

# On Downlink Multiple Access Techniques for RAN WG Study Item on 6G

**Source:** BBC, VIAVI Solutions, Imperial College London, EURECOM, Centre tecnologic de Telecomunicacions de Catalunya (CTTC), EchoStar, Institute for Communication Systems - University of Surrey (ICS), Vestel, Turk Telekomunikasyon, Telstra, Department for Science Innovation and Technology (DSIT), Federated Telecoms Hub / TITAN (FTH), German Aerospace Center (DLR)

**For:** Discussion

**Agenda item:** 16.2 - New RAN WG SI on 6G

# Motivation

- Multiple Access Techniques (MAT) are considered as a key technology to enhance the spectrum efficiency of the radio interface for IMT-2030 [1], [2].
- **Increased spectrum efficiency** is a key target for 6G as emphasized by multiple operators and vendors to the 3GPP 6G Workshop [3]

[1] *Framework and overall objectives of the future development of IMT for 2030 and beyond*, Recommendation ITU-R M.2160-0, Nov. 2023

[2] *Future technology trends of terrestrial International Mobile Telecommunications systems towards 2030 and beyond*, Report ITU-R M.2516-0, Nov. 2022

[3] 6GWS-250243, *Chair's summary of the 3GPP workshop on 6G*, 3GPP RAN 6G Workshop, Incheon –South Korea, March 10-11, 2025

# Motivation

- Relevant **research and pre-standardization activities** → ETSI ISG MAT [3], [4]
  - ETSI Industry Specification Group on Multiple Access Techniques – [ETSI ISG MAT](#)
  - Focus on downlink MAT for the physical layer of the 3GPP radio interface that enhance the transmission efficiency (e.g., spectrum efficiency, power consumption, latency, user fairness, etc.) of specified approaches
  - ETSI ISG MAT exploring candidate techniques such as OMA (Orthogonal Multiple Access), SDMA (Spatial Division Multiple Access), NOMA (Non-Orthogonal Multiple Access) and RSMA (Rate-Splitting Multiple Access)

[3] RP-250031 LS on establishment of ETSI Industry Specification Group on Multiple Access Techniques (ETSI ISG MAT)

[4] ETSI press release, *ETSI Launches New Group on Multiple Access Techniques for 6G Networks* [\[link\]](#)

# Baseline MAT for the 6G Study – downlink (1/2)

- MAT specified in 3GPP to be used as baseline for performance comparisons against any candidate MAT
  - SU-MIMO, and
  - MU-MIMO including advanced receivers to mitigate inter-user interference: TS 38.101-4 [5], TR 38.878 [6]

[5] 3GPP TS 38.101-4: "NR; User Equipment (UE) radio transmission and reception; Part 4: Performance requirements"

[6] 3GPP TR 38.878: "NR demodulation performance evolution".

# Baseline MAT for the 6G Study – downlink (2/2)

- Multi-User Superposition Transmission (MUST)
  - multiplexes messages from multiple UEs in a given time-frequency resource using superposition coding in the power-domain
  - MUST can increase the spectral efficiency and improve user fairness, particularly benefiting users at the cell edge who typically suffer from poor signal conditions.
- MUST was **studied and specified for LTE** [7]
  - superposition of two broadcast signals was only studied in Rel-16 [8]
- Limited/no commercial uptake of MUST

[7] 3GPP TR 36.859: “Study on Downlink Multiuser Superposition Transmission (MUST) for LTE”.

[8] Study on LTE-based 5G terrestrial broadcast, 3rd Generation Partnership Project (3GPP), Technical Report TR 36.776 V16.0.0, Mar. 2019

# Candidate MAT for the 6G Study – downlink (1/2)

- Rate-Splitting Multiple Access (RSMA)
  - RSMA is a flexible MAT with interference management capabilities that can improve the system performance in key scenarios such as high demand density areas and joint multicast-unicast transmissions
    - **increased spectral efficiency**, and
    - **increased fairness** of rates between scheduled UEs
  - RSMA can support multiple delivery modes with the same transmitter and receiver architecture: unicast-only, multicast-only, as well as joint multicast- unicast
- Performance improvements against MU-MIMO including advanced receivers reported in [9], [10]
- **RSMA has not yet been studied in 3GPP**

[9] [RP-231938](#) Rate Splitting Multiple Access (RSMA) for Multi-User MIMO - Enhancement of Unicast and Joint Unicast/Multicast Delivery

[10] [6GWS-250104](#) A BBC View on Multiple Access Techniques for 6G

# Candidate MAT for the 6G Study – downlink (2/2)

- Cache-aided MU-MIMO
  - Significantly **enhances spectral efficiency** for delivery of popular multimedia content (e.g. VoD) where most of the content can be cached in advance
  - Relies on **paradigm of coded caching** where **memory at the receiver** is used to intelligently store interfering data prior to transmission
  - **Multiple low-dimensional MU-MIMO** transmissions are **super-imposed** and interference is cancelled using the cached data in the device memory
- Performance improvements against conventional MU-MIMO reported in [11]
- **Cache-aided MU-MIMO has not yet been studied in 3GPP**

# Proposal

- Include downlink Multiple Access Techniques (MAT) as part of the scope of the RAN WG Study Item on 6G
  - MAT specified in 3GPP to be used as baseline for performance comparisons against any candidate MAT
    - SU-MIMO, and MU-MIMO including advanced receivers to mitigate inter-user interference: TS 38.101-4, TR 38.878.
    - MUST
  - Candidate MAT for the RAN WG Study Item on 6G include Rate-Splitting Multiple Access (RSMA) and Cache-aided MU-MIMO