

# PROPOSED WAY FORWARD ON NOMA

3GPP TSG RAN Meeting #82

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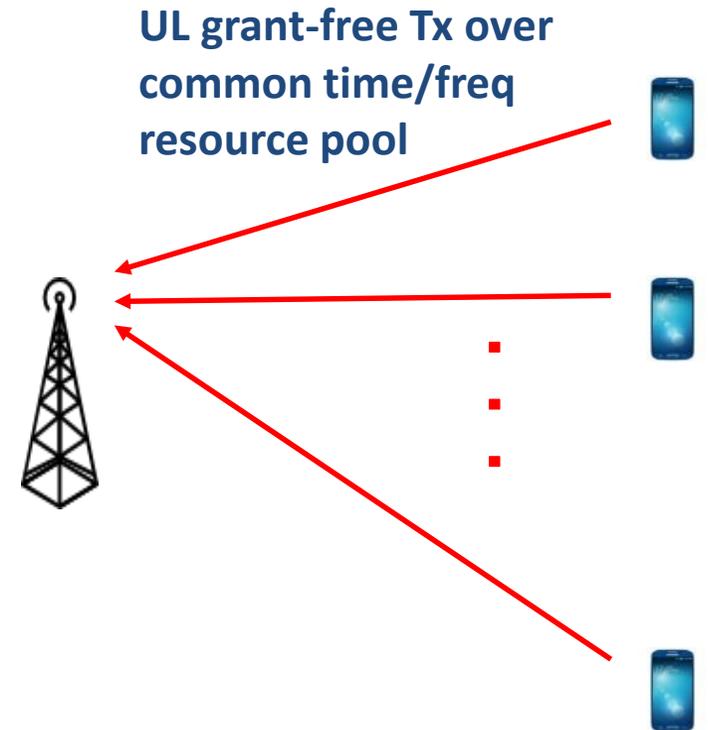
Document for: Discussion, Decision

# INTRODUCTION

Throughout this contribution, “**NOMA**” refers to grant-free (or configured grant) UL NOMA, where multiple UEs autonomously transmit data without explicit grant from gNB over time/freq (T/F) resource pool commonly used by multiple UEs.

**NOMA receiver procedure** at a given point of time for given T/F NOMA resource pool is, in general, comprised of the following two steps:

- **Step 1, UE identification.** Identify the a set of UEs that are simultaneously transmitting. This is common and prerequisite to all NOMA schemes due to the nature of “grant-free” transmission.
- **Step 2, Multi-user decoding.** Decode the packets from the set of UEs identified in Step 1. Advanced receivers such as MMSE-SIC/PIC and EPA are generally assumed to maximize the NOMA gain.



# KEY TAKEAWAYS FROM THE STUDY DURING REL-14 TO 16

**Significant NOMA gain over OMA.** NOMA can substantially improve the system performance over OMA for small packet transmissions for all the use cases studied, eMBB, URLLC, and mMTC.

- Observation from the study in Rel-14 (TR 38.802)
  - SLS results show that all simulated NOMA schemes provide significant capacity gain in terms of packets arrivals rate at a given system outage.
- Observation from the study in Rel-15 & 16 (TR 38.812)
  - NOMA gain observed is 10% - 150%, 42%-250%, and 46%-150%, for eMBB, URLLC, and mMTC, respectively.

**No performance difference among NOMA proposals including Rel-15 PUSCH as it is.** From LLS/SLS results, *no or marginal performance difference is observed among all NOMA schemes studied including LCRS (Low Code Rate Spreading – Intel’s NOMA proposal, Rel-15 PUSCH with no change) under fair/realistic simulation assumptions*

- This implies that the NOMA gain can be mostly achieved by employing advanced receivers (**almost no gain from modifications to Rel-15 PUSCH**). Indeed, this is aligned with Information-theoretic insight from “*the capacity region of multiple access channel with Gaussian noise*”, where the achievability can be proved by successive cancellation receiver w/ no change at the Tx side.

**Limited study on Step 1 (UE identification).** Study during Rel-15&16 has focused on comparison of different NOMA schemes for Step 2 (Multi-user decoding), not much study on necessary enhancements for Step 1. However, Step 1 can be a bottleneck in NOMA performance, as elaborated on the next slide.

