatory UL modulation (from 64QAM to 16QAM) is not supported by specification for an FR1 RedCap UE.
* Recommend that relaxed maximum mandatory DL modulation (from 64QAM to 16QAM) is not supported by specification for an FR2 RedCap UE.
* Recommend that relaxed maximum mandatory UL modulation (from 64QAM to 16QAM) is not supported by specification for an FR2 RedCap UE.

Agreements:* For FR2 bands where a non-RedCap UE is required to be equipped with a minimum of 2 Rx branches,
	+ The minimum number of Rx branches supported by specification for a RedCap UE is 1.
	+ Specification also supports of 2 Rx branches for a RedCap UE.
* Agree the following TPs in R1-2009652 as baseline for TR 38.875:
	+ TP on introduction to UE complexity reduction features in Question 7.1-1
	+ TP for TR clause 7.2.2 in Question 7.2.2-1d
	+ TP on observations of the impact on coverage for UE with relaxed UE processing time in Question 7.5.3-2a
	+ TP on observation of the coexistence impacts for UE with relaxed maximum number of MIMO layers in Question 7.6.4-2
	+ TP on observation of specification impacts for UE with relaxed maximum number of MIMO layers in Question 7.6.5-2
	+ TP on observations of the impact on network capacity and spectral efficiency for UE with relaxed maximum modulation orders in Question 7.7.3-3a
	+ TP on observation of coexistence impacts for UE with relaxed maximum modulation orders in Question 7.7.4-2
	+ TP on description of combinations of UE complexity reduction techniques in Question 7.8.1-1
	+ TP for TR clause 7.8.2 in Proposal 7.8.2-1a
	+ TP on performance impacts for combinations of UE complexity reduction techniques in Question 7.8.3-2
	+ TP on coexistence impacts for combinations of UE complexity reduction techniques in Question 7.8.4-1
	+ TP on specification impacts for combinations of UE complexity reduction techniques in Question 7.8.5-1

Agreements:* Agree the following TPs in R1-2009795 as baseline for TR 38.875:
	+ TP on observations of specification impacts of UE bandwidth reduction in Question 7.3.5-2a
	+ TP on observations of the impact on latency and reliability for UE with relaxed UE processing time in Question 7.5.3-5b
	+ TP on observations of specification impacts for UE with relaxed maximum modulation orders in Question 7.7.5-2a
	+ TP on peak data rate impacts for combinations of UE complexity reduction techniques in Question 7.8.3-1a

Agreements:* Adopt the TP in section 2 of R1-2009803 as baseline text for TR 38.875.
* Adopt the TP in section 3 of R1-2009803 as baseline text for TR 38.875.
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RAN1 made the following agreements related to **study of UE power saving**:

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| Agreements:* To include description of the evaluated schemes #1/#2/#3 as in R1-2009370 to the TR
	+ Further discussion the detailed text proposal for these schemes
	+ Note: the description for scheme #1 is taken as a higher priority than #2/#3

Agreements:* Determine the Xx (smallest power saving gain)-Yy (largest power saving gain) value based on the smallest and largest values reported by each company at least considering:
	+ Separate observations with corresponding Xx-Yy values are captured at least for cross-slot and same slot scheduling cases.
	+ Separate observations for FR1 & FR2
	+ Additonal cases for separate observations
* Capture average/mean value of Xx-Yy excluding the smallest and the largest values among companies.
* Explicitly mention the result/observations if it was provided by a few source companies e.g. 1 or 2 with special setup or assumptions.
* Highlighting the gain is compared to the UE with configuring the maximum blind decoding for PDCCH monitoring defined in Rel-15/Rel-16

Agreements:Incorporate the revised Table 2A/2B and Table 3A/3B in R1-2009493 into Redcap TR 38.875 as baseline. * It is up to TR editor to use a separate excel sheet to include these Tables or directly capture these tables for inclusion in the TR.
* The table will be further updated with potential updated power saving gain results.

Agreements:For FR1, capture the following observations in the TR (editorial modifications by TR editor can be made for inclusion in the TR)* 11 sources ([vivo], [Ericsson], [Qualcomm], [CATT], [Spreadtrum], [OPPO], [Huawei, HiSilicon], [Apple], [Futurewei],[Intel], [ZTE]) reported the evaluation results of power saving gain for FR1 with same-slot scheduling for the 1 Rx antenna case.

The following is observed for 1 Rx antenna case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.7%~5.7%] and [1.3%~11.4%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 2.84% and 5.91%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~3.40%] and [0.02%~6.80%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain by reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.59% and 3.33%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~3.20%] and [0.02%~6.40%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.41% and 3.06%, respectively.
	+ For the VoIP traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.90%~3.88%] and [1.82%~6.48%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 2.59% and 4.74%, respectively.
* 13 sources ([vivo], [Ericsson], [Qualcomm], [Nokia], [CATT], [Spreadtrum], [OPPO], [Huawei, HiSilicon], [Apple], [Futurewei], [Intel], [ZTE], [InterDigital]) reported the evaluation results of power saving gain for FR1 with same-slot scheduling for 2 Rx antennas cases.

The following is observed for 2 Rx antennas case: * For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.64%~6.20%] and [1.55%~12.30%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 3.20% and 6.85%.
* For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~4.10%] and [0.02%~8.20%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.65% and 3.92%, respectively.
* For the heartbeat traffic model with 80ms inactivity timer configuration maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~3.90%] and [0.02%~7.80%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.49% and 3.62%, respectively.
* For the VoIP traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [??%-??%] and [??%~??%]. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 2.85% and 5.66%, respectively.

Agreements:For FR1, capture the following observations in the TR (editorial modifications by TR editor can be made for inclusion in the TR)* 8 sources ([vivo], [Ericsson], [Samsung], [Qualcomm], [OPPO], [Apple], [ZTE], [MediaTek]) reported the evaluation results of power saving gain for FR1 with cross-slot scheduling for the 1 Rx antenna and 2 Rx antennas cases.

The following is observed for 1 Rx antenna case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.66%~4.5%] and [0.81%~9%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 2.79% and 4.64%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~2.7%] and [0.01%~5.5%], respectively With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing 36 PDCCH blind decoding by 25% and 50% are approximately 1.81% and 3.26%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~2.6%] and [0.01%~5.1%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.8% and 3.35%, respectively.
	+ For the VoIP traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.87%~4.5%] and [1.39%~7%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 2.29% and 3.20%, respectively.

The following is observed for 2 Rx antennas case: * For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.77%~4.69%] and [1.44%~9.38%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 3.31% and 6.13%, respectively.
* For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~2.9%] and [0.02%~5.7%], respectively With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.95% and 3.51%, respectively.
* For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.01%~2.5%] and [0.02%~4.94%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 1.69% and 3.21%, respectively.
* For the VoIP traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [0.83%~3.5%] and [1.65%~6.07%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 2.28% and 4.45%, respectively.
* In general, it is expected that the power saving gain by BD reduction for cross-slot scheduling is less than that of the same-slot scheduling.
* In general, it is expected that the power saving gain by BD reduction for 1 Rx case is less than that of the 2 Rx case.

Agreements:Incorporate the revised Table 4A/4B and Table 5A/5B in R1-2009493 into Redcap TR 38.875.* It is up to TR editor to use a separate excel sheet to include these Tables or directly capture these tables for inclusion in the TR.
* The table will be further updated with potential updated power saving gain results.
* Note for Tables 4A & 5A, with the following update

*1 packet requires 1 PDSCH for Heartbeat traffic model; 1 packet requires ~~24~~ 16 PDSCHs for IM model, assuming cell center UE.*Agreements:Fo FR2, capture the following observations in the TR (editorial modifications by TR editor can be made for inclusion in the TR)* 6 sources ([Ericsson], [CATT], [Spreadtrum], [Futurewei], [Intel], [ZTE]) reported the evaluation results of power saving gain for FR2 with same-slot scheduling for the 1 Rx antenna and 2 Rx antennas cases.

The following is observed for 1 Rx antenna case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [1.94%~6.6%] and [3.59%~13.1%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 4.77% and 9.60%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.03%~4.30%] and [0.07%~8.60%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain by reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 2.14% and 4.41%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.03%~4%] and [0.06%~7.9%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.60% and 3.21%, respectively.
	+ For the VoIP traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [2.52%~5%] and [4.66%~9.4%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 3.81% and 7.43%, respectively.

The following is observed for 2 Rx antennas case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [2.45%~6.8%] and [4.54%~13.6%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 4.94% and 9.87%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.04%~4.90%] and [0.10%~11.90%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain by reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 2.55% and 4.95%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.04%~4.6%] and [0.09%~9.2%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 2.38% and 4.64%, respectively.
	+ For the VoIP traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [3.10%~5.5%] and [5.74%~10.5%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 4.27% and 8.27%, respectively.

Agreements:For FR2, capture the following observations in the TR (editorial modifications by TR editor can be made for inclusion in the TR)* 4 sources ([Ericsson], [Samsung], [ZTE], [MediaTek]) reported the evaluation results of power saving gain for FR2 with cross-slot scheduling for the 1 Rx antenna and 2 Rx antennas cases.

The following is observed for 1 Rx antenna case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [1.40%~6.30%] and [2.70%~12.7%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 3.64% and 7.04%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.02%~4.20%] and [0.04%~8.30%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain by reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.30% and 2.60%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.02%~3.9%] and [0.04%~7.6%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.24% and 2.48%, respectively.
	+ For the VoIP traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [1.94%~6.5%] and [3.6%~13.1%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 3.27% and 6.33%, respectively.

The following is observed for 2 Rx antennas case: * + For the instant message traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [1.89%~6.6%] and [3.50%~13.20%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 3.81% and 7.37%, respectively.
	+ For the heartbeat traffic model with 200ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.03%~4.90%] and [0.07%~9.60%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain by reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.56% and 3.13%, respectively.
	+ For the heartbeat traffic model with 80ms inactivity timer configuration, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [0.03%~4.6%] and [0.06%~8.9%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 1.37% and 2.74%, respectively.
	+ For the VoIP traffic model, with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50%, the power saving gains are in the range of approximately [1.97%~6.8%] and [3.95%~13.7%], respectively. With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 20) by 25% and 50% are approximately 3.38% and 6.52%, respectively.
* In general, it is expected that the power saving gain by BD reduction for cross-slot scheduling is less than that of the same-slot scheduling.
* In general, it is expected that the power saving gain by BD reduction for 1 Rx case is less than that of the 2 Rx case.

