**3GPP TSG RAN#90e RP-20xxxx**

**e-Meeting, December 7th – 11th, 2020**

**Agenda item:**

**Source:** 3GPP TSG RAN1 Chairman

**Title:** Email Summary on Rel-17 Coverage Enhancements Work Item Scoping

**Document for:** Discussion/Decision

# Introduction

In this document, we will provide a summary on Rel-17 Coverage Enhancements Work Item scoping based on the following contributions:

* RP-202211 Power aspects for pi/2 BPSK in Rel-17 Indian Institute of Tech (H)
* RP-202267 Scope of Rel-17 WI on NR coverage enhancements Huawei, HiSilicon
* RP-202302 Coverage Enhancement study and WI scope for Rel-17 OPPO
* RP-202324 Views on the scope of Coverage Enhancement WI CMCC
* RP-202352 Views on Coverage Enhancement WI Intel Corporation
* RP-202355 On overlapping objectives across Rel-17 WIs Intel Corporation
* RP-202360 New WID on NR coverage enhancements China Telecom
* RP-202410 Views on WI for NR coverage enhancement Ericsson
* RP-202527 Views on coverage enhancement WID scope NTT DOCOMO, INC.
* RP-202530 On the scope of Rel-17 NR coverage enhancement Samsung
* RP-202559 Views on NR coverage enhancements WI Apple Inc.
* RP-202638 Views on WID scope for Rel-17 coverage enhancements vivo
* RP-202665 Views on WID scoping for Rel-17 NR coverage enhancement ZTE, Sanechips
* RP-202666 Views on Msg3 enhancement for Rel-17 NR coverage enhancement ZTE, Sanechips, Nokia, Nokia

Shanghai Bell, China Telecom, SoftBank, Thales, Sharp

* RP-202680 Views on Coverage Enhancement WI in Rel-17 Nokia, Nokia Shanghai Bell
* RP-202681 On the need for UL RACH enhancements in Rel-17 Nokia, Nokia Shanghai Bell, ZTE, Sanechips
* RP-202694 Way forward on NR Coverage Enhancements MediaTek Inc.
* RP-202711 Views on Rel-17 NR coverage enhancements CATT
* RP-202738 New WID: Power aspects for pi/2 BPSK in NR IITH
* RP-202745 Views on scope of NR Coverage enhancements WI Qualcomm Incorporated
* RP-202402 NR Coverage Enhancement and NTN THALES, Qualcomm, Firstnet, Fraunhofer HHI, Fraunhofer

IIS, Intelsat, Hughes Network Systems, ZTE, Panasonic, ESA, Oppo

# Proposals

The email discussion is organized as follows:

* General
	+ To collect any general thoughts, e.g., interaction between RAN1 and other WGs, overall scoping vs. TU budget, etc.
* Justification
* Detailed Objectives
	+ Potential PUSCH enhancements
		- To collected detailed thoughts on potential PUSCH enhancements
	+ Potential PUCCH enhancements
		- To collected detailed thoughts on potential PUSCH enhancements
	+ Potential enhancements for other channels
		- To collected detailed thoughts on other channels, particularly, msg3 and PRACH
	+ Other aspects
		- To collected detailed thoughts on other aspects, e.g., those raised in RP-202211 and RP-202402, overlapped objectives across WIs, etc.

## General

Questions:

* Any general thoughts? e.g., interaction between RAN1 and other WGs, overall scoping vs. TU budget, etc.

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| **Company** | **Views** |
| Sierra Wireless | As we saw during the SI phase, having coverage enhancement work being done in two SI (CovEnh and RedCap) was very inefficient and should thus be avoided. The CovEnh WI should thus including as many Redcap Coverage requirements as will fit. If it helps, we can move TU’s from Redcap to CovEnh.  |

Proposals:

* TBD

## Justification

Rappoetuer’s draft for justification (as in RP-202360):

*Coverage is one of the key factors that an operator considers when commercializing cellular communication networks due to its direct impact on service quality as well as CAPEX and OPEX. Many countries are making available more spectrum in FR1, such as 3.5GHz, which is typically in higher frequencies than for LTE or 3G. Furthermore, Compared to LTE, NR is designed to operate at much higher frequencies such as 28GHz or 39GHz in FR2. Due to the higher frequencies, it is inevitable that the wireless channel will be subject to higher path-loss making it more challenging to maintain an adequate quality of service that is at least equal to that of legacy RATs. One key mobile application of particular importance is voice service for which a typical subscriber will always expect a ubiquitous coverage wherever she/he is located.*

*The Rel-17 study item 860036 “Study on NR coverage enhancements” evaluates the baseline performance for both FR1 and FR2. The following channels are identified as the potential bottleneck channels for FR1:*

