

Top 3 things that happened on 6G waveform, channel coding and modulation at RAN1 #126

THE VERDICT

1. RAN1 concluded there is no consensus to support any constellation shaping scheme for either DL or UL; some proponents of some schemes stated they would agree to withdraw them. The RAN#112 conclusion reproduced in the chair notes says the shaping study stops if there is no consensus in Q3/26 (RAN1 did not itself declare the study stopped); whether RAN plenary acted on this after the meeting was not checked. (R1-2606762, chair notes, paragraph 153. R1-2606762, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606762.zip)
2. On higher-order modulation, RAN1 observed that DL 4K QAM and UL 1K QAM, if supported, are restricted to fixed wireless access and not eMBB, and gave four options instead of one recommendation: three recommend adopting UL 1K QAM and differ on DL 4K QAM, and the fourth records no consensus to recommend anything. Whether RAN plenary acted on this after the meeting was not checked. (R1-2606762, chair notes, paragraph 159. R1-2606762, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606762.zip)
3. For the new LDPC base graph BG3, RAN1 supported the lower-triangular sub-matrix E (Option E2) and excluded the identity matrix. Answering a RAN plenary task, it agreed that BG3 in UL is mandatory with capability signaling, except that it is optional for UEs with up to 20 MHz maximum UL channel bandwidth in any band supported by the UE; RAN plenary may add exceptions. (R1-2606761, chair notes, paragraph 92. R1-2606761, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606761.zip; R1-2606761, chair notes, paragraph 98. R1-2606761, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606761.zip)

WHAT WAS AGREED

Uplink PAPR reduction shortlist. RAN1 completed a list of three techniques for further down-selection: FDSS with no spectrum extension or truncation, FDSS with spectrum extension, and FDSS with spectrum truncation, each with candidate modulations listed. RAN1 targets a down-selection of transparent or non-transparent FDSS and of the modulation (at least for 16QAM) at RAN1 #126bis; the applicable spectral-efficiency range is FFS.

AGREEMENT Complete the following list of UL PAPR reduction techniques for further down-selection Option 1: FDSS with no spectrum extension or truncation Transparent / non-transparent Modulation [...]

R1-2606760, chair notes, paragraph 51. R1-2606760, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606760.zip

DFT size before spectrum extension or truncation. At least Option 1 (12 times $2^x 3^y 5^z$ subcarriers; the exponents are flattened in the extracted text below) is supported. Whether Option 2 (4 times $2^x 3^y 5^z$) is also supported is to be decided by RAN1 #127.

AGREEMENT R1-2606760, chair notes, paragraph 67. R1-2606760, 3GPP TSG RAN WG1 #126.

https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606760.zip

Constellation shaping (a conclusion, not an agreement). No consensus on any shaping scheme for DL or UL. The chair notes reproduce the RAN#112 condition that the study stops without consensus in Q3/26.

CONCLUSION [...] If there is no consensus on the support of constellation shaping in Q3/26 the study on constellation shaping will be stopped [...]

R1-2606762, chair notes, paragraph 153. R1-2606762, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606762.zip

Higher-order modulation (observations and options for RAN plenary). RAN1 observes that, if supported, DL 4K QAM and UL 1K QAM are restricted to fixed wireless access, to be enforced in the specification; how is FFS. RAN1 listed four options, one of which records no consensus to recommend anything.

CONCLUSION R1-2606762, chair notes, paragraph 159. R1-2606762, 3GPP TSG RAN WG1 #126.

https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606762.zip

BG3 sub-matrix E. RAN1 supported Option E2, a lower-triangular matrix with fewer than I columns of degree above one; E cannot be the identity matrix (Option E1). The value of I is FFS.

AGREEMENT For the sub-matrix E of BG3, support the following option Option E2 (from agreement in RAN1#124bis): A lower triangular matrix, wherein the number of columns [...]

R1-2606761, chair notes, paragraph 92. R1-2606761, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606761.zip

BG3 in uplink. BG3 in UL is mandatory with capability signaling, and optional for UEs with up to 20 MHz maximum UL channel bandwidth in any band supported by the UE. Further exceptions are for RAN plenary.

AGREEMENT R1-2606761, chair notes, paragraph 98. R1-2606761, 3GPP TSG RAN WG1 #126.

https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606761.zip

Small-UCI coding candidates. For evaluation, 5G RM is the baseline against enhanced RM, enhanced PC-Polar, Golay-based, vertical and horizontal, and CRC polynomial codes; companies compare their candidates with 5G RM. This is an evaluation list, not a code selection.