Agreements: Using both absolute increase and relative increase (as summarized in R1-2009571) to capture the observations for PDCCH blocking rate increase into TR 38.875.Agreements: Separate the following observations to capture the PDCCH blocking rate increase into TR 38.875:* + Separate observations for Aggregation Level (AL) distributions for AL [1,2,4,8,16] i.e. C1/C2/C3/Others.
	+ Separate observations for number of simultaneously scheduled UEs X.
	+ Separate observations for 25% and 50% reduction in BD limit.
	+ FFS separate observations for baseline parameters and optional parameters, including comparison between baseline parameters and optional parameters.

Agreements:* For each of the simultaneously scheduled UE numbers denoting as ‘N’ (1<N<=10)
	+ Step 1: Determine a single average/mean value *Average\_a\_N(i)* based on values reported by each company ‘*i*’ with existing Rel-15/16 schemes for DCI transmission
	+ for company ‘j’. M represents the number of configurations that are simulated by company ‘j’ for ‘N’ simultaneously scheduled UEs in a slot.
	+ Step 2: Determine a single average/mean value *Average\_a\_N* by averaging the values from different companies for a sperate observation, excluding the smallest and the largest values of *Average\_a(i)\_N* among companies if number of source companies > 3.

* + - where ‘K’ denotes the number of source companies that simulated a same observation configuration (e.g. ‘N=2’ in Table 10A) after excluding the smallest and largest value.
	+ Step-3: Reuse the same approach to derive the *Average\_b\_N* for Case 2 and Case 3 with approximately 25% and 50% BD reduction.
	+ Step-4: Determine the absolute increase and relative increase as follows:
		- X\_N% = [*Average\_b\_N* - *Average\_a\_N*].

* + - Y\_N% = [(*Average\_b\_N* - *Average\_a\_N)/ Average\_a\_N* ]

* + Step-5: Capture the following into TR for PDCCH blocking rate impact based on the template in Q 8.2.3.1-1

|  |
| --- |
| For FR1 with AL distribution configuration A1 in Table 8 with ‘N’ simultaneously scheduled UE in a slot, it was observed that the PDCCH blocking rate is increased X\_N% from [*Average\_a\_N*] which corresponds to Y\_N% increase relative to [*Average\_a\_N]* |

 Agreements: Capturing the following formulation for PDCCH blocking rate impact observations decoding into TR 38.875 section 8.2.3.1.  -        The observation for PDCCH blocking rate impact is formulated using the vector format: *<N, A%, z1%, x1%,y1%,z2%,x2%,y2%>*, which represents the following: §       With *N* simultaneously scheduled UEs in a slot and *z1%* reduction in maximum PDCCH blind decoding, the PDCCH blocking rate is increased approximately *x1%* from *A%*, which corresponds to *y1%* increase relative to *A%*. With *N* simultaneously scheduled UEs in a slot and *z2%* reduction in maximum PDCCH blind decoding, the PDCCH blocking rate is increased approximately *x2%* from *A%*, which corresponds to *y2%* increase relative to *A%*.  Agreements: To include evaluation results for PDCCH AL distributions of AL configurations A1~A7 of Table 8 in R1-2009659 to the TR 38.875. Agreements: To include evaluation results for number of PDCCH Candidates for AL [1,2,4,8,16] of Table 9 in R1-2009659 to the TR 38.875.Agreements: Adopt the proposal 8.2.3.1 in R1-2009720 for TR 38.875 clause 8.2.3.1.   * Note: the results for A2/A3 may not represent a typical case, e.g., because of the assumptions of unfavorable channel conditions.

**Agreements: Capture the following note into TR 38.875 clause 8.2.3:**

|  |
| --- |
| For the cases where the number of PDCCH candidates per AL is more than 8, the following configuration should be assumed, i.e., multiple overlapping search space sets are allowed. |

Agreements: For FR1, capture the following updated observations in the TR (editorial modifications by TR editor can be made for inclusion in the TR) for same-slot scheduling with 2 Rx antennas: §  For the VoIP traffic model, with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50%, the power saving gains are in the range of approximately [1.16%~4.60%] and [2.32%~7.20%].  With excluding the smallest and the largest values among sources, the mean value of power saving gain with reducing maximum PDCCH blind decoding (i.e. 36) by 25% and 50% are approximately 2.85% and 5.66%, respectively.Agreements:Captured the following into TR 38.875 for section 8.2.4

|  |
| --- |
| * The potential impacts on legacy UEs, in terms of PDCCH blocking probability, when coexisting with RedCap UEs in a shared CORESET depend on the scheduling strategy and system parameters. Depending on the network implementation, if legacy UEs are prioritized over RedCap UEs, there is no any coexistence impact on the legacy UEs at the cost of increased latency at the Redcap device side.
 |

Agreements:Capture the following feature description for Scheme #3 in the TR:

|  |
| --- |
| **Scheme #3**: **Dynamic adaptation of PDCCH Blind Decoding (BD) parameters in connected mode**In Rel-15/16, the parameters of PDCCH monitoring is configured by RRC signaling on a per search space set basis. Scheme #3 is to dynamically adapt PDCCH BD parameters e.g. maximum number of PDCCH candidates per PDCCH monitoring occasion and minimum time separation between two consecutive PDCCH monitoring occasions. ~~For example, to address real-time traffic variations on a cell or for a UE while accounting for blocking, a gNB can indicate reduced/full PDCCH BD on the cell to the UE when traffic is low/high.~~  |

Agreements:Capture the following feature description for Scheme #1 in the TR:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Scheme #1: Reduced maximum number of Blind Decoding (BD) per slot in connected mode** In Rel-15 and Rel-16 NR, the ~~limits on maximum~~ number of BDs per slot is configurable up to the limits ~~are~~ defined for different SCS configurations, as summarized in Table 1. Scheme #1 reduces the maximum number of BDs in a slot. In Rel-15 and Rel-16 specifications, the total number of different DCI sizes configured to monitor is up to 4 with up to 3 different DCI sizes with C-RNTI. Two alternatives were studied under Scheme #1, which includes reduced maximum number of BDs per slot with additionally reduced DCI size budget (Alt.1a) and reduced maximum number of BDs per slot without reduced DCI size budget (Alt.1b). Table 1: Blind decoding limits in NR.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SCS [kHz]** | **15** | **30** | **60** | **120** |
| **Max # BD per slot (in NR)** | 44 | 36 | 22 | 20 |

 |

Agreements: Capture the following feature description for Scheme #2 in the TR:

|  |
| --- |
|  In Rel-15/16 NR, the range of PDCCH monitoring periodicity is configurable, which is in a range of a few symbol (s) to 2560 slots subject to UE capability. Scheme#2 is to extend the minimum separation between two consecutive PDCCH monitoring occasions, spans or slots with configured PDCCH candidates to be X slots, where X>1.  |

 Agreements: Capturing the following into TR 38.875 for latency impact:

|  |
| --- |
| The latency impact due to BD reduction may largely depend on PDCCH blocking rate performance impact. If the PDCCH blocking rate is increased by BD reduction, the latency performance is expected to be increased; Otherwise, BD reduction has no impact on the latency.   |

 Agreements Capture the following into TR 38.875 for section 8.2.3 for scheduling flexibility impacts.

|  |
| --- |
| Scheduling flexibility may or may not be impacted by BD reduction depending on multiple factors at least including BW, Subcarrier Spacing (SCS), CORESET size, AL distribution, channel condition, number of Als per UE, number of UEs that need to be simultaneously scheduled, DCI size budget reduction, etc.  |

 Agreements Capture the following four paragraphs into TR 38.875 clause 12 for PDCCH monitoring:

|  |
| --- |
|  The PDCCH monitoring reduction for RedCap UEs has been studied. The study includes the evaluation of power saving benefit, system performance impacts, coexistence impacts, potential schemes, and the corresponding specification impacts. The power saving benefit by PDCCH monitoring reduction for RedCap UEs has been evaluated based on the agreed power model and traffic model, with the results and observations captured in section 8.2.2. In addition, scheduling flexibility and latency impacts have also been studied in Section 8.2.3.The system performance impact has been evaluated using PDCCH blocking rate as the metric, with the results and observations captured in section 8.2.3. In addition, scheduling flexibility and latency impacts have also been studied in Section 8.2.3.Three candidate schemes for PDCCH monitoring reduction have been identified and studied with the corresponding coexistence and specification impacts captured in sections 8.2.4 and section 8.2.5, respectively.  |

Agreements Capturing the following into TR 38.875 for section 8.2.5

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| --- |
| * Depending on the considered techniques, for scheme with reducing maximum number of PDCCH candidates, specification impact may include reducing the limit on maximum number of PDCCH candidates.
* For Extending the PDCCH monitoring gap to X slots (X), the minimum separation between two consecutive PDCCH monitoring occasions, spans or slots configured with PDCCH candidates is increased from 1 slot to X>1 slots and X needs to be specified.
* For dynamic adaptation of PDCCH BD parameters in connected mode, specification impacts may include mechanisms used to dynamically adapt PDCCH BD parameters e.g., maximum number of BDs per PDCCH monitoring occasion, span or slot and minimum time separation between two consecutive PDCCH monitoring occasions, spans or slots configured with PDCCH candidates.
* The existing Rel-15/Rel-16 PDCCH monitoring configuration can still be used to configure the BD candidates and PDCCH monitoring gap. Additional specification impacts may include one or more of following: reducing DCI size budget, modification to DCI size alignment rule, DCI format design (including single PDSCH scheduling and multiple PDSCHs scheduling), modification to PDCCH candidates dropping rule, to minimize the PDCCH blocking rate impact and network restriction.
 |

Agreements: Adding the rows in proposal 8.2.2-1 for Table 2A,2B,2C and 2D with new notes in R1-2009839Agreements: Update the agreement based on the new evaluation results for IM traffic model and Heartbeat traffic model in R1-2009839  |

