

3GPP TSG RAN Meeting #93-e
Electronic Meeting, September 13 - 17, 2021
Agenda: 9.0.2
RP-211954



Further NR coverage enhancements

China Telecom
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■ Summary of RAN Rel-18 WS on UL enhancements

📶 2. Uplink enhancements, with the following example areas:

- >4 Tx operation
- Enhanced multi-panel/multi-TRP uplink operation
- Frequency-selective precoding
- Further coverage enhancements

■ In our view, areas for UL enhancement can be divided into two WIs.

» UL capacity enhancement:

- >4 Tx operation
- Enhanced multi-panel/multi-TRP uplink operation
- Frequency-selective precoding
- UL Tx switching enhancement

» UL coverage enhancement:

- PUSCH enhancement
- PUCCH enhancement
- PRACH enhancement

■ Motivations

- » More than 10 companies (including 6 operators) submit UL coverage enhancement related contributions in RAN Rel-18 workshop.
- » Cov_Enh SI in Rel-17 has identified UL channels as bottleneck channels. Some Cov_Enh solutions were included in Rel-17' Cov_Enh WI scope for PUSCH and PUCCH coverage enhancement.
- » The performance gap and remaining gap is summarized in the following table. It can be seen that there're still several dBs remaining gap considering practical NR deployment scenarios. Thus, it is beneficial to continue enhancing UL coverage in Rel-18.

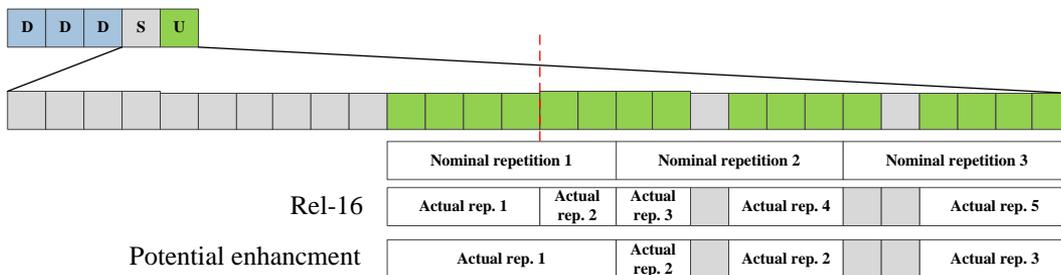
Tab. Baseline coverage performance & solutions' gain in TR 38.830

Channels	Scenario	MPL Gap	Solutions in Rel-17 WI	Remaining gap
PUSCH (eMBB)	Urban 4GHz TDD (ISD = 400m)	~(-7) dB	Rep. Type A: 2~3dB gain DMRS bundling: ~1dB gain TB processing: 1~2dB gain	Several dBs
	Rural 4GHz TDD NLOS O2I (ISD = 1732m)	~(-5.4) dB		Several dBs
PUSCH (VoIP)	Rural 4GHz TDD NLOS O2I (ISD = 1732m)	~(-1.8) dB		-
	Rural 4GHz TDD NLOS O2I (ISD = 3000m)	~(-11) dB		Large
PUCCH (F3 11bits)	Rural 4GHz TDD NLOS O2I (ISD = 1732m)	~(-2.5) dB	DMRS bundling: ~1dB gain	~ 1.5 dB

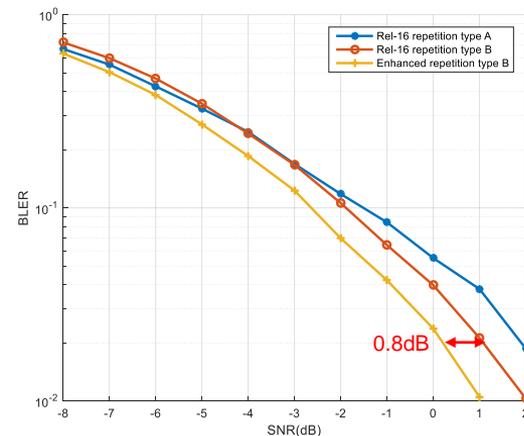
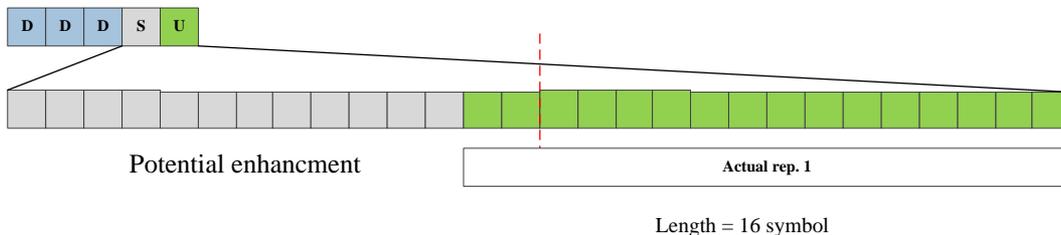
■ Enhancement on PUSCH repetition type B

- » Actual PUSCH transmission across the slot boundary/invalid symbols.
- » The length of actual repetition larger than 14 symbols.