AGREEMENT R1-2606761, chair notes, paragraph 103. R1-2606761, 3GPP TSG RAN WG1 #126.
https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606761.zip

WHO PUSHED WHAT

Which, if any, constellation shaping approach should 6GR support?

These are contributions submitted to the meeting (register: not treated), not a tally: the meeting's summary of company preferences is in the modulation chair notes, R1-2606762. RAN1 then concluded there was no consensus on shaping.

NTT DOCOMO NTT DOCOMO proposes 1D-NUC, potentially for modulation order Q_m at least 6.

Support 1D-NUC for 6GR modulation. 1D-NUC could be supported for modulation order $Q_m \geq 6$ for moderate shaping gain. [...]

R1-2606495, Proposal 1, paragraph 27. R1-2606495, NTT DOCOMO, 3GPP TSG RAN WG1 #126. © NTT DOCOMO.
https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606495.zip; register: not treated

Tejas Networks Tejas Networks proposes probabilistic shaping.

Support Probabilistic Shaping (PS) in 6GR due to possible gain (1-2 dB) over Uniform Constellation (UC).

R1-2606777, Proposal 8, paragraph 214. R1-2606777, Tejas Networks, 3GPP TSG RAN WG1 #126. © Tejas Networks.
https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606777.zip; register: not treated

Samsung Samsung proposes ending the shaping study and using uniform QAM alone if no single scheme gains consensus.

If no consensus is reached on a single constellation shaping scheme, the study should be terminated per the RAN Plenary directive, and equal probability uniform [...]

R1-2606785, Proposal 1, paragraph 12. R1-2606785, Samsung, 3GPP TSG RAN WG1 #126. © Samsung.
https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606785.zip; register: not treated

1Finity 1Finity proposes considering neither geometric nor probabilistic shaping.

Constellation shaping (both GS and PS) is not considered in 6GR.

R1-2606099, Proposal 3, paragraph 27. R1-2606099, 1Finity, 3GPP TSG RAN WG1 #126. © 1Finity.
https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606099.zip; register: not treated

Which uplink waveform enhancements warrant further work?

These submissions were not treated. Qualcomm's $\pi/2$ BPSK truncation proposal is close to the shortlisted FDSS-with-truncation option, though its quoted text does not mention FDSS; LG's option numbering is its own.

Qualcomm Qualcomm proposes DFT-s-OFDM with $\pi/2$ BPSK and frequency-domain truncation.

For low-PAPR waveform design for 6G uplink, recommend introducing DFT-S-OFDM waveforms with $\pi/2$ -BPSK and frequency-domain truncation.

R1-2606370, Proposal 2.2, paragraph 78. R1-2606370, Qualcomm, 3GPP TSG RAN WG1 #126. © Qualcomm.
https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606370.zip; register: not treated

CATT CATT proposes supporting symmetric and asymmetric FDSS spectrum extension.

Both symmetric and asymmetric FDSS-SE for DFT-s-OFDM can be supported in 6GR.

R1-2605713, Proposal 2, paragraph 27. R1-2605713, CATT, 3GPP TSG RAN WG1 #126. © CATT.
https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2605713.zip; register: not treated

LG Electronics LG Electronics proposes relaxing the DFT-size restriction.

Proposal #2: For 6GR waveform study, for DFT-S-OFDM waveforms, relax the restriction on the DFT size for efficient & flexible resource management as option 2.

R1-2605504, Proposal 2, paragraph 70. R1-2605504, LG Electronics, 3GPP TSG RAN WG1 #126. © LG Electronics.
https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2605504.zip; register: not treated

How should the new LDPC base graph be constructed?

Both not-treated submissions assume 44 information columns and a maximum lifting size of 192; this evidence does not show those as agreed BG3 dimensions. CATT's lower-triangular extension sub-matrix is in line with the supported Option E2.

Tejas Networks Tejas Networks proposes 44 information columns and maximum lifting size 192 for further study.

For 6GR LDPC extension with maximum code block size 8448 and mother code rate around 2/3, RAN1 should consider $K_b = 44$ with $Z_{max} = [\dots]$

R1-2605655, Proposal 2, paragraph 47. R1-2605655, Tejas Networks, 3GPP TSG RAN WG1 #126. © Tejas Networks.
https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2605655.zip; register: not treated

CATT CATT proposes row splitting, no inherent double edges and a lower-triangular extension sub-matrix.

Proposal 6: For the 6GR LDPC base graph design with $k_b=44$ and $Z_{max}=192$, it is proposed to: Adopt row-splitting scheme and reject architectures containing inherent [...]