RAN1 made the following agreements related to **study of coverage loss/recovery**:

|  |  |
| --- | --- |
| Agreements**:*** If coverage recovery target ~~performance requirement~~ is based on Option 1
	+ Maximum pathloss loss (MPL) is used as the coverage evaluation metric
* If coverage recovery target ~~performance requirement~~ is based on Option 3
	+ Maximum isotropic loss (MIL) is used as the coverage evaluation metric

Agreements:* For Option 3, down-selection on the following alternatives for coverage recovery
	+ Alt 1: A single coverage recovery target based on the same bottleneck channel is used for initial access channels and non-initial access channels of RedCap UE
	+ Alt 2: Identify 2 coverage recovery targets for the RedCap UE initial access channels and non-initial access channels, respectively:
	+ The 1st target is based on the bottleneck channel among the initial access channels of the reference NR UE
	+ The 2nd target is based on the bottleneck channel among all the channels of the reference NR UE
	+ Note: The initial access channels include at least PBCH, PRACH, Msg2, Msg3, Msg4 and PDCCH CSS

Agreements:* Agree in principle using Option 3 for determining the coverage recovery target
	+ Option 3: The coverage recovery target for each channel of RedCap UE corresponds to the link budget of the bottleneck channel(s) for the reference NR UE within the same deployment scenario
	+ Note: The reference UE is a Rel-15/16 NR UE with mandatory features only
* FFS For Option 3, companies report their individual observations of the amount of compensation for each channel by comparing the link budget with that of the bottleneck channel for the reference NR UE (i.e. the LB of the channel for RedCap UE – the LB of the bottleneck channel for the reference UE)
	+ A representative value of the amount of compensation is derived by taking the mean value (in dB domain) from all the compensation values including both negative and non-negative values
		- Excluding the highest & the lowest values when the number of samples is more than 3
		- If the number of samples used to compute a representative value is less than 4 for each scenario, this representative value is not used for bottleneck identification
		- In this case, observations may still be drawn
	+ The representative value of a channel is used for identifying whether the channel needs coverage recovery
		- Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero

Agreements**:*** For Option 3, companies report their individual observations of the amount of coverage loss for each channel by comparing the link budget with that of the bottleneck channel for the reference NR UE (i.e. the LB of the channel for RedCap UE – the LB of the bottleneck channel for the reference UE)
	+ A representative value of the amount of coverage loss is derived by taking the mean value (in dB domain) from all the compensation values including both negative and non-negative values
		- Excluding the highest & the lowest values when the number of samples is more than 3
		- If the number of samples used to compute a representative value is less than 4 for each scenario, this representative value is not used for bottleneck identification
		- In this case, observations may still be drawn
	+ The representative value of a channel is used for identifying whether the channel needs coverage recovery
		- Coverage recovery is not needed if the representative value of a channel is larger than or equal to zero
		- The amount of coverage recovery to recommend will depend on further discussion of the techniques, scenarios, etc

**Agreements:*** Capture the following to the TR 38.875
	+ Coverage recovery for Msg2 PDSCH was studied from several aspects, including TBS scaling [and Msg2 PDSCH repetition]
	+ It is noted that TBS scaling is an existing technique mandatory for Rel-15 UE
	+ Potential specification impacts of Msg2 PDSCH repetition (if supported) include
		- Msg2 PDSCH repetition configuration
		- Mechanism to differentiate enhanced UE and legacy UE, e.g., separate PRACH configurations (e.g, separate PRACH occasions or preambles)

Agreements:* Capture the following to the TR 38.875
	+ Coverage recovery for Msg4 PDSCH was studied from several aspects, including scaling factor for TBS determination, PDSCH repetition and the use of the lower-MCS table.
	+ Some techniques, such as scaling factor for TBS determination and PDSCH repetition have been studied also in the Rel-17 coverage enhancement SI
	+ Potential specification impacts of using the lower-MCS table for Msg4 PDSCH include
		- Related signaling design

Agreements:* + Capture the link budget evaluation results (Urban 2.6 GHz) in Table 3.1-1 to Table 3.1-3 in R1-2009660 to the Appendix of TR 38.875
		- The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2 and PRACH.
		- MPL results to be included also. Up to editor to use the same or different tables

Agreements:Adopted the updated TP in section 3.1 of R1-2009660 as baseline text for TR clause 9.1* + Remove “and coverage recovery is needed” from the TP

Agreements:* + Capture the link budget evaluation results (rural 0.7 GHz) in Table 3.2-1 to Table 3.2-3 in R1-2009660 to the Appendix of TR 38.875
		- The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2 and PRACH.
		- MPL results to be included also. Up to editor to use the same or different tables.

Agreements:Adopted the updated TP in section 3.2 of R1-2009660 as baseline text for TR clause 9.1* + Remove “and coverage recovery is needed” from the TP

Agreements:* Capture the link budget evaluation results (Urban 4 GHz) in Table 3.3-1 to Table 3.3-3 in R1-2009660 to the Appendix of TR 38.875
	+ The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2, PRACH and DL PSD.
	+ MPL results to be included also. Up to editor to use the same or different tables.

Agreements:Adopted the updated TP in section 3.3 of R1-2009660 as baseline text for TR clause 9.1* Remove “and coverage recovery is needed” from the TP
* Add the following sentence to the last paragraph of the TP
	+ It should be noted that for DL PSD 24 dBm/MHz and 1 Rx RedCap UE case Msg2 results are based on no TBS scaling

Agreements:* For FR2 indoor scenario, the representative value is derived based on results for max TRP 12 dBm. The aggregated value for UL channels has then been obtained by considering
	+ Results presented by companies assuming max TRP 12 dBm; and
	+ Results presented by companies assuming max TRP 23 dBm, where corresponding MIL values have been reduced by 11 dB, and each company is counted only once (no double value is considered, if any).

Agreements**:*** Capture the following observations for FR1 coverage recovery to the TR 38.875
	+ For FR1, under the consideration of potential reduced antenna efficiency due to device size limitations, the MIL(s) of PUSCH and/or Msg3 are worse than that of the bottleneck channel for the reference NR UE and coverage recovery is needed. The amount of coverage recovery is up to 3 dB. For other UL channels, coverage recovery may be not needed.
	+ For FR1 including both FDD and TDD bands and RedCap UE with 2 Rx and reduced antenna efficiency, the MIL(s) of all the downlink channels are better than that of the bottleneck channel for the reference NR UE and coverage recovery is not needed.
	+ For RedCap UE with 1 Rx and reduced antenna efficiency, dependent on frequency bands and the assumption of DL PSD, the need for coverage recovery can be different
		- For carrier frequency of 4 GHz with DL PSD 24 dBm/MHz, coverage recovery may be needed for the downlink channels of Msg2, Msg4 and PDCCH CSS. A small or moderate compensation can be considered:
			* [1 dB] for PDCCH CSS
			* [2-3 dB] for Msg4
			* [5-6 dB] for Msg2 without TBS scaling. It is noted that coverage loss for Msg2 can be compensated by using the existing TBS scaling technique.
		- For other carrier frequencies or DL PSD other than 24 dBm/MHz, coverage recovery is not needed for the downlink channels if the target for coverage recovery is based on the MIL of the bottleneck channel for the reference NR UE
		- It is noted that in the methodology for RedCap UE coverage recovery target determination, absolute ISD/MPL targets are not considered
		- The determination of which channels require coverage recovery and the amount of coverage recovery depend on the choice of the target for coverage recovery

Agreements:* Capture the following observations for FR2 coverage recovery to the TR 38.875
	+ For FR2, there is no assumption of reduced antenna efficiency for RedCap UE and the MIL of the UL channels is the same as the reference NR UE and coverage recovery for UL channels is not needed.
	+ [For RedCap UE with 100 MHz BW and 1Rx, although there is performance loss from reducing the number of Rx branches to 1, the MIL(s) of all the DL channels is better that that of the bottleneck channel for the reference NR UE and coverage recovery for DL channels is not needed. ]
	+ For RedCap UE with 50MHz BW and 1Rx, coverage recovery may be needed for PDSCH when the same target data rate as the reference NR UE is assumed, and the amount of coverage recovery to be considered is approximately [2-3 dB]
		- The tradeoff between data rate and coverage can be considered and the amount of coverage recovery may depend on this choice.
	+ The determination of which channels require coverage recovery and the amount of coverage recovery depend on the choice of the target for coverage recovery
		- E.g. coverage recovery may not be needed for FR2 indoor scenario when the target is based on an MPL value from a target ISD of 20m
		- ~~E.g. a large amount of coverage recovery may be needed for the initial access channels if the target is to achieve the same coverage for the initial access channels between RedCap UE and the reference NR UE~~

Agreements:* Capture the following to the TR 38.875
	+ Coverage recovery for broadcast PDCCH (PDCCH monitored in a Type0/0A/1/2/3-PDCCH CSS) was studied from several aspects, including PDCCH repetition, compact DCI, new AL [of 12, 24 or 32], PDCCH transmission via CORESET or search space bundling, PDCCH-less mechanism for SIB1 and/or SI message
	+ If PDCCH repetition is supported, the potential specification impacts include
		- Repetition configuration (e.g. intra-slot or inter-slot)
		- DMRS design among PDCCH repetitions
		- Search space design for PDCCH repetition
	+ If compact DCI is supported, the potential specification impacts include
		- DCI format with a small payload size
		- Reuse existing format by fixing some DCI bits
	+ If new AL is supported, the potential specification impacts include
		- Mechanism for codeword generation and mapping to CCEs
		- CORESET duration extension
		- Related signaling design
	+ If PDCCH transmission via CORESET bundling is supported, the potential specification impacts include
		- CORESET bundling configuration
		- DMRS design among CORESET bundling
	+ If PDCCH-less is supported, the potential specification impacts include
		- Mechanism or resource allocation for indicating scheduling information for SIB1 and/or SI message in L1 signals(s)/channels(s) other than PDCCH
	+ It is noted that some of the techniques may have compatibility issue if RedCap and normal UEs share the same initial DL BWP