Example 1



Example 2



Simulation results from TR 38.830

Performance gain	
eMBB	Voice
0.3~1.3dB(120km/h)	0.8~2 dB (3km/h)

■ UE transmit waveform design to reduce MPR

» Tone reservation

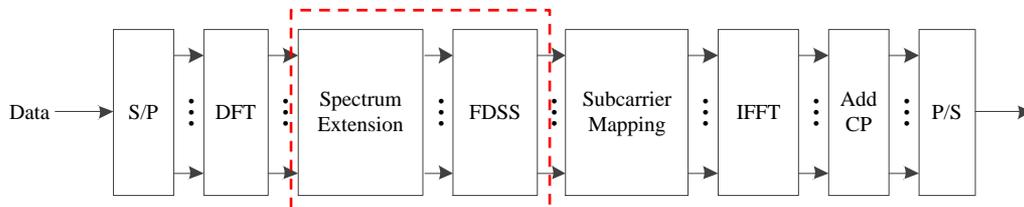
- Dedicate a subset of available sub-carriers (PRT, Peak Reduction Tones) to reducing the PAPR of the waveform.
- Utilize PRTs to cancel the peaks in the original waveform while leave the data tones unaltered.



Can provide 1~1.5dB gain due to increase in Tx power (From TR 38.830)

» Frequency Domain Spectral Shaping (FDSS) with spectral extension for QPSK

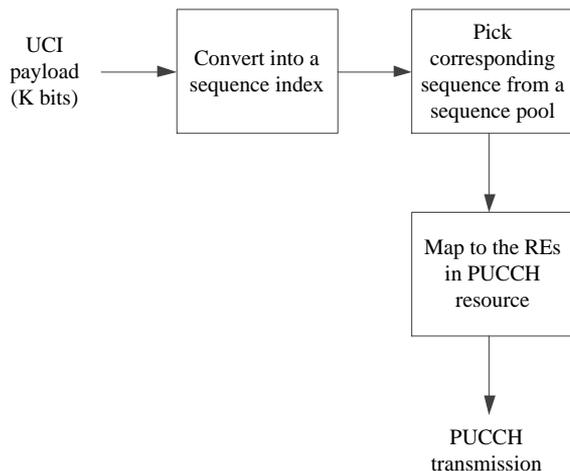
- Extend the spectral shaping framework defined in Rel-15 (for $\pi/2$ BPSK) for QPSK scenario.



■ DMRS-less PUCCH with UCI payload up to 11 bits

» Utilize sequence based PUCCH to transmit more than 2 bits UCI

- A new PUCCH format is needed to be specified, new sequences may also be needed.
 - Rel-15/16 sequence: CGS/ZC/Gold/m-sequence
- Receiver needs to perform non-coherent sequence detection for reception of the new PUCCH format.

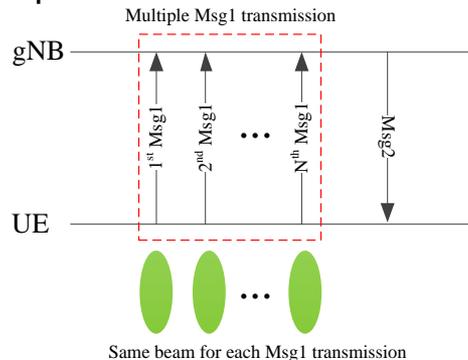


Simulation results from TR 38.830

Simulated scenario	Performance metric	Performance gain
Scenario 1: 2 bits UCI Baseline: PF1	1% FA, 1% ACK miss detection, 0.1% NACK to ACK error	3~4dB (3 Source)
Scenario 2: 3/4/6 bits UCI Baseline: PF3		1~2.8dB (3 Source)
Scenario 3: 11 bits UCI Baseline: PF3		0.9~4.8dB (6 Source)

Multiple PRACH transmissions

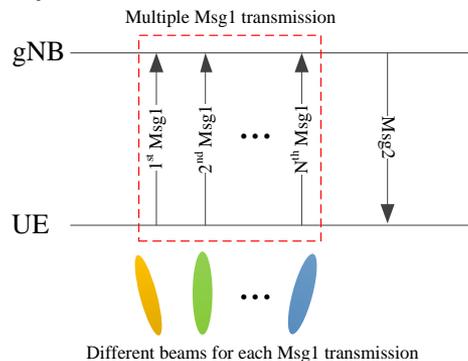
» Multiple PRACH transmissions with the same beam



Simulation results from TR 38.830

Performance gain	
w/ 2 Msg3 repetitions	w/ 4 Msg3 repetitions
3.7dB (FR1)	5.2dB (FR1)
1.7dB (FR2)	3.7dB (FR2)

» Multiple PRACH transmissions with different beams



Simulation results from TR 38.830

Performance gain	
w/ 2 Msg3 repetitions	w/ 4 Msg3 repetitions
2.5dB (FR1)	4.7dB (FR2)
2dB (FR2)	

- Specification of PUSCH enhancements [RAN1, RAN4]
 - » Specify enhancement on PUSCH repetition type B [RAN1]
 - Actual PUSCH transmission across the slot boundary/invalid symbols
 - The length of actual repetition larger than 14 symbols
 - » Study and if necessary specify power domain enhancement, e.g., UE transmit waveform design to reduce MPR [RAN1, RAN4]
- Specification of PUCCH enhancements [RAN1, RAN4]
 - » Specify DMRS-less PUCCH with UCI payload up to 11 bits
- Specification of PRACH enhancements for short formats for FR2 [RAN1, RAN2]
 - » Multiple PRACH transmissions with the same beam
 - » Multiple PRACH transmissions with different beams
- Left overs of Rel-17 WI on coverage enhancement

Thanks!
