3GPP TSG-RAN WG2 #111e Tdoc draftR2-2008199

Electronic meeting, August 17th – 28th 2020

Agenda Item: 8.12.1

Source: Rapporteur (Ericsson)

Title: Summary of [AT111][108][REDCAP] Scope and skeleton update

Document for: Discussion, Decision

# 1 Introduction

This document summarizes the following discussion during RAN2#111-e:

* [AT111e][108][REDCAP] Scope and skeleton update (Ericsson)

Scope: Discuss the SI scope in [R2-2006910](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_111-e/Docs//R2-2006910.zip) and the skeleton update in [R2-2007366](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_111-e/Docs//R2-2007366.zip)

Initial intended outcome: summary of the offline discussion with e.g.:

* + - List of agreeable proposals (if any)
		- List of proposals that require online discussions

and skeleton update

Initial deadline (for companies' feedback): Monday 2020-08-24 16:00 UTC

Initial deadline (for rapporteur's summary in R2-2008189): Monday 2020-08-24 18:00 UTC

The discussion in based on [R2-2006910](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_111-e/Docs//R2-2006910.zip) [2] and there are questions related to the TR skeleton [3] as well.

As background for the discussion on the study item scope, the SID includes the following objectives [1]:

*The study item includes the following objectives:*

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

* *Reduced number of UE RX/TX antennas*
* *UE Bandwidth reduction*

*Note: Rel-15 SSB bandwidth should be reused and L1 changes minimized*

* *Half-Duplex-FDD*
* *Relaxed UE processing time*
* *Relaxed UE processing capability*

*The study includes evaluations of the impact to coverage, network capacity and spectral efficiency*

*Note1: The work defined above should not overlap with LPWA use cases. The lowest data rate and bandwidth capability considered should be no less than an LTE Category 1bis modem.*

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

* *Reduced PDCCH monitoring by smaller numbers of blind decodes and CCE limits [RAN1].*
* *Extended DRX for RRC Inactive and/or Idle [RAN2]*
* *RRM relaxation for stationary devices [RAN2]*

*Study functionality that will enable the performance degradation of such complexity reduction to be mitigated or limited, including [RAN1]:*

* *Coverage recovery to compensate for potential coverage reduction due to the device complexity reduction.*
	+ *Note: For FR1, coverage analysis for wearables can include consideration of potential reduced antenna efficiency due to device size limitations as part of the antenna gains. The extent of additional recovery of coverage loss due to reduced antenna efficiency is to be limited to 3 dB*
* *The study includes evaluations of the impact to network capacity and spectral efficiency*

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

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

*Note2: Potential overlap with coverage enhancements study is discussed and resolved in RAN#87 or later.*

*Note3: Coexistence with Rel-15 and Rel-16 UE should be ensured*

*Note4: This SI should focus on SA mode and single connectivity*

Companies are asked to provide input on the described scope in questions below. Please indicate especially if some objective is not clear, or if there are some aspects missing from the proposed scope of discussion.

# 2 Discussion

## 2.1 UE complexity reduction features

As discussed in [1] and in other submitted contributions, RAN1 has the main responsibility of defining the features which describe a RedCap UE, where a number of agreements have been made already.

For RAN2, it mainly remains to be discussed which particular aspects of RAN2 protocols and procedures are impacted and whether changes are needed. Companies are welcome to provide their initial views on what RAN2 should further consider or discuss related to the UE complexity reduction features.

The RAN1 agreements before RAN2#111-e are listed in the Appendix for reference. It should be noted the final feature list is not yet completed and the evaluation from RAN2 side is subject to change.

**Question 1 (Expected RAN2 impact): What are expected impacts in RAN2 protocols and procedures due to introduction of RedCap UEs in NR/5GS? What other aspects, not already covered by the objectives in the SID [3], RAN2 should consider in their work?**

*Note: The discussion can be based on already agreed features in RAN1 and based on expectations on possible not yet agreed RedCap features.*