Agreements:* Capture the following to the TR 38.875
	+ Coverage recovery for PUSCH was studied from several aspects, including cross-slot or cross-repetition channel estimation, lower DM-RS density in time domain, enhancements on PUSCH repetition Type A and/or Type B, frequency hopping or BWP switching across a larger system bandwidth
	+ Some techniques, such as cross-slot or cross-repetition channel estimation, lower DM-RS density in time domain, enhancements on PUSCH repetition Type A and/or Type B have been studied also in the Rel-17 coverage enhancement SI
	+ Potential specification impacts of frequency hopping or BWP switching across a larger system bandwidth include:
		- Frequency domain hopping offsets/positions
		- Faster switching/RF retuning time.
			* Note this aspect requires RAN4 involvement, where the corresponding study in RAN4 is not performed yet.
		- Transmission/reception interruption during RF retuning time

Agreements**:*** Capture the following to the TR 38.875
	+ Coverage recovery for Msg3 was studied including repetition for Msg3 PUSCH initial and/or retransmission
	+ It is noted that enhancements on Msg3 PUSCH repetition have been studied also in the Rel-17 coverage enhancement SI

Agreements**:*** Capture the following to the TR 38.875
	+ Coverage recovery for PDSCH was studied from several aspects, including the use of the lower-MCS table, larger aggregation factor for PDSCH reception, cross-slot or cross-repetition channel estimation, increasing the granularity of PRB bundling, frequency hopping or BWP switching across a larger system bandwidth.
	+ Some techniques, such as the lower-MCS table and larger aggregation factor for PDSCH reception are existing techniques with optional UE capability signaling
	+ If cross-slot or cross-repetition channel estimation for PDSCH is supported, potential specification impacts include:
		- Time-domain precoder cycling and DM-RS configuration
	+ If hopping or BWP switching across a larger system bandwidth is supported, potential specification impacts include
		- PDSCH hopping configuration
		- Faster switching/RF retuning time
			* Note this aspect requires RAN4 involvement, where the corresponding study in RAN4 is not performed yet.
		- Transmission/reception interruption during RF retuning time
	+ Potential specification impacts of increasing the granularity of PRB bundling include
		- Related signaling design

Agreements:* Capture the link budget evaluation results (indoor 28 GHz) in Table 3.4-1 to Table 3.4-3 in R1-2009660 to the Appendix of TR 38.875
	+ The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of assumption for Msg2, PRACH and UE maximum Tx power.
	+ MPL results to be included also. Up to editor to use the same or different tables

Agreements:* Adopted the updated TP in section 3.4 of R1-2009722 as baseline text for TR clause 9.1
* Adopt the following update to observations for FR2 indoor coverage recovery

|  |
| --- |
| * Capture the following observations for FR2 coverage recovery to the TR 38.875
	+ For FR2, there is no assumption of reduced antenna efficiency for RedCap UE and the MIL of the UL channels is the same as the reference NR UE and coverage recovery for UL channels is not needed.
	+ ~~[~~For RedCap UE with 100 MHz BW and 1Rx in FR2 indoor scenario, although there is performance loss from reducing the number of Rx branches to 1, the MIL(s) of all the DL channels is better that that of the bottleneck channel for the reference NR UE, for which max TRP 12dBm is assumed, and coverage recovery for DL channels is thus not needed.~~]~~
	+ For RedCap UE with 50MHz BW and 1Rx, coverage recovery may be needed for PDSCH when the same target data rate as the reference NR UE is assumed, and the amount of coverage recovery to be considered is approximately [2-3 dB]
		- The tradeoff between data rate and coverage can be considered and the amount of coverage recovery may depend on this choice.
	+ The determination of which channels require coverage recovery and the amount of coverage recovery depend on the choice of the target for coverage recovery and/or max TRP for the reference NR UE
		- E.g. coverage recovery may not be needed for FR2 indoor scenario when the target is based on an MPL value from a target ISD of 20m
		- ~~E.g. a large amount of coverage recovery may be needed for the initial access channels if the target is to achieve the same coverage for the initial access channels between RedCap UE and the reference NR UE~~
		- E.g. coverage recovery for some DL channels may be needed for RedCap UE with 100 MHz BW (e.g. Msg2/4, PDSCH) or 50 MHz BW (e.g. Msg2/4, PDSCH, PDCCH) and 1Rx when max TRP 23 dBm is assumed for the reference NR UE
 |

 |

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

|  |
| --- |
| Agreements:* Adopt the updated TP as baseline text for TR clause 10

The SLS evaluations for the impacts of UE complexity reduction and antenna inefficiency to network capacity and spectrum efficiency are summarized in Table 4-1 to 4-25. Burst traffic model and optional full buffer traffic are considered. The impact from potential coverage recovery techniques is reflected in some of the SLS results in the sense that we allow the PDSCH/PUSCH spectral efficiency to go lower due to, e.g. repetitions and/or HARQ transmissions (i.e. trading data rate for coverage).For burst traffic evaluation, FTP model 3 is assumed for eMBB users. The assumption of traffic model for RedCap users varies across the sourcing companies. The instant message (IM) traffic model which in average generates an offered load of 400 kbps/s (0.1 MB payload every 2 s) is assumed for RedCap users by some sourcing companies. Compared to the assumed traffic model for the eMBB users which have an offered load of 20 Mbps (0.5 MB payload every 200 ms), the RedCap users will produce a very low data volume even with a 50-50 split of eMBB and RedCap users. The use of IM traffic for downlink capacity evaluation corresponds to video surveillance and industrial wireless sensor use cases for which traffic pattern is dominated by UL transmissions. In addition, the IM traffic may also be possible for some low data rate wearable use cases.Some companies have considered to reuse the same FTP model 3 for RedCap users by assuming wearable use cases have DL heavy traffic and the traffic pattern is the same for RedCap users and eMBB users. It should be noted that among the companies assuming FTP3 traffic model for RedCap, there may be differences in the average traffic volume assumption. Such a difference may contribute to different conclusion.For burst traffic evaluation with IM traffic model for RedCap users:* 3 sources observed that the RedCap users have minor or no impact on spectral efficiency and capacity, and little impact to the performance of co-existing eMBB users in the system
* It is further noted that the 1 Rx RedCap users do not make an appreciable change on the user throughput performance of the eMBB users compared to the 2 Rx RedCap users

For burst traffic evaluation with FTP model 3 for RedCap users:* One source with the respective simulation assumptions including the schedulable bandwidth reported the user throughput performance of the eMBB users is not degraded with the presence of the RedCap users in the system.
* One source with the respective simulation assumptions including the schedulable bandwidth reported the impact on spectral efficiency will be substantial. It is further observed substantial cell spectral efficiency loss about 30% due to UE Rx antenna reduced from four to two and DL modulation order restriction from 256QAM to 64QAM in FR1 and about 50% spectral efficiency reduction due to UE Rx antenna reduced from four to one and DL modulation order restriction from 256QAM to 64QAM in FR1.

For optional full buffer traffic evaluation:* One source with the respective simulation assumptions including the schedulable bandwidth reported a minor degradation of the spectral efficiency for the eMBB users and the degree of spectral efficiency loss is irrespective of the number of Rx antennas for RedCap users.
* One source with the respective simulation assumptions including the schedulable bandwidth reported the impact on spectral efficiency will be substantial. It is further observed substantial cell spectral efficiency loss about 54% due to UE Rx antenna reduced from four to two and DL modulation order restriction from 256QAM to 64QAM in FR1 and about 70% spectral efficiency reduction due to UE Rx antenna reduced from four to one and DL modulation order restriction from 256QAM to 64QAM in FR1.

Agreements:* Capture the SLS evaluation results in Table 4-1 to Table 4-25 in R1-2009722 to TR 38.875
	+ The tables will be further updated with potential updated evaluation results (to catch potential typos) and a clarification of evaluation assumption
 |

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

|  |
| --- |
| **Conclusion:*** Defer to RAN2 on the framework how to indicate the capabilities of RedCap UEin connected mode
* Note: Possible early identification is used for UEs in idle mode and is discussed in AI8.6.5
* Note: RAN1 continues the discussion on the exact composition of the set of L1 capabilities of the RedCap UE type

 **Conclusion:*** Following coexistence issuesare not studied in Rel.17 RedCap SI
	+ Efficient Beam-based operation in FR2
	+ Efficient resource usage in FR2
	+ How to mitigate the PRACH collision in FR2

Agreements:* At least for RedCap UE identification, explicit definition of RedCap UE type(s) is needed. P~~p~~ending conclusions on the reduced complexity features in AI8.6.1 and RedCap UE identification in AI8.6.5, the definition of the RedCap UE types can be based on one of:
	+ Option 1: All the reduced capabilities recommended at the end of the RedCap study
	+ Option 2: Only include the reduced capabilities that the network needs to know during initial access, if any
	+ Option 3: All the recommended reduced capabilities as well as recommended power saving features
	+ Option 4: The corresponding minimum set of the reduced capabilities that one RedCap UE type shall mandatorily support
	+ FFS for other usages

Agreements:* **If early identification during initial access is supported, at least maximum supported UE BW during initial access is included in the set of L1 capabilities of the device type for RedCap early identification**
	+ Note**: 20 MHz for FR1 and 100 MHz for FR2**
	+ **~~Identification of UEs optionally supporting bandwidths larger than 20 MHz in FR1 or larger than 100 MHz in FR2 after initial access, if supported, is not supported by early identification during initial access~~**
	+ **FFS other L1 capabilities**
	+ **Note: This does not preclude the case where the early indication only indicates whether it is a Redcap UE or which type of the Redcap UEs if multiple UE types are defined**
 |

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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Conclusion:*** For access control for RedCap UEs, detailed signaling options associated with system information are postponed to the WI phase.

Agreements:* As a next step, for the study on the options for RedCap UE identification during RAN1 #103-e meeting, RAN1 to focus on establishing feasibility, necessity, and identifying pros and cons for the following schemes:
	+ **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.

Agreements:* Considerations on Option 4 (during MsgA transmission) are deprioritized until further progress is made on Options 1 and 2 for 4-step RACH procedure.

Agreements:* **Observation:** Identification of RedCap UE type(s) during transmission of Msg1 could be feasible from the perspective of RAN1, at least for the following solutions:
	+ Separation of PRACH resources (e.g., occasions and/or formats) or PRACH preambles between RedCap and non-RedCap UEs
	+ Separation of initial UL BWP for RedCap and non-RedCap UEs
* **Note:** The appropriateness of each solution, considering the number of UE type(s) to be indicated, etc. needs further considerations.