* *1st priority*
	+ *PUSCH for eMBB (for FDD and TDD with DDDSU, DDDSUDDSUU and DDDDDDDSUU)*
	+ *PUSCH for VoIP (for FDD and TDD with DDDSU, DDDSUDDSUU)*
* *2nd priority*
	+ *PRACH format B4*
	+ *PUSCH of Msg.3*
	+ *PUCCH format 1*
	+ *PUCCH format 3 with 11bit*
	+ *PUCCH format 3 with 22bit*
	+ *Broadcast PDCCH*

*The following channels are identified as the potential bottleneck channels for Urban 28 GHz scenario:*

* + *PUSCH eMBB (DDDSU and DDSU)*
	+ *PUSCH VoIP (DDDSU and DDSU)*
	+ *PUCCH F3 11bits*
	+ *PUCCH F3 22bits*
	+ *PRACH B4*
	+ *PUSCH of Msg3*

*The Rel-17 study item 860036 “Study on NR coverage enhancements” studies the enhancements for PUSCH, PUCCH and other channels/signals. The study item concludes that it is beneficial to support a set of enhancements for PUSCH, and further establishes detailed recommendations as given in Section 7 in TR 38.830.*

Questions:

* Any comments/suggestion on the justification of the work item?
	+ Note that it is understood that discussion on justification for the work item depends on the discussion on the detailed objectives. This implies that a fully stable justification section may not be possible before the conclusion of the detailed objectives
	+ However, it is necessary to have early discussion on the justification section so that some level of convergence can be achieved in parallel

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| **Company** | **Views** |
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Proposals:

* TBD

## Detailed Objectives

### Potential PUSCH Enhancements

Related RAN1 agreements/conclusion:

*Agreements: Capture the following observation into the TR.*

* *Enhancements on PUSCH repetition type A is beneficial for PUSCH coverage enhancements for TDD. It is recommended to support enhancements on PUSCH repetition type A in Rel-17, including the following two options (potential down-selection during the WI phase):*
	+ *Option 1: Increasing the maximum number of repetitions, e.g., up to 32.*
	+ *Option 2: The number of repetitions counted on the basis of available UL slots.*

***Agreements:*** *Capture the following observation into the TR.*

*TB processing over multi-slot PUSCH is beneficial for PUSCH coverage enhancements. It is recommended to support TB processing over multi-slot PUSCH in Rel-17, including:*

* *TBS determined based on multiple slots and transmitted over multiple integer slots.*

***Agreements:*** *Capture the following observation into the TR.*

*Joint channel estimation is beneficial for PUSCH coverage enhancements. It is recommended to support Joint channel estimation or DM-RS bundling for PUSCH in Rel-17, including:*

* *Joint channel estimation over consecutive PUSCH transmissions*
* *Inter-slot frequency hopping with inter-slot bundling*

Rappoetuer’s recommendation (as in RP-202360):

* + Specify one or two options for enhancement on PUSCH repetition type A [RAN1]
		- Option 1: Increasing the maximum number of repetitions, e.g., up to 32.
		- Option 2: The number of repetitions counted on the basis of available UL slots.
	+ Specify mechanism to support TB processing over multi-slot PUSCH [RAN1, RAN4]
		- TBS determined based on multiple slots and transmitted over multiple integer slots. [RAN1]
		- [Sub-PRB transmission with multi-slot aggregation, e.g. 6 tones [RAN1, RAN4]]
	+ Specify mechanism to enable joint channel estimation [RAN1, RAN4]
		- Mechanism to enable joint channel estimation over consecutive PUSCH transmissions, including cross-slot channel estimation over consecutive slots and joint channel estimation over multiple PUSCH transmission within one slot [RAN1]
		- Inter-slot frequency hopping with inter-slot bundling to enable joint channel estimation [RAN1]
		- Specify the requirements for power consistency and phase continuity [RAN4]

Questions:

* Do you agree with the recommended scope for potential PUSCH enhancements? Why/why not?
	+ Please elaborate detailed thoughts

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| **Company** | **Views** |
| Sierra Wireless | In general, agree. Some specific comments:We would like to make this change to this bullet:* + - Option 1: Increasing the maximum number of repetitions~~, e.g.,~~ up to 32.

Increasing repeats beyond 32 would move into the LPWA (NB-IOT/LTE-M) type coverage category which should be strictly avoided. Also, >32 repeats would significantly decrease spectral efficiency and adds no coverage for eMBB case where data rate is 100kbps. We would like to make these changes to this bullet: * + - ~~[~~Sub-PRB transmission with multi-slot aggregation~~, e.g. 6 tones~~ [RAN1, RAN4]~~]~~

We do not think it is appropriate or needed for RAN PL to give guidance on the number of sub-carriers- WGs will make that decision. Editorial: “mechanism” should be “mechanism(s)” throughout |

Proposals:

* TBD

### Potential PUCCH Enhancements

No consensus in recommendation was made by RAN1, although a variety of aspects were discussed for potential PUCCH enhancements.

