

Agenda Item: 9.1.1

Source: Samsung

Title: On the scope of Rel-17 NR coverage enhancement

Document for: Discussion and Decision

Use cases for coverage enhancement

- ◇ Scenarios for FR1 evaluation
 - ◆ Urban 4GHz/2.6GHz TDD
 - ◆ Rural 4GHz/2.6GHz TDD NLOS O2I, 2GHz FDD NLOS O2I, 700 MHz FDD NLOS O2I
 - ◆ Rural 4GHz with long distance TDD LOS O2O

- ◇ Scenarios for FR2 evaluation
 - ◆ Urban 28GHz TDD NLOS O2I/O2O
 - ◆ Suburban 28GHz TDD NLOS O2I/O2O
 - ◆ Indoor 28GHz TDD NLOS

- ◇ Evaluation in TR 38.830 shows as bottleneck channels for coverage in FR1 and FR2
 - ◆ PUSCH
 - ◆ PUCCH
 - ◆ PRACH
 - ◆ Msg3 PUSCH

Coverage enhancement for PUSCH

- ◇ Enhancements for PUSCH repetition type A/B
 - ◆ Simple solution to improve coverage with minimal impact to UE/gNB implementation, widely used for improving coverage in NB-IoT/eMTC UEs operating at low SNR
 - ◆ Type A – larger number of repetitions, flexible symbol resource allocation in different slots
 - ◆ Type B – more efficient resource utilization, transmission of a repetition across slot boundary and unavailable UL symbols

- ◇ Cross-slot channel estimation
 - ◆ Channel estimation accuracy can be a performance bottleneck in poor coverage scenario
 - ◆ Cross-slot channel estimation over (non-)consecutive slots, cross-repetition channel estimation within one slot, inter-slot frequency hopping with inter-slot bundling to enable cross-slot channel estimation

- ◇ Sub-PRB transmission for VoIP
 - ◆ Improves spectral efficiency while lowering the code rate
 - ◆ Number of tones, sub-PRB transmission with single slot and sub-PRB transmission with multi-slot aggregation

- ◇ TB processing over multi-slot PUSCH
 - ◆ Allows operating at lower coding rate/lower MCS on parts of a large TBS
 - ◆ TBS determined based on single slot and transmitted in parts over multiple slots, TBS determined based on multiple slots and transmitted over multiple slots

◇ Enhancements for PUCCH repetitions

- ◆ Simple solution to improve coverage with minimal impact to UE/gNB implementation
- ◆ Allows a more efficient resource utilization
- ◆ Increased flexibility respect to Rel-16 PUCCH repetitions by removing restrictions related to start symbol of a repetition, completion of a repetition within a slot, repetition to occur in consecutive symbols (similar to PUSCH type B repetitions)

◇ Indication/maximum of number of PUCCH repetitions

- ◆ Dynamic indication allows an adjustment of a number of repetitions according to UCI payload and number of symbols per repetition
- ◆ Increase beyond a maximum of 8 repetitions (can depend on the maximum UCI payload to be supported for PUCCH repetitions and the SCS)

Coverage enhancements during initial access

- ◇ Uplink coverage during initial access for FR2 needs improvement
 - ◆ Evaluation in TR 38.830 shows PRACH and Msg3 PUSCH as bottleneck channels
 - ◆ Deployments show a high percentage of failure in completing the random access procedure

- ◇ Improvements for channels during initial access
 - ◆ Multi-beam transmission for PRACH preamble allows to select a best beam and shorten the duration of the RA procedure
 - ◆ Beam quality reporting in Msg3 allows a refinement of the beam used by gNB/UE before beam establishment procedure in connected mode
 - ◆ Transmission of Msg3 with repetitions allows to improve the Msg3 uplink coverage

Proposal for WID scope

- ◇ Specify enhancements for PUSCH coverage
 - ◆ Enhancements on PUSCH repetition type A and type B
 - ◆ Mechanisms to support cross-slot channel estimation and DM-RS bundling
 - ◆ TB processing over multi-slot PUSCH
 - ◆ Mechanisms to support sub-PRB transmission for VoIP

- ◇ Specify enhancements for PUCCH coverage
 - ◆ PUSCH repetition type-B like PUCCH repetition
 - ◆ Dynamic PUCCH repetition factor indication

- ◇ Specify mechanisms to enhance coverage during initial access procedure
 - ◆ Enhancements for PRACH coverage in FR2, e.g., multiple PRACH transmissions with the same beam and multiple PRACH transmissions with different beams
 - ◆ Beam reporting during initial access procedure, including the best SSB, alternative SSB beam and early CSI report in Msg3 PUSCH
 - ◆ Transmission of Msg3 PUSCH with repetitions