Agreements:* Observation: Identification of RedCap UE type(s) during transmission of Msg5 or as part of UE capability reporting are feasible options from the perspective of RAN1

Agreements:* **Observation:** If early identification of RedCap UE type(s) via Options 1, 2, or 4 are not supported, then RedCap UE type(s) need to be identified either during transmission of Msg5 or as part of UE capability reporting.

*Agreements:** **Observation:** Early identification of RedCap UE type(s) during transmission of Msg1 may be necessary for:
	+ coverage recovery (including link adaptation) for one or more of: Msg2 PDCCH/PDSCH, Msg3 PUSCH and PDCCH scheduling Msg3 reTx, Msg4 PDCCH/PDSCH or PUCCH in response to Msg4, Msg5 PUSCH and associated PDCCH, if it is determined that coverage recovery for RedCap UEs is necessary for one of more of these channels;
	+ identifying UE minimum processing times capabilities for PDSCH processing and PUSCH preparation, if relaxations to UE min processing times are defined for N1 and N2;
	+ identifying UE capability for UL modulation order for Msg3 and Msg5 scheduling, if relaxations to max UL modulation order (i.e., UL modulation order restricted to lower than 64QAM) are introduced;
	+ identifying UE max bandwidth capability for Msg3 and Msg5 scheduling and PUCCH in response to Msg4.
* **Note:** Exact necessity depends on outcome of studies on UE cost/complexity reduction in AI 8.6.1 and Coverage Recovery in AI 8.6.3, and the SI on Coverage Enhancements.

 Agreements:* **Observation:** The following pros and cons are identified for identification of RedCap UE type(s) during transmission of Msg1:

|  |  |
| --- | --- |
| **Pros** | **Cons** |
| Enables efficient handling of different UE minimum processing times between RedCap and non-RedCap UEs for: minimum timing between PDSCH carrying RAR and start of Msg3 PUSCH; minimum timing between PDSCH carrying Msg4 and the corresponding HARQ-ACK feedback; minimum timing between PDCCH with the reTx grant and the corresponding Msg3 PUSCH retransmission, if relaxed UE min processing times are introduced for RedCap UEs.  | Potential reduction in PRACH user capacity (for the options based on separation of PRACH preambles), impacting ~~both~~ RedCap and non-RedCap UEs respectively, e.g., if the total PRACH resources in the cell is not increased. The exact impact depends on numbers of device type(s)/sub-types/capabilities to be identified and exact details of PRACH preamble partitioning schemes. |
| Enables coverage recovery, including link adaptation, for any one or more of: broadcast PDCCH, PDSCH associated with Msg2, PDSCH associated with Msg4, and PUSCH associated with Msg3, if coverage recovery is needed for these channels. | Potential increase in UL OH from PRACH (for the options based on separation of PRACH resources), impacting both RedCap and non-RedCap UEs. |
| The option of configuring separate initial UL BWPs, in addition to the above pros, enables address congestion (if congestion may occur) in the initial UL BWP that may otherwise need to be restricted to the mandatory required BW for RedCap UEs in the band/FR. | Potential increase in UL OH and complexity in configuration and maintenance of multiple initial UL BWP for the gNodeB, for the option of configuring separate initial UL BWPs. |
|  | The indication mechanisms in this category may be limiting in terms of the number of further sub-types/capabilities within RedCap device type that may be distinguished, if such sub-types/capability indication are introduced. |
|  | Higher impact to RAN1 and RAN2 specifications as well as increased SIB signaling OH compared to other options. |

Agreements:* **Observation:** The following pros and cons are identified for identification of RedCap UE type(s) during transmission of Msg5 or in UE capability report:

|  |  |
| --- | --- |
| **Pros** | **Cons** |
| This option of UE capability reporting offers a simple option for indication of RedCap UE type, including possibility of indicating further RedCap sub-types/capabilities if introduced. | Cannot facilitate additional coverage recovery (if needed) or separate link adaptation for broadcast PDCCH and/or Msg2 and/or Msg4 PDSCH, and/or Msg3 PUSCH for RedCap UEs. Too conservative scheduling and link adaptation for all UEs imply increased system OH for initial access in the initial DL and UL BWPs. |
| Limited or no impact to RAN1 specifications. | If UE minimum processing times are relaxed, cannot facilitate scheduling with separate minimum timing relationships for RedCap UEs between PDSCH carrying RAR and start of Msg3 PUSCH; minimum timing between PDSCH carrying Msg4 and the corresponding HARQ-ACK feedback; minimum timing between PDCCH with the reTx grant and the corresponding Msg3 PUSCH retransmission. This could result in increased initial access latency for non-RedCap UEs. |
|   | Cannot address the issue where Msg3 or PUCCH in response to Msg4 or Msg5 is scheduled with a bandwidth/hopping range larger than the maximum RedCap UE bandwidth in the UL initial BWP. |

 Agreements:* **Observation:** Identification of RedCap UE type(s) during transmission of Msg3 may be feasible from the perspective of RAN1, at least for the following solutions:
	+ Using the spare bit in existing Msg3 definition
	+ Extending the Msg3 size to carry additional one or more bits, indicating RedCap UE type(s)
* **Note:** The appropriateness and feasibility of each solution, considering the number of UE type(s) to be indicated, coverage performance for Msg3, etc. need further considerations from RAN2 and RAN1.

Agreements:* **Observation:** If early identification of RedCap UE type(s) via Option 1 is not supported, identification of RedCap UE type(s) during transmission of Msg3 may be necessary for coverage recovery (including link adaptation) for one or more of: Msg4 PDCCH/PDSCH, Msg5 PUSCH and associated PDCCH
* **Note:** Exact necessity depends on outcome of studies on Coverage Recovery in AI 8.6.3

 Agreements:* **Observation:** The following pros and cons are identified for identification of RedCap UE type(s) during transmission of Msg3:

|  |  |
| --- | --- |
| **Pros** | **Cons** |
| Enables coverage recovery (if needed) and/or appropriate link adaptation for PDSCH (and associated PDCCH and PUCCH) for Msg4, and scheduling of Msg5. | If only the spare bit in Msg3 is used, it would consume the single spare bit currently available in Msg3 payload, and this may not be desirable. |
| Limited impact to RAN1 specifications if only the spare bit in Msg3 payload is utilized. | If extended Msg3 size is introduced, mechanisms to enable detection between use of legacy Msg3 and extended Msg3 definitions necessary. |
| The option of extending Msg3 size may offer good scalability in the number of bits for such UE identification; e.g., if sub-types of RedCap device types (if defined) are to be indicated in Msg3. | The option of only using the spare bit in Msg3 scales poorly – limiting to a single-bit indication may not be sufficient if intending to distinguish between further sub-types/capabilities within RedCap device type, if RedCap UE sub-types/capabilities are defined in the context of RedCap UE identification. |
|   | Cannot facilitate additional coverage recovery (including separate link adaptation) for broadcast PDCCH and/or Msg2 PDSCH, and/or Msg3 PUSCH (and associated PDCCH) for RedCap UEs. |
|   | If UE minimum processing times are relaxed, cannot facilitate scheduling with separate minimum timing relationships for RedCap UEs (compared to non-RedCap UEs) between PDSCH carrying RAR and start of Msg3 PUSCH; minimum timing between PDCCH with the reTx grant and the corresponding Msg3 PUSCH retransmission. This could result in increased initial access latency for non-RedCap UEs. |
|   | May degrade reliability/coverage of Msg3 in case of increased Msg3 payload size. |
|   | Cannot address the issue where Msg3 is scheduled with a bandwidth/hopping range larger than the maximum RedCap UE bandwidth in the UL initial BWP. |

 **Conclusion:** The option of carrying RedCap UE type(s) identification as part of UCI multiplexed in Msg3 PUSCH is not considered during the Rel-17 RedCap SI. |

##### 2.1.1.4 RAN1#104e

RAN1 carried out the following offline email discussion:

* [104-e-Post-R17-RedCap-01] Email discussion for RedCap TR update
	+ The TR update includes the RAN2-endorsed TP in [R2-2102056](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2102056.zip)
	+ TR 38.875 V1.1.0 was endorsed in [R1-2102270](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104-e/Docs/R1-2102270.zip) (version with revision marks available in [R1-2102269](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_104-e/Docs/R1-2102269.zip))

#### 2.1.2 Remaining Open issues

None.

## 2.2 RAN2

#### 2.2.1 Agreements

##### 2.2.1.1 RAN2#111e

To this meeting, 66 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**:

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| --- |
| 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

##### 2.2.1.2 RAN2#112e

To this meeting, 66 contributions were submitted (for details see agenda item 8.12 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_112-e/Docs/TDoc_List_Meeting_RAN2%23112-e.xlsx)).

An updated TR 38.875 skeleton was provided in [R2-2009616](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_112-e/Docs/R2-2009616.zip). The updates in Sections 8, 10 and 11 were endorsed in RAN2.

