

3GPP TSG RAN Rel-18 workshop
Electronic Meeting, June 28 – July 2, 2021
Agenda:4.1
RWS-210149



NR uplink enhancements for Rel-18

China Telecom
June-2021

■ Motivations

- » Both coverage & capacity are 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.
- » For coverage, better coverage capability brings more flexibility in NR network deployment as well as better service quality and less CAPEX and OPEX, which is beneficial to operators.
- » For capacity, the emergence of uplink centric services (e.g. real-time HD video, AR/VR/MR) brings challenge to UL capacity.



Fig. HD video surveillance



Fig. Machine vision



Fig. AR/VR

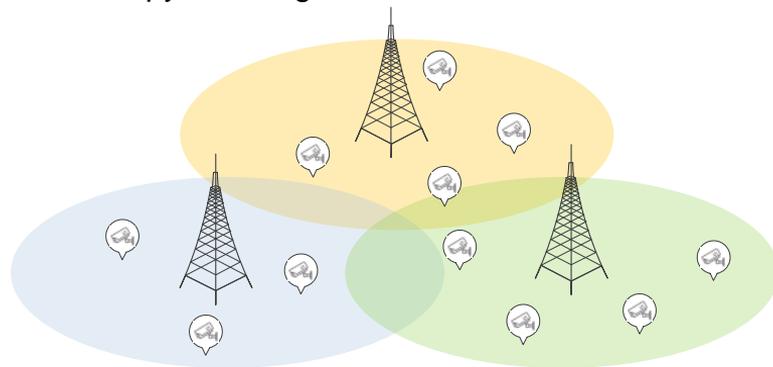
- From coverage aspect,
 - » Cov_Enh SI in Rel-17 has identified UL channels as bottleneck channels.
 - » Some Cov_Enh solutions were included in Rel-17' Cov_Enh WI scope for PUSCH and PUCCH coverage enhancement.
 - » The performance gap and remaining gap is summarized in the following table. It can 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

■ From capacity aspect,

- » Emergence of uplink centric services brings challenge to UL capacity.
- » For outdoor scenarios, e.g., Real-time HD video transmission services (e.g. HD video surveillance, HD video transmission by UAV, HD live broadcast) may be critical applications for 5G system to ensure human safety and property safety as well provide various entertainment.
 - For 2K/4K video streaming, UL data rates per 1 HD camera:
$$\{(2560 \times 1440) \text{ or } (4096 \times 2160)\} \text{Pixel} \times (8) \text{bit/Pixel} \times (25) \text{fps} / (102) \approx 7 \text{ or } 17 \text{Mbps (H.264)}$$
 - Tens of HD cameras may be needed in one cell, which will occupy non-neglectable UL resources. Thus, UL capacity enhancement is needed.



■ From capacity aspect,

- » For Indoor scenarios, e.g., XR services, machine vision (several hundreds Mbps ~ Gbps) also put forward higher requirements on UL capacity.

Tab. Image recognition latency and UL data rate for intermediate data uploading in TR 22.874

User application	Maximum end-to-end latency	User experienced UL data rate	
		AlexNet	VGG-16
Person identification in security surveillance system	Several seconds	1.6~21.6Mbps	8~240Mbps
Photo enhancements at smartphone	Several seconds	1.6~21.6Mbps	8~240Mbps
Video recognition	Several seconds	16~216Mbps	80Mbps~2.4Gbps
AR display/gaming	7~15ms	80Mbps~1.08Gbps	0.4~12Gbps
Remote driving	10ms	80Mbps~1.08Gbps	0.4~12Gbps
Remote-controlled robotics	10~100ms	80Mbps~1.08Gbps	0.4~12Gbps

- » Considering operator's practical network deployment,
 - For TDD spectrum, DL-heavy frame structure are generally adopted.
 - For both TDD and FDD spectrum, UL carrier cannot be separately configured. Additionally, the modulation and MIMO order of UL is lower.

- Specification of PUSCH enhancements [RAN1, RAN2, 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
 - » Specify mechanism to support sub-PRB transmission with multi-slot aggregation, e.g. 6 tones [RAN1, RAN4]
 - » Specify mechanism to support higher layer compression, e.g. packet aggregation [RAN2, RAN1]
- 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
- UE transmit waveform design to reduce MPR, e.g. including tone reservation, FDSS (Frequency Domain Spectral Shaping) with and without spectral extension for QPSK. [RAN1, RAN4]

- Specify mechanism to support 8 transmission layers for UL [RAN1]
- Specify 1024 QAM for UL [RAN1, RAN4]
- Specify DMRS enhancement [RAN1]
 - » 24 DMRS ports for UL
 - » DMRS overhead reduction
- Specify mechanism to enable flexible spectrum allocation [RAN2, RAN1, RAN4]
 - » More UL carriers than DL carriers
 - » Flexible association of DL and UL carriers
- Study and specify (if necessary) mechanism to enable UE cooperation [RAN1, RAN2, RAN4]

Thanks!