|  |  |
| --- | --- |
| **Company** | **View** |
| Qualcomm | * Study the impact of reduced coverage on cell re-/selection and RACH procedures
* Discuss whether Redcap should have reduced maximum number of DRBs, HARQ processes (DL/UL), active CG/SPS, and Scells to help lower complexity/cost. Or what the minimum number of those configurations that RedCap should support.
* Discuss whether RRC processing delay requirement may be relaxed, due to RedCap UE’s lower processing capability
* Discuss whether any simplification to user plane protocols may be made for RedCap UE’s, due to their reduced capabilities and/or lower performance requirements
 |
| OPPO | Discuss whether to balance the load for RedCap UEs and normal UEs, if they are served in the same cell. |
| Xiaomi | We agree with the rapporteur that RAN1 defines what describes a RedCap UE and RAN2 should study if those complexity reduction features, such as bandwidth reduction will have impact on RAN2 procedures. To ensure the Redcap UEs coexistence with Rel-15 and Rel-16 UE, the potential specification impacts can be considered from the control plane and user plane respectively. For the control plane, except form UE capability and access restrictions, we would like to study the RAN1 impacts of control channel messages (SIB, RAR and paging) as well as cell re-/selection. Regarding to the impact to user plane, we would like to study the data transmission and possible DRX enhancement for specific IoT scenarios. More details can be found in our submitted contribution. |
| Ericsson | Depending on RAN1 agreements, there may be impact on idle mode procedures and initial access e.g. in case UE wouldn't support the bandwidth of legacy CORESET#0 or initial UL/DL BWPs. Such impacts should be avoided if possible – but if needed RAN2 should further discuss RAN2 impact.Relaxed processing time (RAN2), half-duplex FDD and reduced number of HARQ processes (brought up in RAN1) are features where we think gains may not warrant the additional complexity. Relaxed processing time should in our preference have no impact in RAN2. At minimum RAN2 should understand the impact of these features in RAN2 specifications and further provide input to TR/RAN1 on the potential impact.  |
| Futurewei | Signaling and procedure related to initial access and cell (re)selection, such as system information acquisition, random access, access control, RRM measurements, etc. |
| Apple | In general, we agree with the comments from companies above. In addition, we would like to bring up the validity of the scenario where the NW (gNB) only caters to RedCap UEs. We do NOT see the practicality of this, but want RAN2 to make a decision on whether this needs to be supported (i.e., bar legacy UEs and allow only RedCap UEs).  |

**Question 2 (RAN2 input on features): Do you think there is need for RAN2 to provide other input to RAN1 regarding the UE complexity reduction features. If yes, please elaborate on what input you think is needed.**

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| --- | --- | --- |
| **Company** | **Yes / no** | **Comments** |
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##

## 2.2 UE power saving and battery lifetime enhancement

Two RAN2-specific objectives related to UE power saving are mentioned in the SID [3]: 1) Extended DRX for RRC Inactive and/or Idle, and 2) RRM relaxation for stationary devices.

Discussion paper [1] contains proposal for RAN2 to provide solutions and analysis to TR 38.875 on extended DRX for RRC Inactive and Idle modes and RRM relaxation for stationary RedCap devices. This is inline with the SI scope and companies are asked to confirm the understanding of this scope and provide additional comments, if any:

**Question 3 (Power saving scope): Do you agree that for UE power saving and battery lifetime enhancement, RAN2 should focus only on studying extended DRX for RRC Inactive and Idle modes and RRM relaxation for stationary RedCap devices, and provide input on these objectives to TR 38.875?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / no** | **Comments** |
| Qualcomm | No | We think other power saving enhancements not mentioned in the SID (for example, C-DRX enhancements for target RedCap use cases) can be studied too during the SI phase, as long as their power saving benefits can be justified.  |
| OPPO | Yes |  |
| Xiaomi | No | We also think other power saving enhancements can be taken for Redcap devices. At least we can take some from in R16/R17 UE power saving. For instance, the current scope mentioned E-DRX for RRC Inactive and/or Idle, however we think it is equally important to reduce the power consumption for Redcap UE during RRC\_CONNECTED mode. So some skemes can be taken from R16 UE power saving which was mainly focused on RRC-Connected mode. And we can also pick up some schemes form R17 UE power saving once they have got some progress. |
| Ericsson | Yes | We think introduction of eDRX should be prioritized. Any other power saving enhancements can already apply to RedCap UEs as well, assuming they do not depend on capabilities which RedCap UE would not have.Regarding other possible enhancements, such should only be studied (or further, standardized) if clear benefits vs. complexity can be shown. RAN2 is unfortunately short on time just to complete the existing objectives already so we think we should stick to the existing scope. |
| Futurewei | Yes | Given the available time, it is already very challenging to complete this study.This study also has close relation with other R17 SI/Wis, such as power saving. Hence, extending its scope without approval from RAN is not recommended.  |
| Apple | No | C-DRX should also be considered for power-saving. The RedCap UEs should also benifit from power-saving in connected mode. |

The SID only mentions "RRM relaxation for stationary devices", and it is not explicitly stated whether such relaxation should apply to neighboring cells and/or the serving cell. Also, it is not explicitly stated whether relaxation should apply in RRC\_IDLE and/or RRC\_INACTIVE and/or RRC\_CONNECTED. Companies are asked to provide preliminary input on what they think should be the scope of the RRM relaxation objective.