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

* [AT112-e][111][REDCAP] TP drafting for the TR (Ericsson)
	+ Summarized in R2-2010784
* [AT112-e][112][REDCAP] Capabilities (Intel)
	+ Summarized in R2-2010785
* [AT112-e][113][REDCAP] Identification and access restrictions (Huawei)
	+ Summarized in R2-2010786
* [AT112-e][114][REDCAP] Power saving (CATT)
	+ Summarized in R2-2010787

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

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| Agreements:* RedCap UE capabilities can be categorized as:
	+ Min capabilities all RedCap UEs support (i.e. mandatory for RedCap UE) if identified;
		- FFS on whether some features are mandatory with signaling for RedCap UE, i.e. IOT bit;
		- (Note: RedCap UEs might have the same set of higher layer capabilities, however this is FFS in RAN2)
	+ Optional capabilities (signaled explicitly)
* Following scenarios are considered when design the capability signaling for RedCap UE, but FFS on the details, e.g. what each category of features may include and on the applicability of the cases:
	+ For the features that are mandatory for non-Redcap UEs:
		- Case1: The Redcap UE mandatorily supports the feature with the same value;
		- Case2: The Redcap UE mandatorily supports the feature, but with different value (e.g. bandwidth value);
		- Case3: The Redcap UE optionally supports the feature;
		- Case4: The Redcap UE does not support the feature at all.
	+ For the features that are optional for non-Redcap UEs:
		- Case1: The Redcap UE does not support the feature at all.
		- Case2: The Redcap UE supports the feature with different value;
		- Case3: The Redcap UE supports the feature with the same value;
		- Case4: The Redcap UE mandatorily supports the feature

Agreements via email - offline 112:* Following capability design principle is considered for RedCap UE, but details should be discussed in WI phase:
	+ Alternative 1:
		- The UE capability requirements for a RedCap device type, that are different from those for non-RedCap UEs, are listed in the specifications. That is:
			* Mandatory features for non-RedCap UE that are not supported for RedCap UE;
			* Mandatory features for non-RedCap UE that are optional for RedCap UE;
			* Mandatory features for non-RedCap UE that are supported for RedCap UE but with different value;
			* Optional features for non-RedCap UE that are not supported for RedCap UE;
			* Optional features for non-RedCap UE that are mandatorily supported for RedCap UE.
		- For a RedCap device type, define new signaling fields in UE Capability for the features that are mandatory w/o capability signaling for non-RedCap UEs but are optional for Redcap UEs, or mandatory with capability signaling for non-RedCap UEs but with different value for RedCap UEs.The possible new introduced signaling fields for RedCap UEs should not apply to non-RedCap or legacy UEs for mandatory features w/o capability signaling.
	+ Alternative 2:
		- Directly define the UE capabilities required for RedCap devices, including:
			* Mandatory features for RedCap UEs (defined in specification);
			* Optional features for Redcap UEs (introduce signaling fields in an independent container defined specifically for Redcap UE).
* Regarding how can the network know whether the UE is RedCap UE or not in order to handle UE capabilities properly, following options are considered and to be captured in the TR, the further analysis/down selection should be done in WI phase (following options may not be mutually exclusive, and may not be an exhaustive list):
	+ Option 1: RedCap device type is indicated as part of the capability signaling
	+ Option 2: Define a new IE specifically for RedCap Ues containing these additional Redcap specific capabilities that is included only by Redcap UEs.
	+ Option 3: The network obtains the RedCap based on identification solution, e.g. during Msg1, Msg3, MsgA,etc, (pending RAN1 conclusion), and forwards it to target during Handover.
	+ Option 4: NW identifies RedCap UE based on the reported capabilities. That is, assuming there are capabilities specific to RedCap UEs not used by non-RedCap UEs, it should be clear to NW the UE is Redcap without any additional type indication (if such is not needed e.g. during initial access).
* Regarding how to ensure the RedCap UE is only used for intended use cases, following potential solutions are considered in the SI phase (other solutions are not precluded), and to be captured in the TR (The formulation of the options should be discussed before capturing in the TR.). The decision which way to go will be made in WI phase and if needed based on consultation with other groups (e.g. SA2, CT1)
	+ Option 1: RRC Reject based approach

One potential problem could be when a RedCap UE requests a service that does not match the RedCap UE type. This would be similar to if e.g. an NB-IoT UE requested a video call to be set up. RAN can already reject an RRC connection establishment attempt e.g. based on the establishment cause provided in Msg3 or through higher layer mechanisms.RAN can reject an RRC connection establishment attempt for a RedCap UE if the service the UE requested is not allowed for the RedCap UE. That is, the RAN needs to identify whether the UE is a RedCap UE or not, and be aware of the requested service, e.g. based on the cause value or other ways. * + Option 2: subscription validation

During RRC connection setup, UE indicates it is a RedCap UE to core network, e.g. * + - UE includes this indication in its NAS signaling message to core network; or
		- UE informs this indication during its RRC connection establishment procedure to RAN; RAN then informs core network of UE’s RedCap type in its Initial UE Context message to core network.

After network receives UE’s RedCap indication, it validates UE’s indication against its subscription plan, which includes information such as the set of services allowed for the UE. Based on the outcome of this validation, network then decide whether to accept or reject UE’s registration request. For example, network may reject UE if UE indicates RedCap but its subscription does not include any RedCap-specific services.Note: SA2, CT1 confirmation is needed.* + Option 3. Verification of RedCap UE

Network can additionally perform capability match procedure between UE’s reported radio capabilities and the set of capability criteria associated with UE’s RedCap type, to prevent a hacked or misconfigured UE from falsely reporting as a RedCap UE. * + Option 4. Left up to network implementation
 |

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

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| Agreements:* Whether it is needed to identify RedCap UEs during Msg3 from RAN2 perspective or not depends on the following two aspects:
	+ Whether Msg4/5 special handing for RedCap UE is needed, pending RAN1
	+ Whether there is a need to reject part of RedCap UEs in addition to cell barring and UAC mechanism

Agreements:* Include the possible options (msg1, msg3, msg5) in the TP without saying anything on RAN2 preferences on when identification is required
* Do not send a LS on RedCap UE identification to RAN1 and wait for more RAN1 process
* Postpone the LS to SA1 on UAC enhancement for RedCap UEs.
* Postpone the discussion on the camping indicator for RedCap UEs to the WI phase.
* Postpone the discussion on intraFreqReselection indicator for RedCap UEs to the WI phase.
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RAN2 made the following agreements related to **study of UE power saving**:

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| Agreements via email - offline 114:* For UE in RRC IDLE/INACTIVE and eDRX cycle is less than 10.24s, paging monitoring does not use PTW and PH, if any.
* The target REDCAP UE, considering mobility, is not limited to a fixed UE, but can also experience some low mobility, and this, during some “stationary” periods of time.
* The RRM relaxation of REDCAP UEs is triggered based on measurements, as a baseline. Other triggering conditions for the “level-1” (still device at fixed location) UEs are not excluded, e.g. the possibility to signal their stationary property explicitly.
* R16 NR RRM relaxation procedures are taken as a baseline to study further enhancements of neighbor cells RRM relaxation for REDCAP UEs in RRC IDLE/INACTIVE.

Agreements:* Relaxation of neighbor cells RRM measurements in RRC\_CONNECTED will be studied in this SI/WI
* RAN2 will study whether lower values than 5.12s for eDRX cycle for RRC\_IDLE and RRC\_INACTIVE REDCAP UEs, e.g. 2.56s, can also be considered.
* eDRX cycle extension in RRC\_IDLE beyond 10.24s for REDCAP UEs will be studied in this SI/WI. For UE in RRC IDLE and eDRX cycle is equal to 10.24s, among the solution options, we start from the assumption that paging monitoring does not use PTW and PH.
* the eDRX cycle in RRC\_IDLE is extended up to 2621.44s for REDCAP UEs, as a baseline (longer value e.g. 10485.76s can also be considered)
 |

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

* [POST112-e][111][REDCAP] TP drafting for the TR (Ericsson)

 Scope: draft a TP based on meeting agreements

 Intended outcome: Endorsed TP in R2-2011165

 Deadline: Friday 2020-11-20

* [POST112-e][154][REDCAP] eDRX cycles (CATT)

 Scope: Progress on eDRX cycles for Idle and Inactive

 Intended outcome: email discussion report

 Deadline: Jan 12 1100 UTC

* [POST112-e][155][REDCAP] RRM relaxations (ZTE)

 Scope: Progress on solutions for RRM relaxations

 Intended outcome: email discussion report

 Deadline: Jan 12 1100 UTC

RAN2 endorsed TPs were provided in [R2-2011165](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_112-e/Docs/R2-2011165.zip).

##### 2.2.1.3 RAN2#113e

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_113-e/Docs/TDoc_List_Meeting_RAN2%23113-e.xlsx)).

An updated version of TR 38.875 based on v1.0.0 was provided in [R2-2100984](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113-e/Docs/R2-2100984.zip). The updates were endorsed in RAN2.

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

* [AT113-e][107][REDCAP] L2 capabilities and UE types (Huawei)
	+ Summarized in R2-2102017 and R2-2102037.
* [AT113-e][108][REDCAP] UE identification and access restriction (Ericsson)
	+ Summarized in R2-2102018 and R2-2102039.
* [AT113-e][109][REDCAP] eDRX cycles (CATT)
	+ Summarized in R2-2102019 and R2-2102040.
* [AT113-e][110][REDCAP] RRM relaxations (ZTE)
	+ Summarized in R2-2102020, R2-2102038 and R2-2102048.

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

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| Agreements via email - from offline [107]* Capture ‘maximum number of DRBs mandatory supported’ in the TR as one L2 capability which can be reduced for RedCap UEs.

Agreements online:* Capture the following in the TR on reducing total layer-2 buffer size for RedCap UEs:

“According to the calculation in TS 38.306, with peak data rate reductions, L2 buffer requirements for RedCap UEs are implicitly reduced accordingly. The need for further reduction compared to calculation in TS 38.306 needs more discussion”.* Capture ‘18-bit SN for PDCP and RLC AM’ in the TR as one L2 capability which can be reduced for RedCap UEs if clear benefit is identified.
* Capture in the TR that the gain to reduce RRC processing delay needs further discussion.

