3GPP TSG RAN Rel-19 workshop
Taipei, June 15 - 16, 2023
Agenda:5
RWS-230235

NR coverage enhancements for Rel-19

China Telecom
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Rel-17/18 coverage enhancements

- In Rel-17, following features are specified for NR coverage enhancements
  - » **PUSCH enhancements**: maximum number of repetition up to 32, available slot counting, TBoMS, DMRS bundling, inter-slot frequency hopping with DMRS bundling
  - » **PUCCH enhancements**: dynamic repetition indication, DMRS bundling, inter-slot frequency hopping with DMRS bundling
  - » Type A PUSCH repetitions for **Msg3**
- In Rel-18, following features are being studied/specified for NR coverage enhancements
  - » **PRACH enhancement**: multiple PRACH transmissions w/ same beam and different beams
  - » **Power domain enhancement**: Enhancements to realize increasing UE power high limit for CA and DC, MPR/PAR reduction
  - » Dynamic switching between DFT-S-OFDM and CP-OFDM

Motivation of coverage enhancements in Rel-19

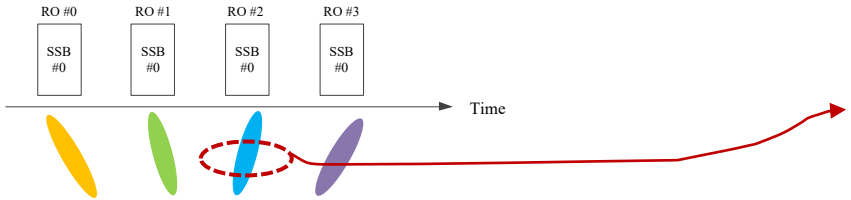
- Further extension of coverage enhancements solutions
  - » Rel-17 and Rel-18 work have provided a fundamental solutions for coverage enhancement, but there are some additional restrictions on the specified solutions, which can be further improved. On the other hand, the target UL data rate is set as 1Mbps for urban scenario, however, from operators' requirement, the target data rate is higher than 1Mbps in practical network, e.g., 2Mbps. Thus, a better coverage performance is needed.
- State of art technique for coverage extension
  - » Reconfigurable intelligent surface (RIS) has been studied in both academia and industry in recent years as a hot topic. Different from network-controlled repeater (NCR), RIS mainly consist of passive or nearly passive electronic units which can adjust the phase and/or amplitude of the impinging signals. Moreover, RIS may work in a reflection/refraction mode, which can directly reflect/refract the impinging signals in a beamforming manner. RIS intends to provides a low-cost, low-power consumption coverage extension & energy efficient solutions both for indoor and outdoor.

Potential schemes/scopes for further Cov. Enh. (1/4)

- Enhanced DMRS bundling
  - » DMRS bundling is beneficial to improve PUSCH coverage performance. However, in Rel-17, modulation order is restricted to not higher than QPSK for DMRS bundling, and only single TB is supported. The theoretical supported data rate w/ QPSK is **0.8Mbps w/ 4 repetitions, 0.4Mbps w/ 8 repetitions** for TDD DDDSU DDSUU, which can hardly meet the practical requirement of operators. In addition, DMRS bundling for non-consecutive slots is not supported in Rel-17, which limits the performance of DMRS bundling for TDD system.
  - » Thus, we propose to support the following schemes:
    - DMRS bundling for different TBs
    - High modulation order for DMRS bundling
    - DMRS bundling for non-consecutive slots

Potential schemes/scopes for further Cov. Enh. (2/4)

- Multiple PRACH transmissions with different beams
  - » During the discussion in Rel-18, it can be observed that multiple PRACH transmissions with different beams will facilitate the coverage in some cases, e.g., for the case when beam correspondence is not supported. In addition, beam indication for subsequent UL transmission can be realized based on multiple PRACH transmissions with different beam, e.g., beam indication for Msg.3 transmission.
  - » Thus, we have the following proposals for multiple PRACH transmissions with different beams
    - Support multiple PRACH transmissions with different beams.
    - Support mechanism to realize UL beam indication based on multiple PRACH transmissions.

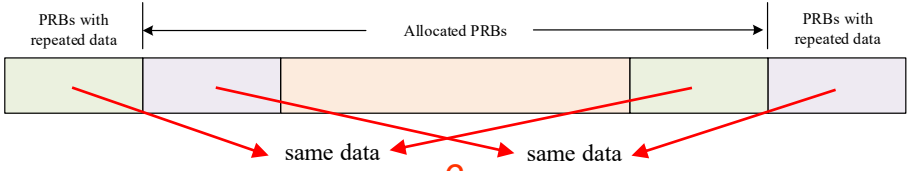


PRACH transmissions with different beams

For instance, if gNB can identify this beam is the best UL beam for corresponding UE, then indicate it to the UE.