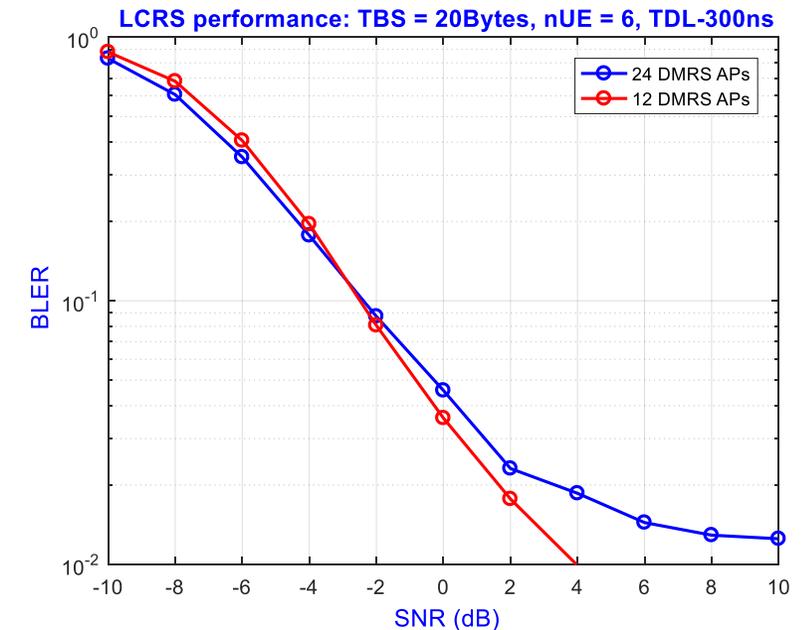
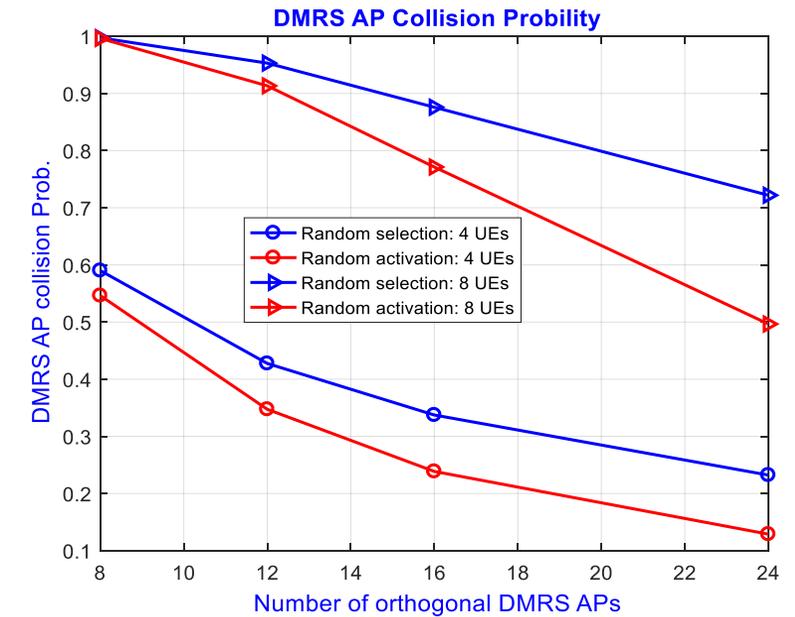
# POTENTIAL AREAS OF NORMATIVE WORK (1/2)

## Observations from the NOMA SI

- DMRS is assumed to be used for Step 1 execution (UE identification). Once a DMRS collision occurs, gNB is not able to exactly identify the set of UEs transmitting, and thereby unlikely to decode the corresponding packets.
- **Most companies have assumed in their simulations DMRS capacity larger than supported by Rel-15**
- Simulation results on the right hand side illustrate
  - DMRS capacity increase from Rel-15 can significantly reduce the DMRS antenna port (AP) collision probability
  - DMRS capacity increase can substantially improve the system performance

## DMRS enhancement

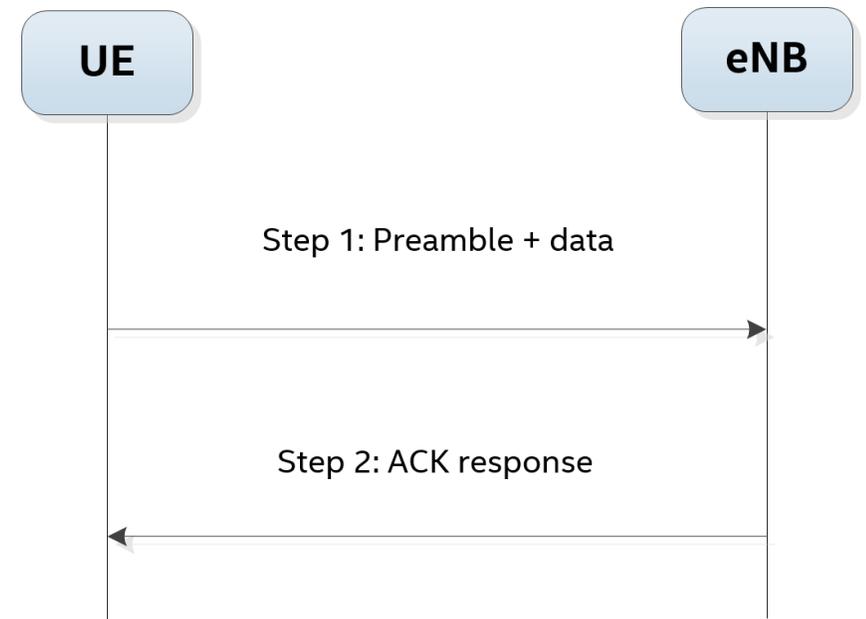
- Study & work on DMRS enhancement to increase the number of DMRS APs.



# POTENTIAL AREAS OF NORMATIVE WORK (2/2)

## 2-step RACH

- As illustrated in the figure, preamble and data can be transmitted together in the first step.
  - “Rel-15 PUSCH + NOMA receiver” can be used to maximize the 2-step RACH gain in terms of capacity, latency, and power consumption.
  - In addition to general procedure, need to study/work on potential modifications to preamble and/or DMRS for 2-step RACH considering NOMA
- Applicable for all UE modes, RRC\_IDLE, RRC\_INACTIVE, and RRC\_CONNECTED.
- 2-step RACH can be also beneficial for positioning including mmWave based positioning depending on NR positioning study.



# PROPOSED WF ON NOMA

No change in data part (i.e., reusing NR Rel-15 PUSCH) for NOMA

Study/work further on

- DMRS enhancements considering NOMA performance improvement
  - Assume NOMA receiver, e.g., MMSE-SIC/PIC, EPA, etc.
- 2-step RACH
  - Enable “data” transmission together with “preamble” by UE at the 1<sup>st</sup> step
  - Applicable to all UE modes, RRC\_IDLE, RRC\_INACTIVE, and RRC\_CONNECTED.
  - In addition to general procedure, need to study/work on potential modifications to preamble and/or DMRS for 2-step RACH considering NOMA

