



3GPP TSG RAN Meeting #75  
Dubrovnik, Croatia, March 6-9, 2017

RP-170424

# Studies on UL NOMA for NR in Rel-15

Agenda item: 9.1

Source: Intel Corporation

Document for: Discussion

# Background

Some agreements related NOMA during Rel-14 NR SI

- *Non-orthogonal multiple access should be investigated for diversified NR usage scenarios and use cases.*
- *NR should target to support UL non-orthogonal multiple access, in addition to the orthogonal approach, targeting at least for mMTC.*
- *NR should target to support UL “autonomous/grant-free/contention based” at least for mMTC.*

Although initial studies were performed during the Rel-14 SI, it was also acknowledged that further in-depth studies and analyses would be necessary and was not possible due to time constraints as part of the Rel-14 NR SI

# On the studies performed during Rel-14 NR SI

The basic definitions and terminology for UL NOMA and grant-free UL transmissions were established. A significant amount of results at link- and system-levels were reported, with some of them showing the potential promise of UL NOMA and grant-free schemes in terms of system spectral efficiency improvement. However, due to time constraints, the study during Rel-14 NR SI on UL NOMA was not exhaustive or conclusive.

- For system-level evaluations, reference for comparison was a basic UL NOMA scheme with basic receiver.
  - *No true comparison at system-level of NOMA schemes against OMA.*
- Differences in the baseline assumptions made meaningful comparison of gains across companies very challenging.
- Most evaluations (even those assuming MA resource and signature collisions) assumed separation of UEs based on their transmitted RS.
  - *Need better alignment of assumptions related to channel estimation and DM-RS, especially considering DM-RS collisions.*
- Sufficient time was not available for in-depth studies on various important aspects including, but not limited to, impact from MA resource, MA signature and/or RS collisions, HARQ and retransmissions, link adaptation, identification of UL transmissions for grant-free transmissions, details of advanced receiver options and associated complexity analysis, etc.
- The studies were primarily focused on the mMTC use case.

# Rel-15 NR SI on UL NOMA (1/3)

Analyze and evaluate the feasibility and performance gains from UL NOMA targeting diverse set of use cases

- Discuss and decide on common reference OMA scheme to establish the gains from NOMA over OMA at the system-level.
- Performance evaluations at link- and system-levels should consider different target KPIs and underlying assumptions for mMTC, URLLC, and eMBB (small packet transmissions).
- The assumptions agreed during the NR Phase 1 SI should be considered as a starting point, at least for mMTC and URLLC use cases.
  - Study and decide on additional parameters to better align the assumptions for meaningful comparisons of results across companies
    - These relate to traffic model, deployment scenarios, and Rx and Tx impairments (time and frequency offsets, receiver NF)

# Rel-15 NR SI on UL NOMA (2/3)

Study different NOMA schemes in conjunction with UL grant-free transmissions

- NOMA schemes identified during the NR Phase 1 SI should be considered as the starting point
  - Different NOMA transmission schemes with different spreading schemes at bit-level, modulated symbol-level, etc.
- Study the performance of different eNB receivers for UL NOMA
  - Consider impact of different receivers (MMSE, MMSE-IRC, SIC, PIC, MPA-based joint MUD, etc.) for demodulation/decoding as well as for channel estimation