Rappoetuer’s recommendation (as in RP-202360):

* Specification of PUCCH enhancements [RAN1, RAN4]
	+ [Specify DMRS-less PUCCH with UCI payload up to 11 bits [RAN1, RAN4]]
	+ [Specify mechanism to support PUSCH-repetition-Type-B like PUCCH repetition [RAN1]]
	+ [Specify signaling mechanism to support dynamic PUCCH repetition factor indication [RAN1]]
	+ [Specify mechanism to support DMRS bundling across PUCCH repetitions [RAN1, RAN4]]

Questions:

* Which one(s) of the above potential PUCCH enhancements would you recommend? Why/why not?
	+ Please elaborate detailed thoughts

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| **Company** | **Views** |
| Sierra Wireless | No strong view but feel that only ONE mechanism should be chosen to fit in TU budget.  |

Proposals:

* TBD

### Potential Enhancements for Other Channels

No consensus in recommendation was made by RAN1, although a variety of aspects were discussed particularly for msg3 and PRACH enhancements.

#### Potential Msg3 Enhancements

Rappoetuer’s recommendation (as in RP-202360):

* [Specify mechanism to support PUSCH repetitions for Msg3 [RAN1]]

Questions:

* Would you recommend supporting PUSCH repetitions for Msg3? Why/why not?
	+ Please elaborate detailed thoughts

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| **Company** | **Views** |
| Sierra Wireless | Recommend for inclusion in WI. Should not be large item and would be good for RedCAP UEs with 3dB antenna degradation. |

Proposals:

* TBD

####  Potential PRACH Enhancements

Rappoetuer’s recommendation (as in RP-202360):

* [Specify PRACH enhancements for short formats for FR2 [RAN1, RAN2]]
	+ Multiple PRACH transmissions with the same beam
	+ Multiple PRACH transmissions with different beams

Questions:

* Would you recommend supporting PRACH enhancements for short formats for FR2? Why/why not?
	+ Please elaborate detailed thoughts

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| **Company** | **Views** |
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Proposals:

* TBD

#### Any other channels?

Questions:

* Any other channels that you would recommend? Why?
	+ Please elaborate detailed thoughts

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| **Company** | **Views** |
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Proposals:

* TBD

### Other Aspects

#### Potential power boosting for pi/2 BPSK for PUSCH for PC2 UEs

Related RAN1 agreements/conclusion:

***Conclusion:***

* *RAN plenary to decide whether to support power boosting for pi/2 BPSK for PUSCH for PC2 UEs.*
	+ [Specify power boosting for pi/2 BPSK for PUSCH for PC2 UEs [RAN4]]

Reference RP-202211 has some detailed proposals.

Questions:

* Do you recommend specifying power boosting for pi/2 BPSK for PUSCH for PC2 UEs? Why/why not?
	+ Please elaborate detailed thoughts

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| **Company** | **Views** |
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Proposals:

* TBD

#### Potential Interaction with NTN

Reference RP-202402 proposed to take into consideration of NTN to the extent possible in NR coverage enhancement work item, along with some detailed proposals.

Question:

* Do you recommend taking into account NTN in NR coverage enhancement work item (e.g., justification, objectives)? Why/why not?
	+ Please elaborate detailed thoughts

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| **Company** | **Views** |
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Proposals:

* TBD

#### Any other specific aspects?

Question:

* Any other specific aspects that you would like to disucss? E.g., any other objectives that you’d like to recommend to be included in the work item? Handling of overlapped objectives with other WIs? Others?
	+ Please elaborate detailed thoughts (particularly, if you have any preference regarding where/how to handle overlapped objectives with other WIs)

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| **Company** | **Views** |
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Proposals:

* TBD

# Conclusion

Based on the email discussion, the following are proposed:

* TBD

# References

RP-202211 Power aspects for pi/2 BPSK in Rel-17 Indian Institute of Tech (H)

RP-202267 Scope of Rel-17 WI on NR coverage enhancements Huawei, HiSilicon

RP-202302 Coverage Enhancement study and WI scope for Rel-17 OPPO

RP-202324 Views on the scope of Coverage Enhancement WI CMCC

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RP-202402 NR Coverage Enhancement and NTN THALES, Qualcomm, Firstnet, Fraunhofer HHI, Fraunhofer IIS, Intelsat, Hughes Network Systems, ZTE, Panasonic, ESA, Oppo