R1-2605714, Proposal 6, paragraph 80. R1-2605714, CATT, 3GPP TSG RAN WG1 #126. © CATT.
https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2605714.zip; register: not treated

STILL OPEN

- For all three FDSS options, transparent or non-transparent operation and the applicable spectral-efficiency range are open, as is the condition for applying the finally selected scheme. (R1-2606760, chair notes, paragraph 51. R1-2606760, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606760.zip)
- Support for DFT-size Option 2 is to be decided by RAN1 #127, and its upper bound on RBs is FFS. (R1-2606760, chair notes, paragraph 67. R1-2606760, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606760.zip)
- How the fixed-wireless-access restriction on DL 4K QAM and UL 1K QAM would be reflected in the specification is FFS. (R1-2606762, chair notes, paragraph 159. R1-2606762, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606762.zip)
- The value of I for BG3 sub-matrix E is FFS, and RAN plenary may add exceptions to the BG3 uplink rule. (R1-2606761, chair notes, paragraph 92. R1-2606761, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606761.zip; R1-2606761, chair notes, paragraph 98. R1-2606761, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606761.zip)

WHAT TO WATCH NEXT MEETING

- At RAN1 #126bis, the chair notes target down-selection of transparent or non-transparent FDSS and of modulation (at least 16QAM) for the three options. (R1-2606760, chair notes, paragraph 51. R1-2606760, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606760.zip)
- DFT-size Option 2 is due for decision by RAN1 #127, so it may be discussed at RAN1 #126bis. (R1-2606760, chair notes, paragraph 67. R1-2606760, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606760.zip)
- Whether a value of I for BG3 sub-matrix E is proposed at the next RAN1 meeting. (R1-2606761, chair notes, paragraph 92. R1-2606761, 3GPP TSG RAN WG1 #126. https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_126/Docs/R1-2606761.zip)

SOURCES

- [R1-2606762](#) Session Notes of AI 10.3.2 (Modulation, Joint channel coding and modulation). Session record; register lists Ericsson as editor. Chair notes. Register status: endorsed at R1-126.
- [R1-2606761](#) Session Notes of AI 10.3.1 (Channel Coding). Session record; register lists Ericsson as editor. Chair notes. Register status: endorsed at R1-126.
- [R1-2606760](#) Session Notes of AI 10.2.1. Session record; register lists NTT DOCOMO as editor. Chair notes. Register status: endorsed at R1-126.
- [R1-2606495](#) Discussion on Modulation. NTT DOCOMO. Contribution. Register status: not treated at R1-126. No decision recorded in the register.
- [R1-2606777](#) Discussion on Modulation for 6GR. Tejas Networks. Contribution. Register status: not treated at R1-126. No decision recorded in the register.
- [R1-2606785](#) Discussion on Modulation for 6GR. Samsung. Contribution. Register status: not treated at R1-126. No decision recorded in the register.
- [R1-2606099](#) Discussion on modulation for 6GR. 1Finity. Contribution. Register status: not treated at R1-126. No decision recorded in the register.
- [R1-2606370](#) Waveforms for 6GR. Qualcomm. Contribution. Register status: not treated at R1-126. No decision recorded in the register.
- [R1-2605713](#) Discussion on waveform for 6GR. CATT. Contribution. Register status: not treated at R1-126. No decision recorded in the register.
- [R1-2605504](#) Discussion on waveform for 6GR. LG Electronics. Contribution. Register status: not treated at R1-126. No decision recorded in the register.
- [R1-2605655](#) Discussion on Channel Coding for 6GR air interface. Tejas Networks. Contribution. Register status: not treated at R1-126. No decision recorded in the register.
- [R1-2605714](#) Channel coding for 6G network. CATT. Contribution. Register status: not treated at R1-126. No decision recorded in the register.

Coverage: RAN1 #126 (Maastricht, 2026-08-24 to 2026-08-28), agenda items 10.2.1, 10.3.1, 10.3.2. Scout read 61 recorded decisions and 167 company positions or contribution passages on these agenda items (catalog synced 2026-09-23) and cites 7 decisions and 9 positions from 12 TDocs. Every quoted passage was matched verbatim against the TDoc text; the summaries around the quotes are Scout's reading. Register statuses are copied from the 3GPP TDoc register: not treated means a document was not handled on its own, though its content may have fed feature-lead summaries or merged revisions. Not covered: other agenda items and meetings, plenary TDocs and plenary decisions after the meeting, email discussions after the meeting, and anything not yet in the chair notes or register.

- The shaping contributions shown are a sample of submissions, not a measure of support; the chair notes point to the preference summary.
- The system-level results for 4K and 1K QAM are in tables in the chair notes and are not reproduced here.
- RAN plenary decisions after the meeting, including any shaping closure or further BG3 exceptions, were not checked.

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