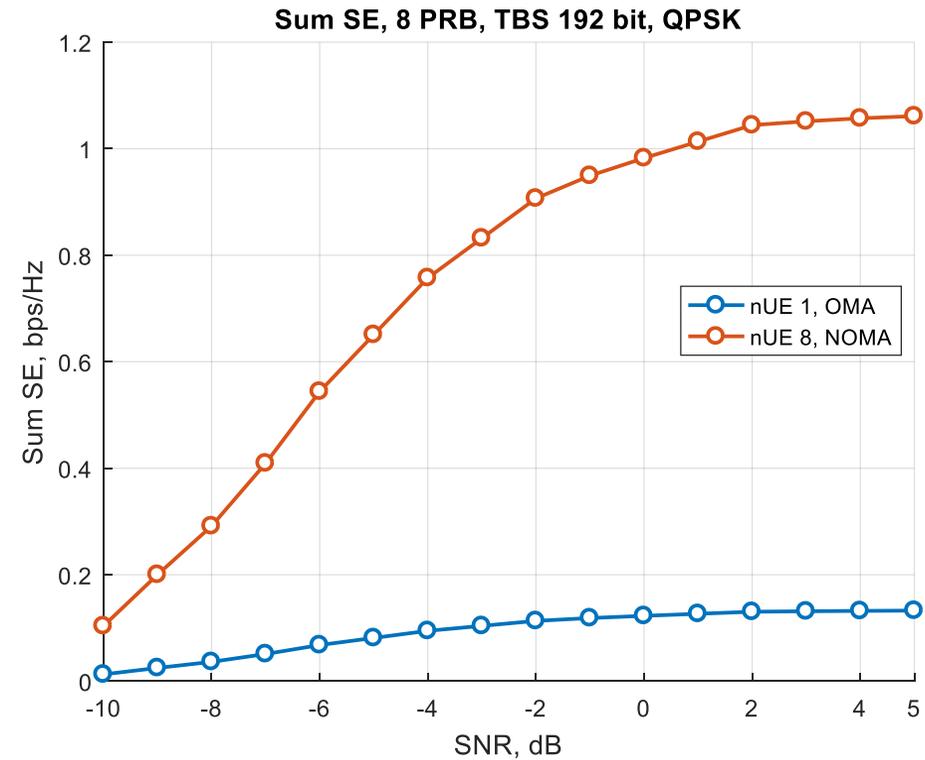
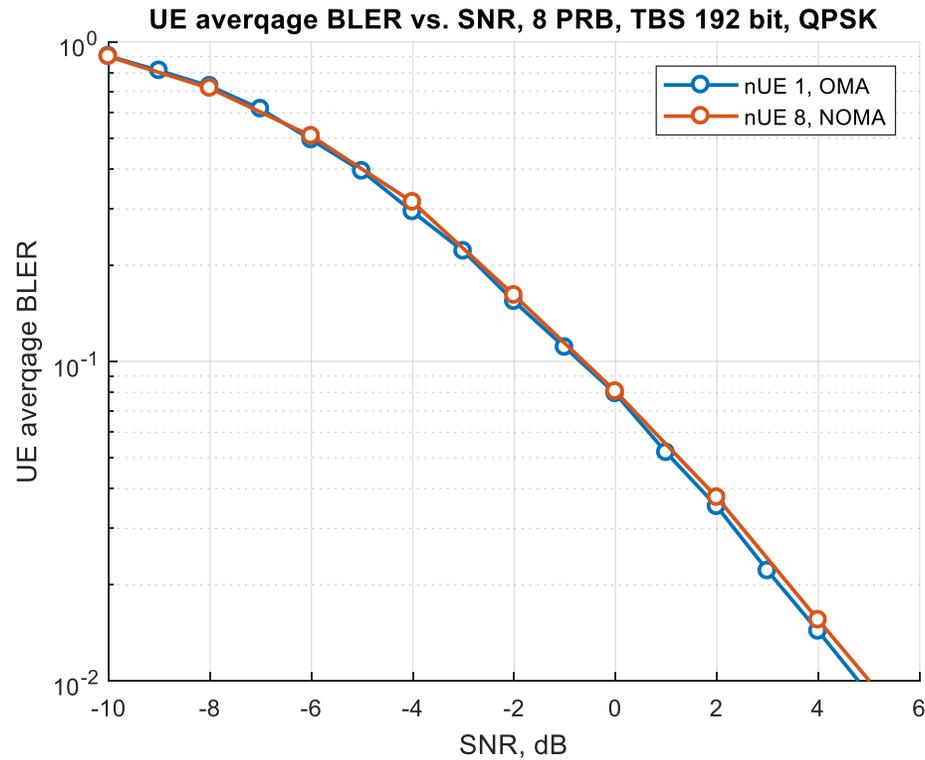
# Rel-15 NR SI on UL NOMA (3/3)

## Study different NOMA schemes in conjunction with UL grant-free transmissions

- Identify different system design details for support of UL NOMA with grant-free transmissions, *including, but not limited to:*
  - *resource configuration for grant-free UL NOMA transmissions;*
  - *support of retransmissions/HARQ schemes;*
  - *link adaptation;*
  - *UE identification (identification of UL transmissions);*
  - *channel estimation and DM-RS design options;*
  - *relationship between grant-free and grant-based schemes, etc.*
- For URLLC, the study should take into account decisions made on grant-free UL transmissions made during the NR Phase 1 SI