Agreements:* Capture the text below in the general section of the TR:

“The power consumption of RedCap UEs may be impacted because of paging false alarm and unnecessary SIB1 reading. Paging false alarm and unnecessary SIB1 reading are not specific to RedCap UEs and are discussed in R17 power saving WI. Enhancements introduced by R17power saving WI should also be applicable to RedCap UEs.”* Capture the pros/cons to have only one v.s. multiple RedCap UE type(s) in the TR as below:

From RAN2 perspective, the pros and cons to define only one device type or multiple device types are: Only one RedCap UE type: Pros: - No market fragmentation of “types”  - Simpler specification, e.g. on early identification, access control, etc. - Avoid non-technical discussion outside 3GPP’s scope, e.g. product management, similar to the discussions on LTE categories  Cons: - Cannot provide independent access control for different UE types, if this was deemed necessary Multiple RedCap UE types: Pros: - Flexible access control is possible if necessary, e.g. independent access control for different UE types  Cons: - Potential market fragmentation of ‘types’ leading to loss of economies of scale and increased device costs - More specification complexity/effort, e.g. on early identification, access control, etc. - May lead to non-technical discussion outside 3GPP’s scope, e.g. product management, similar to the discussions on LTE categories The need on independent access control for different RedCap UE types is not discussed in the SI phase. |

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

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| Agreements via email - from offline [108]* Capture following text in 11.1 in description of Option 4:

“Option 4: During MsgA transmission* E.g., via separate initial UL BWP or in MsgA preamble part via separate PRACH resource or PRACH preamble partitioning, or in MsgA PUSCH part.”
* Capture the following as ”pros” for Option 1:
* “Enables RRC connection rejection of RedCap UE for access restriction (for UEs coming from RRC\_IDLE and RRC\_INACTIVE if the UE context is not found).”
* ”Makes it possible to differentiate or enable prioritization of non-RedCap UEs vs. RedCap UEs during contention resolution if RedCap UE type is visible to MAC layer.”
* ”Enables the RedCap UE to operate in an initial BWP which is wider than the RedCap UE bandwidth, as the gNB can take into account UE RF-retuning time while transmitting RAR”
* Update the text in 11.1 in “feasibility” of Option 2 as follows:

“Feasibility: Identification of RedCap UE type(s) based on Msg3 may be feasible at least for the following solutions, which don’t need to be mutually exclusive:* Using the spare bit in existing Msg3 definition.
* Extension of existing RRC message or Msg3 size to carry additional one or more bits, indicating RedCap UE type(s).
* Introduction of new larger RRC message (e.g. on CCCH1).
* New MAC control element or LCID”
* Capture the following as ”pros” for Option 2:
* “Enables RRC connection rejection of RedCap UE for access restriction (for UEs coming from RRC\_IDLE and RRC\_INACTIVE if the UE context is not found).
* ”Makes it possible to differentiate or enable prioritization of non-RedCap UEs vs. RedCap UEs during contention resolution if RedCap UE type is visible to MAC layer.”
* -”Enables handling of different processing delay requirements (if such are agreed and specified) for RRC procedures between RedCap and non-RedCap i.e. RRC Setup -> RRC Setup Complete and RRC Resume and RRC Resume Complete delays.”
* Add to ”feasibility” of Option 3:

”From RAN2 perspective this is already covered by existing signalling with limited specification impact.”* Capture the following as ”cons” for Option 3:
* “Cannot enable RRC connection rejection of RedCap UE for RedCap-specific access restriction (for UEs coming from RRC\_IDLE and RRC\_INACTIVE if the UE context is not found)”.
* Update the text proposal for Option 4 with the following and capture the TP in the TR:
* Align wording of pros and cons with Option 1-3 (where applicable).
* Clarify that for fallback case indication in MsgA preamble part is beneficial.
* Add the UE differentiation / prioritization to “pros” as in Option 1 and 2.
* Capture following text in 11.2.1 in Description of feature “The purpose of the feature is to not only provide the same functionality as for legacy UEs but to have RedCap specific access restrictions to be able to avoid or limit negative impact on legacy performance.” (19/20)
* Capture following text in 11.2.1 on Cell barring: ”For RedCap UEs, an explicit or implicit indication in broadcast system information can be used to indicate whether a RedCap UE can camp on the cell or not. If a RedCap UE is not allowed to camp on a cell or the RedCap UE considers the cell as barred, it could be of interest to bar all cells on the frequency to ensure RedCap UEs only camp on the strongest cell. Legacy UEs have the same functionality and the IE intraFreqReselection configures in the UE should consider only the current cell as barred or all cells on the frequency. For RedCap it remains to be determined if the functionality should be controlled by the same intraFreqReselection IE or if a new separate parameter should be introduced.” (20/20)
* Update the text proposal and capture text in 11.2.2 Analysis of coexistence and 11.2.3 Analysis of specification impacts once it is clear which options and mechanisms for access restrictions are captured in the TR.

Agreements;* Capture following options with descriptions in TR for RedCap UAC (first two have been agreed to be studied earlier):

1) Define new Access Identity or Identities for RedCap UE2) Define new Access Category or Categories for RedCap UE3) Broadcast a separate set of parameters for RedCap UEs4) Use existing broadcasted UAC parameters for RedCap UEs without any changes* Capture in the TR that one option (without giving any recommendation) is that the network should be able to differentiate between RedCap and non-RedCap UEs using UAC (e.g. configure different parameters to RedCap and non-RedCap UEs)
* Capture following text in 11.2.1 on RRC Connection reject: ”To save radio resources and limit negative impact on legacy network performance it is beneficial to bar or reject UEs as early as possible, preferably without additional signalling. Therefore, cell barring and UAC is beneficial compared to RRC connection rejection. However, if the network is aware the UE is a RedCap during initial access, it is possible for the network to reject RRC connection based on UE being a RedCap UE. There is no additional specification impact in case early indication is specified.” (detailed wording can still be discussed)

Agreements:* The legacy UAC principle is assumed for RedCap. The details of how RedCap UEs are using access identity(s) and/or access category(s) are to be discussed during normative phase.
* Capture following text in 11.2.1 on RRC Connection reject: ”To save radio resources and limit negative impact on legacy network performance it is beneficial to bar or reject UEs as early as possible, preferably without additional signalling. Therefore, cell barring and UAC is beneficial compared to RRC connection rejection. However, if the network is aware of the UEs type during initial access, it is possible for the network to reject RRC connection based on the UE type. There is no additional specification impact in case early indication is specified.”
* Capture following text in clause 11.2.2 Analysis of coexistence with legacy UEs:

“It is possible that separate RACH configuration is provided for RedCap UEs. In such case, it would be possible to configure different RACH parameters to RedCap and non-RedCap UEs, such as different maximum number for preamble transmission, different back-off timer after an attempt or a different power ramping step for RedCap UEs”.* Update the text referring to UAC in clause 11.2.1 in the TR with following:

”In UAC each access attempt is associated with an Access Category and one or more Access Identities (defined in TS 24.501). The possible solutions for RedCap UAC that have been considered in the study are the following (the options do not need to be mutually exclusive):* Define one or more RedCap specific Access Identities. Access Identities are connected to the UE type and are (currently) used to lift the barring for certain identities, e.g. for special access classes or UEs configured for prioritized services.
* Define RedCap specific Access Categories. Access Categories are related to the type of access attempt and is set per access attempt type depending on what triggered the access (set by NAS if NAS triggered, or by RRC if AS triggered). There can only be one Access Category per access attempt. To be able to treat different RedCap access attempt types differently, e.g. apply different barring to different access types, multiple Access Categories for RedCap could be defined.
* Use some of the operator defined Access Categories for RedCap. The description of the previous solution applies also to this solution, the difference is that this solution has no specification impact but cannot be used for initial attach to the network since it depends to CN configuration of the UE.
* Broadcast a different set of UAC parameters for RedCap UEs. This makes it possible for NW to flexibly and separately provide UAC parameters for RedCap UEs while avoiding impact on UAC configuration of non-RedCap UEs.
* Use existing broadcasted UAC parameters for RedCap UEs with no changes, that is, the same UAC parameters apply for all UEs (non-RedCap UEs and RedCap UEs) and no new Access Categories and Access Identities are defined. This option requires no specification changes.

 UAC is defined in TS 22.261 and TS 24.501, and feasibility of the options (e.g. defining new Access Identities or Access Categories) should be consulted with SA1/CT1.”  |

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

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| Agreements:* Capture in the TR that from RAN2 perspective it is recommended for UE in RRC IDLE and eDRX cycle is equal to 10.24s, that paging monitoring does not use PTW and PH. Send an LS to SA2 to check this
* Capture in the TR the related pros/cons aspects listed below (the list can be further checked and amended if needed):

Pros:• It enables longer eDRX cycles needed by some RedCap UEs and yet allow other UEs that do not need long eDRX cycles (>10.24s) to reuse NR R16 eDRX implementation without additional development work and without a need for an explicit capability signalling.• NR already has 10.24sec interval in C-DRX• For 10.24 s and RRC\_INACTIVE similar solution was adopted for LTE in eMTCCons:• It is different from LTE solution for eDRX cycle = 10.24s in RRC\_IDLE• It will impact 5GC and RAN2 will need to inform/consult SA2/CT1• UE can no longer have multiple opportunities to receive its paging during an eDRX cycle* Regarding the support of eDRX value up to 10485.76s, capture in the TR the pros/cons aspects listed below:

Pros• The upper limit of the H-SFN (10bit) already is 10485.76s• The CN already supports eDRX values up to 10485.76s• It is future-proof• No reason to artificially limit without technical concernCons:• There are no REDCAP use cases that require eDRX cycles beyond 2621.44s• Little power saving gain beyond 2621.44s. Simulation results show that the gain is saturated at around 40mins.* Capture in the TR that RAN2 recommends supporting a common design for handling eDRX cycle = 10.24s in RRC\_IDLE and RRC\_INACTIVE.

Agreements via email - from offline [109]* It should be possible for (at least some) REDCAP Ues to receive emergency broadcast services.
* Capture in the TR the two options for the deciding node for the eDRX configuration for RRC INACTIVE: RAN or CN.
* Capture in the TR the below arguments in favour of each option.

Option 1: CN decides the eDRX parameters for RRC\_INACTIVE· CN has better insight on UE traffic profile· Better for addressing potential core network impacts· CN is responsible for eDRX in RRC\_IDLE (and UE needs to monitor for CN paging also in RRC\_INACTIVE)· If RAN2 agrees to consider a common PTW and eDRX cycle configuration, CN based eDRX configuration can be supported with minimum impact to specifications where RAN follows the CN configured cycle justified by its simplicity and less impact expected to other WGsOption 2: RAN decides the eDRX parameters for RRC\_INACTIVE· It provides more flexibility to the RAN node in the configuration of the eDRX parameters· It allows RAN to configure different eDRX cycle for RRC INACTIVE· In R16 eMTC connected to 5GC, it is already NR-RAN that choses and configures the final eDRX cycle for RRC\_INACTIVE, based on idle mode eDRX cycle as provided by the AMF* Agree the below TP on eDRX parameters configuring node.
* Capture in the TR that RAN2 sees a benefit and recommends extending the eDRX cycle in RRC\_INACTIVE beyond 10.24s for REDCAP Ues.

Agreements online:* SA2/CT1 must be consulted on the feasibility prior to the introduction of eDRX cycles longer than 10.24 seconds in RRC Inactive.
* Agree the TP as in R2-2102019 for capturing agreements #1, #2 and #4 from online GTW session with the addition that "further update according to the conclusions on P2 and P4 are possible"
* Capture in the TR the justifying benefits listed below and associated issues to solve.