**Question 4 (RRM relaxation scope): Which cells and RRC states RAN2 should focus on when studying RRM relaxation for stationary RedCap devices?**

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| --- | --- | --- | --- |
| **Company** | **Neighboring/serving cell** | **RRC state(s)** | **Comments** |
| Qualcomm | Both | all | We may prioritize RRM relaxation in RRC Idle/Inactive over RRC Connected, but in the SI phase we do not have to eliminate a particular RRC state without discussion.  |
| OPPO | Both | all | In the study phase, we don’t have to limit the scope, i.e. we can study all these combinations. However, we have the opinion of down-prioritizing serving cell RRM relax in the WI phase. |
| Xiaomi | Both | all | We are open to study all those cases. |
| Ericsson | Both | all | Preference to study both cell types for RRC\_IDLE and RRC\_INACTIVE, whereas for RRC\_CONNECTED only neighboring cell measurements to avoid impacts on NW performance. |
| Futurewei | Both | all | Both serving cell and neighboring cell can be considered for RRM relaxation in RRC\_IDLE/INACTIVE and RRC\_CONNECTED states, given the vastly diverse use cases of Redcap UE.  |
| Apple | Both  | All states |  |

## 2.3 Standardization framework and principles for constraints for reduced capabilities

One of the objectives in the SI is to "study standardization framework and and principles for how to define and constrain such reduced capabilities". Proposal in [1] is for RAN2 to focus on providing RAN2 view on how and how many RedCap UE types should be defined and for RAN2 to further study how to possibly constrain or extend the capability signaling framework for RedCap UEs or use cases.

**Question 5 (UE types): Do you agree that RAN2 should study if, how and how many UE types should be defined for RedCap UEs from RAN2 point of view and provide input to RAN1 and TR 38.875?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes / no** | **Comments** |
| Qualcomm | Yes | RAN2 can discuss at high-level how many types of RedCap UEs are needed. RAN1 can discuss details in the definition of a RedCap UE type. |
| OPPO | Yes | But the final decision may not be mad by RAN2 only. |
| Xiaomi | No | RAN1 should define the specific capabilities or group of capabilities that can be reduced. So we think how and how many UE types should be defined in RAN1 and RAN1 is currently discussing this. We should wait for their inputs and based on which to study capability signalling. |
| Ericsson | Yes | RAN2 can discuss the need for UE types from RAN2 point of view, understanding that the final decision is not only up to RAN2 but RAN1 is involved as well.  |
| Futurewei | Yes | This is related to the email dicussion [109]. |
| Apple | Yes | We also agree this is related to email disc 109. Our view is for RAN2 to study the UE types, but we are hesitant to use these types in RRC signaling. We think the types can be primarily used for marketing purposes, and instead of using these types explicitly for constraining RedCap UEs, RAN2 can work with what RAN1 agrees and try to not add too many types in signaling to be used for restricting access. The main concern with such approach is the backward compatibility with the addition of newer types. We think it’s better to define a very small set of types into which any new future RedCap additions would go into. We see that RAN2 will probably use these types for access restriction and we want to make sure that this is not complicated. |

**Question 6 (Capability framework): Do you agree that RAN2 should discuss whether there is need to constrain or extend the existing capability signaling framework due to introduction of RedCap UEs in NR/5GS, and provide possible input in TR 38.875?**

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| --- | --- | --- |
| **Company** | **Yes / no** | **Comments** |
| Qualcomm | No | We do not see strong needs to extend/enhance the existing capability signaling framework for RedCap.  |
| OPPO | No | RAN2 may need to first confirm to use existing capability signaling framework as baseline and then consider how to accommodate the new UE type.  |
| Xiaomi | - | See above. It is too early to discuss this. |
| Ericsson | - | RAN2 should indeed discuss whether there is need for extensions, the outcome would depend on if/how UE types would be defined and how this would map into capabilities. Agree with OPPO that existing capability framework should be taken as the baseline.  |
| Futurewei | Yes | This is related to the email dicussion [109]. |
| Apple | ?? | We do not fully understand by what extend means. Our view is that RedCap should use the existing capability transfer framework, where newer capabilities are added (just like addition of capabilities for any new feature). We may also have to define capabilities for mandatory without signaling features, and here we have to put a requirement that only RedCap UEs will set these fields. If this is what is meant by extension, then yes. If a new (seperate) capability enquiry/reply procedure is what extends means, then we do not see the need.  |

**Question 7 (Constraining of reduced capabilities): Do you agree that RAN2 should discuss whether and how it can be ensured RedCap UEs are used only for intended use cases, and provide possible input in TR 38.875?**

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| --- | --- | --- |
| **Company** | **Yes / no** | **Comments** |
| Qualcomm | Yes | We think RAN2 can discuss what enhancements are needed to ensure RedCap UEs are used only for their intended use cases. If necessary, we can involve other working group (e.g. SA) too.  |
| OPPO | Yes | This is already indicated in the SID. |
| Xiaomi | Yes | RAN2 should study the signalling framework for defining reduced capabilities UE to ensure those device types are identifiable to the network for intended use cases. However, whether it involves early identification of RedCap UE during initial access should be first discussed in RAN1. |
| Ericsson | Yes | Note that CT/SA must be involved for the part on "*ensure those device types are only used for the intended use cases”* in the SID as this (use case) cannot be determined by RAN alone. |
| Futurewei | Yes | This is related to the email dicussions 109 &110. |
| Apple | Yes, butsssss | Yes to discuss, but ensuring RedCap UEs are used for intended purposes is something that can be taken care of by CT (NAS signaling).  |