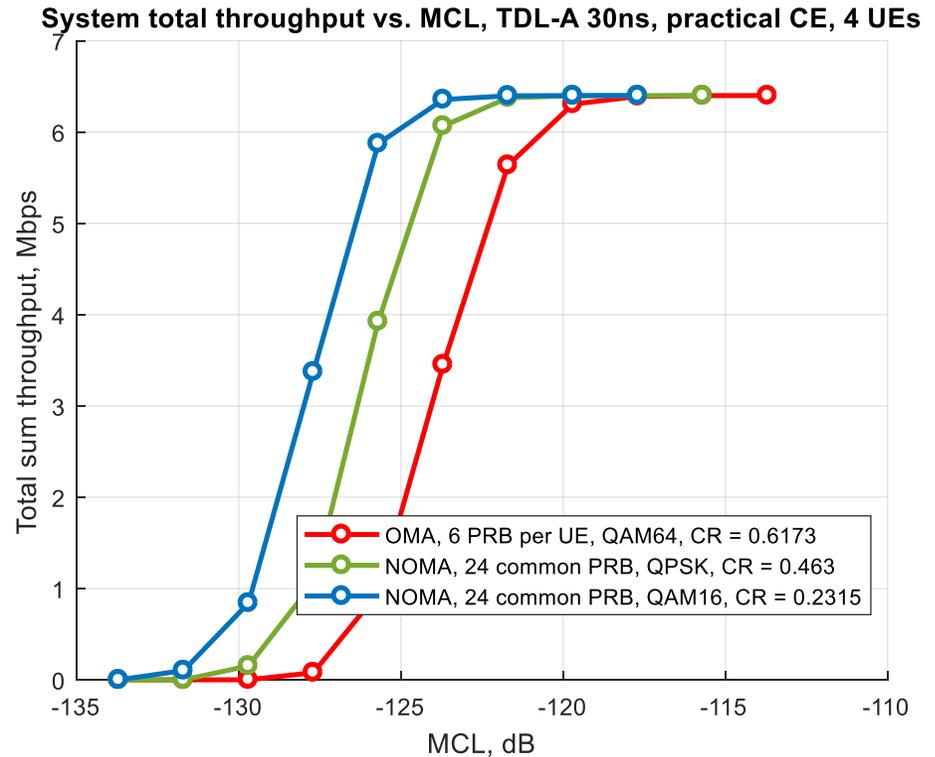
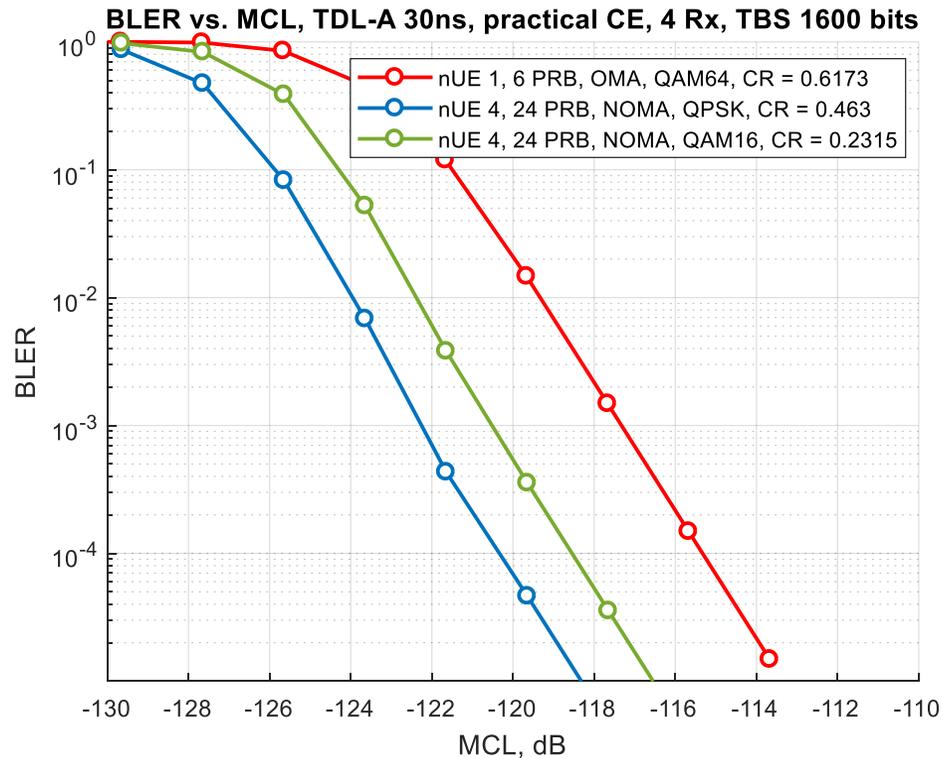
# Appendix

# NOMA Link Level performance (1/2)



Using NOMA, it is possible to achieve more efficient spectrum utilization.

# NOMA Link Level performance (2/2)



NOMA could be more robust than OMA for high code rate transmission cases.

# NOMA System Level performance

## NOMA for mMTC

### Figure description:

- PDR – packet drop ratio
- LCRS – Low Code Rate Spreading with PIC-based reception scheme
- SSMA – Short Sequence based Spreading with PIC-based reception scheme

UL NOMA can significantly increase mMTC system performance for high loading scenarios.