Benefits· It is very beneficial to have >10.24 sec in RRC\_INACTIVE to effectively support the usage of SDT (small data transfer) for e.g. use cases with periodic uplink data with periodicity > 10.24 s. TS 22.104 provides such usecases, e.g. some industrial wireless sensors need to transfer small packets while they are not very sensitive to DL traffic delay, but they have strict battery lifetime requirement.· Based on the results in the Appendix of the TR, there is a clear power saving gain vs eDRX in RRC\_IDLE at least for eDRX cycles of 10.24 s – couple of minutes, where the UE in eDRX in RRC\_INACTIVE additionally benefits from less signaling. Based on these results, lifetime of several years would not be achievable in some cases (e.g. 1 minute IAT) if only RRC\_IDLE can be used, because of the signaling overhead.· Signaling reduction is an additional benefit from network point of view – there is need for less RRC signalingIssues:· Impact on NAS retransmission, SA2/CT1 must be consulted on the feasibility· Potential handling of different eDRX cycles > 10.24s and/or PTWs, one for IDLE the other for INACTIVE· Need to study which Node decides the eDRX cycle for RRC\_INACTIVE* Agree the TP for eDRX > 10.24s in Inactive as in R2-2102019, with the addition of the sentence as in 1. above
* Capture in the TR that RAN2 will consider the following configurations for the PTW and eDRX for RRC\_IDLE and RRC\_INACTIVE (SA2/CT1 must be consulted on this before taking a decision on which way to go):

· Common PTW and eDRX cycle configuration· A common PTW but with different eDRX cycle· A common eDRX cycle but with different PTW length· Different eDRX cycle and different PTW length* Agree the updated TP as in R2-2102019 on configuration solutions for the PTW and eDRX for RRC\_IDLE and RRC\_INACTIVE, with the removal of "as a baseline for its simplicity"
* Capture in the TR the below five options allowing REDCAP UEs to reduce paging power consumption and/or receive emergency broadcast services (and resulting recommended eDRX lower bound) and the associated pros/cons.

Option 1: eDRX supports a lower bound of 2.56s.Option 2: For RedCap UEs, if the NAS configures the UE with a 2.56 DRX cycle, the RedCap UE follows this DRX even when the RAN paging cycle is shorter. eDRX lower bound can be kept to baseline 5.12s.Options 1-2 pros/cons:Pros• It enables a mix of smartphones and RedCap UEs in the network, with an appropriate paging cycle configured for each of them.• Specifically to option 2, it allows lower power consumption for page reception without any change to lower bounds of eDRX Cons:• This solution assumes such REDCAP Ues do not need to monitor gNB configured default broadcasted paging (and UE-specific RAN paging) cycles, thus resulting in network not being able to reach such RedCap Ues by using default broadcasted paging cycles and/or UE-specific RAN paging cycles. This may result e.g. in a potential risk of UE missing SI change indicator.• Specifically for Option 2, it requires a different way to determine the UE DRX cycle for REDCAP Ues in both the UE and the gNB.Option 3: gNB can configure 2.56s default broadcasted DRX cycle for those RedCap Ues that need to receive emergency broadcast services and a shorter UE-specific RAN paging cycle for Ues with tighter latency requirements (e.g. smartphones). eDRX lower bound can be kept to baseline 5.12s.Pros• Consistent with the LTE solution.• Solution based on Network implementation and there is no additional impact.• RedCap UEs can benefit from lower power consumption, as well as receive emergency broadcast.Cons:• A default broadcasted DRX value of 2.56s is expected seldom used in existing deployments supporting smartphones requiring changes to the paging cycle in existing deployments and configuring on top a UE-specific RAN paging cycle for each such smartphones.• A default broadcasted DRX value of 2.56s is expected seldom used in existing deployments supporting smartphones, requiring changes to the paging cycle in existing deployments and configuring on top a UE-specific RAN paging cycle for each such smartphonesOption 4: RedCap Ues that need to receive emergency broadcast services are not expected to request to be configured with eDRX, and no specific handling/configuration is required for those Ues. eDRX lower bound can be kept to baseline 5.12s.Pros• No specification or configuration impact.Cons:• Those REDCAP Ues do not benefit from eDRX power saving.Option 5: REDCAP UE can request an eDRX configuration while still monitoring in between (by implementation) for ETWS and CMAS. eDRX lower bound can be kept to baseline 5.12s.Pros• No specification impact, no impact on network side. • Uses existing LTE baseline.• UE can be configured with long eDRX cycle for power saving. It is up to UE implementation how often it monitors for ETWS/CMAS informationCons:• Those REDCAP UEs do not benefit from full eDRX power saving.* TP as in R2-2102040 on eDRX lower bound and emergency broadcast reception with power saving agreed with modifications according to 1. above (the TR rapporteur will suggest which section this will go)

TP on eDRX upper bound below agreed with the move of the sentence on RAN4 elsewhere (TR rapporteur will fix this)Section 8.3.1:From RAN2 perspective, extended DRX can be specified and configured for RedCap Ues so that eDRX cycles can be used in RRC\_IDLE and in RRC\_INACTIVE states. Other Section (up to TR rapporteur):For the upper bound, the eDRX cycle should support up to 10485.76s, since the upper limit of the H-SFN (10bit) already is 10485.76 seconds, and CN already supports eDRX values up to 10485.76 seconds. Although little power saving gain has been observed beyond 2621.44 seconds (simulation results show that the gain is saturated at around 40 minutes), there is no reason to artificially limit without technical concern, unless RAN4 indicates such eDRX value requires UE to perform RRM on serving cell outside PTW. Agreements:* Irrespective of RRC state, whether to enable/disable RRM relaxation function for Redcap UEs is within network’s control.
* The following enhancements for triggering neighbour RRM relaxation in RRC\_IDLE/RRC\_INACTIVE are endorsed for inclusion in the TR. Among these solutions, -Enhancement #1, #2, #3 and #5 can be considered as higher priority. Exact TP and whether some amendments are needed/ further enhancements need to be added can be further discussed:

• Enhancement 1: Introduce additional SsearchDeltaP\_stationary threshold to support 2 level speed evaluation (i.e. stationary, low mobility); • Enhancement 2: Take into account of beam switching in low mobility evaluation; • Enhancement 3: UE determines its stationary property based on subscription information (e.g. USIM); • Enhancement 4: Introduce an additional SsearchDeltaP\_correction threshold and configure the UE to use it if only it detects that it observes higher received signal power variation that do not violate stationarity i.e., rotating around itself, dynamically changing multipaths;• Enhancement 5: Introduce additional TSearchDeltaP\_stationary to support 2-level stationarity (i.e. fixed location vs low mobility);* The following enhancements for neighbour RRM relaxation methods in RRC\_IDLE/RRC\_INACTIVE are endorsed for inclusion in the TR. Exact TP and whether some amendments are needed/ further enhancements need to be added can be further discussed:

• Enhancement 1: UE can stop measurements on neighbor cells for T (T>>1) hours; • Enhancement 2: Enabling further relaxation via reducing the number of monitored RS; • Enhancement 3: UE only perform measurements on a number of dedicated intra-freq, inter-freq cells; • Enhancement 4: Minimize the number of measured frequencies; * For neighbour cell RRM relaxation in RRC\_CONNECTED, “fixed or immobile UEs” are considered with higher priority than “slightly moving UEs”.

Agreements via email - from offline [110]:* For measurement relaxation methods, RAN2 can discuss preferable solutions, but RAN4 should be consulted before making the final decision.
* Capture in TR the potential solutions for neighbour cell RRM relaxation methods in RRC\_CONNECTED. The exact mechanism, if any, should be decided by RAN4. From RAN2’s perspective, other solutions are not precluded (e.g. network does not configure measurements for mobility purpose, UE only performs measurement on single RS type).
* To capture simulation results of R2-2100459 to TR (take into account the received comments).
* To capture simulation results from R2-2101257 to TR.

Agreements:* No recommendation on prioritization for neighbour cell RRM relaxation among different RRC states
* Indicate in the TR conclusions that irrespective of RRC state, serving cell RRM relaxation for Redcap UEs is not considered in Rel-17
* Capture the observation 1 from R2-2101461 to TR. Detailed wording to be discussed offline

Agreements:* Capture in TR the following solutions to assist triggering neighbour RRM relaxation in RRC\_CONNECTED.

• Solution 1: UE reports “stationary” status to network in Msg5; • Solution 2: Network provides (e.g. low mobility, not-at-cell-edge) evaluation parameters to UE via dedicated signalling; • Solution 3: AMF sends “stationary” indication to gNB (based on UE subscription); • Solution 4: UE reports “stationary” in UE Assistance Information to network;* Capture in the TR that it is recommended to support eDRX value up to 10485.76 s for RRC Idle, unless RAN4 indicates such eDRX value requires UE to perform RRM on serving cell outside PTW
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RAN2 agreed to hold the following post-meeting email discussion:

* [POST113-e][116][REDCAP] TP finalization (Ericsson)

 Scope: merge all the agreed TP (with necessary fine tuning for editorials/clarifications) and review of the final recommendations. More recommendations can be added (e.g. on number of RedCap UE types, on UAC and on RRM relaxation) if that is possible

 Intended outcome: Endorsed TP in R2-2102056

 Deadline: Nov 26th (Deadline set in order for R1 to finally agree the complete TR for RP).

RAN2 endorsed TPs were provided in [R2-2102056](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2102056.zip) (and taken into account by RAN1 as described in Section 2.1.1.4 above).

#### 2.2.2 Remaining Open issues

None. RAN2 has confirmed that the SI can be concluded from RAN2 perspective.

## 4. References

RAN1#101e

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#102e

144 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))

RAN1#103e

187 contributions (for details see agenda item 8.6 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_103-e/Docs/TDoc_List_Meeting_RAN1%23103-e.xlsx))

RAN2#111e

66 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))

RAN2#112e

66 contributions (for details see agenda item 8.12 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_112-e/Docs/TDoc_List_Meeting_RAN2%23112-e.xlsx))

RAN2#113e

61 contributions (for details see agenda item 8.12 in [Tdoc list](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/TDoc_List_Meeting_RAN2%23113-e.xlsx))