Potential schemes/scopes for further Cov. Enh. (3/4)

- Power domain enhancement
  - » During the discussion in Rel-18, high power transmission in CA/DC and MPR/PAR reduction are both proved to facilitate the coverage, especially for non-transparent FDSS, simulation results have shown that over 1dB gain can be obtained in some cases. However, it seems hard to reach a consensus on the potential enhancement technology based on the current state of both RAN1 and RAN4.
  - » Thus, we have the following proposal for power domain enhancement, while it depends on the progress of the Rel-18 coverage enhancement.
    - Support FDSS with spectrum extension.
      - ➢ DMRS sequence type, extension and mapping method determination for non-transparent FDSS
      - ➢ Signaling indication and design for TB size calculation, power control bandwidth and others
    - Support PHR report framework enhancements for realizing high power uplink transmissions in CA/DC.

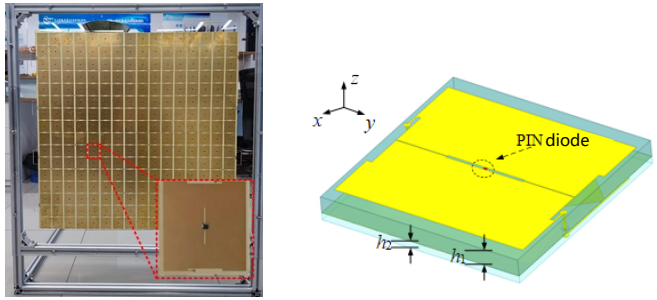


Potential schemes/scopes for further Cov. Enh. (4/4)

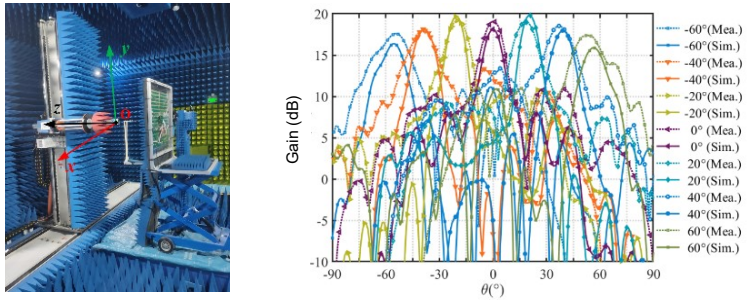
- Msg5 PUSCH repetition
  - » Based on the filed test, **Msg5 PUSCH becomes the coverage bottleneck** during the initial access. The main reason lies in: Msg5 has a very large payload size, e.g., >100 Bytes; repetition is not supported. The situation would get worse when Msg3 repetition is implemented cause more UEs would access to the network while congested during Msg5 transmission.
  - » Thus, we have the following proposal:
    - Support Msg5 PUSCH repetition

Potential benefits of RIS

- Study on RIS
  - » RIS mainly consists of passive or nearly passive electronic elements, which are programmable and can adjust the phase and/or amplitude of the impinging signals to realize beamforming. RIS intends to provides a low-cost, low-power consumption coverage extension & energy efficient solutions both for indoor and outdoor scenarios.

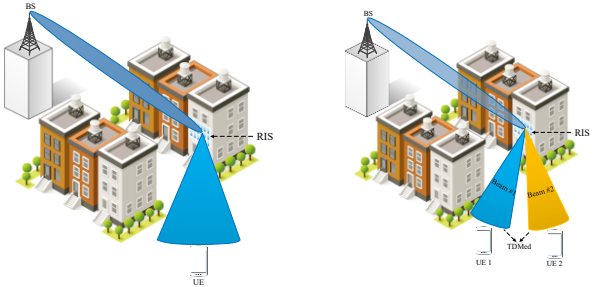


Demo of RIS and RIS element



Gain of reflection beam based on test

  - » RIS is beneficial for the coverage, especially for FR2.
    - E.g., deal with coverage issue due to blockage



Potential scopes for the study on RIS

- The potential scope of the study on RIS
  - » Generally, we think the study can include at least the following aspects.
    - Deployment scenarios
      - E.g., O2I, I2I, O2O etc.
    - System model
      - RIS type (e.g., reflection, active/passive); RIS architecture, related component (forwarding, control); Modeling of RIS element (materials and related parameters, e.g., reflection factor)
    - For UE-transparent/UE-non-transparent RIS, study shared control mechanism with NCR (signaling, control information, beam management), RIS-specific control mechanism, if any.
    - RIS capability (Beam switching, supported beams)
    - Full duplex operation
    - Performance evaluation

Potential scopes for Rel-19 coverage enhancements

- The potential scope is listed as follows
  - » Support DMRS bundling enhancement
    - DMRS bundling for different TBs; High modulation order for DMRS bundling; DMRS bundling for non-consecutive slots.
  - » Support multiple PRACH transmissions with different beams.
  - » Support further power domain enhancements.
    - Support FDSS with spectrum extension; Support PHR enhancement for CA/DC.
  - » Support Msg5 PUSCH repetition.
  - » Study the following aspects for reconfigurable intelligent surface
    - Deployment scenarios; System model
    - Shared control mechanism with NCR, and RIS-specific control mechanism, if any.
    - RIS capability, Full duplex operation
    - Performance evaluation

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Thanks!