## 2.4 Functionality for identification of restricted capability UEs

The network should be able to identify RedCap UEs from "normal" NR UEs e.g. to control access of such UEs to the system. Couple of different ways to achieve this are discussed in the submitted contributions and according to the SI [3], RAN2 should study the options and provide view on which would be the best way. Correspondingly, proposal in [1] is for RAN2 to provide input to TR 38.875 on the possible identification mechanisms, and on the possible access restriction mechanisms. Companies are asked to confirm the understanding of the RAN2 scope.

**Question 8 (Identification of UEs in RAN): Do you agree that RAN2 should discuss and provide input to TR 38.875 on mechanisms how to identify RedCap UEs and how to control the access of RedCap UEs in RAN?**

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| --- | --- | --- |
| **Company** | **Yes / no** | **Comments** |
| Qualcomm | Yes | We think some form of explicit indication is necessary for network to identify RedCap UEs. Control access of RedCap UEs in RAN can be based on access barring and UAC. |
| OPPO | Yes | For early RedCap UE’s identification, e.g. in RACH procedure, we should wait for RAN1’s input. For RedCap UE’s access control, we also think extension to access barring and UAC can be studied by RAN2. |
| Xiaomi | Yes | Whether it involves early identification of RedCap UE during initial access should be first discussed in RAN1. For RedCap UE’s access control, the UAC can be reused and further studied. Other tools, e.g., random access back-off for Redcap can be considered further. |
| Ericsson | Yes |  |
| Futurewei | Yes | This is related to the email dicussions 109 &110. |
| Apple | Yes, but | Yes to discuss. But we are not keen on identifying mechanisms to idenity RedCap UEs (they are known anyway with Ue capability). If identification is needed for restricting acces, we do not see the need for the NW to identify before restricting, UAC can just bar without the need for the NW to identify. |

## 2.5 TR skeleton for TR 38.875

The TR skeleton for TR 38.875 is provided in [2]. This version is based on the initial version v0.0.1 endorsed in RAN1#101-e and further revised.

The above questions cover the sections in TR 38.875 where RAN2 input is expected. Companies are asked to provide input on the TR skeleton, e.g. if there are sections which should be added, changed or removed, etc.

**Question 9: Please provide input, if any, on the TR skeleton in [2].**

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| **Company** | **Input** |
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## 2.6 Organization of the RAN2 work during the study phase

If RAN2 identifies need to update the skeleton or provide other text input already from RAN2#111-e, it should be possible to send LS to RAN1 e.g. containing RAN2 changes on the skeleton, if needed. This can be evaluated once the discussion has progressed.

Otherwise, RAN2 should consider whether to start email discussions on the different aspects discussed above, to facilitate the eventual input to TR 38.875.

**Question 10: Do you agree that RAN2 should initiate email discussions Post-RAN2#111-e on the different aspects and objectives discussed above, where the scope is drafting input to TR 38.875, to be agreed in RAN2#112.**

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| --- | --- | --- |
| **Company** | **Yes / no** | **Comments** |
| Qualcomm | Yes | The scope of the post meeting email discussion can be reviewing the draft TR which captures agreements made in this meeting (#111-e).  |
| OPPO | Yes | Post-meeting email discussion can help to progress the study phase. |
| Xiaomi | Yes |  |
| Ericsson | Yes | Email discussions should be utilized to progress the work. The details can be further discussed once we see what kind of progress is achieved during RAN2#111-e. |
| Futurewei | Partially Yes | Only limited number, no more than 2, please! |
| Apple | Partially Yes | Same view as Futurewei. |

# Summary and proposals

TBD

# References

1. [R2-2006910](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_111-e/Docs//R2-2006910.zip), Scope of RedCap SI, Ericsson, RAN2#111-e, Electronic meeting, August 2020.

1. [R2-2007366](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_111-e/Docs//R2-2007366.zip), R38.875 skeleton updates for Study on support of reduced capability NR devices, Ericsson, RAN2#111-e, Electronic meeting, August 2020.

1. [RP-201386](https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_88e/Docs/RP-201386.zip), Revised SID on Study on support of reduced capability NR devices, Ericsson, RAN#88e, Electronic meeting, June 29 – July 3, 2020.

# Appendix: RAN1 agreements from RAN1#101-e

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).
 |

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 |

 |

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.
 |

Delegate contact information:

|  |  |
| --- | --- |
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