**3GPP TSG RAN meeting #96e RP-221079**

**Electronic Meeting, March 17-23, 2022**

## Status Report to TSG

**Agenda item:** 9.2.11

|  |  |
| --- | --- |
| **WI / SI Name** | Study on XR Enhancements for NR |
| included in this status report | Study Item: Yes | Core part: No | Performance part:No | Testing part:No |
| **Acronym** | FS\_NR\_XR\_enh |
| **Unique ID** | 940087 |
| **TSG Tdoc of latest approved WI/SI description (if any)** | [RP-220285](http://3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_95e/Docs/RP-220285.zip) |
| **Target Completion Date****(indicate if changed)** | Study Item: 12/2022 | Core part: N/A | Performance part: N/A | Testing part: N/A |
| **Overall Completion level** | Study Item: 33% | Core part: N/A | Performance Part: N/A | Testing part: |

Note: Overall completion level percentage numbers should use one of the colors below:

* x0%: Normal progress, no RAN plenary action needed
* xx%: Progress behind schedule, may need RAN plenary intervention. If so, SR should clearly define requested action
* xx%: Progress critically behind, RAN plenary shall intervene. SR should define requested action

**Source:**

|  |  |
| --- | --- |
| **Leading WG** | RAN2 |
| **Rapporteur** | **Name** | Benoist Sébire |
| **Company** | Nokia |
| **Email** | benoist.sebire@nokia.com |

## 1 Work plan related evaluation

|  |  |
| --- | --- |
| **Do you want to modify the time budget for this WI/SI compared to what was endorsed at the last RAN meeting?** | No |

*If you answered No: Then please remove the Excel file from the zip file of this status report.*

*If you answered Yes: Then please fill out the attached Excel template to request a modification of the time budgets for your WI /SI. The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI. The basis are the endorsed time budgets of the last RAN meeting. Please highlight all changes of the values.
 One time unit (TU) corresponds to ~ 2 hours in the meeting.
 If this status report covers a WI with Core and Performance part, then please have one line for each in the attached Excel table.
 Note: If no Excel table is attached, then this means no time budget change.*

**Additional explanations/motivations for the time budget changes in the attached Excel table:**

## 2. Detailed progress in RAN WGs since last TSG meeting (for all involved WGs)

## 2.1 RAN1

#### 2.1.1 Agreements

**RAN1 #109-e (May 2022)**

**Agreement**

The TR skeleton (in R1-2205329) for TR 38.835 Study on XR enhancements for NR is endorsed from RAN1 perspective. Send LS to RAN2 to convey this agreement. The LS to RAN2 is endorsed in R1-2205443.

XR specific power saving techniques

**Agreement**

Rel-17 evaluation methodology for XR power saving captured in TR 38.838 is used as the baseline evaluation methodology for UE power evaluation of Rel-18 SI on XR enhancements

**Agreement**

Companies are encouraged to compare performance of the following Rel-15/16/17 features with the proposed enhancements for Rel-18 XR power saving evaluations. Power saving gain is calculated w.r.t. the AlwaysOn baseline.

* Rel-15/16 CDRX including long DRX cycle, short DRX cycle and DRX command MAC CE and DCP
* Rel-17 PDCCH adaptation including PDCCH skipping and SSSG switching

Note: up to companies to report the configuration of the Rel-15/16/17 features

**Agreement**

For power saving study of Rel-18 XR SI, CDRX enhancements to evaluate in this study item are to be selected from the following:

* High priority Issue 1-1: Alignment between CDRX and XR traffic for resolving the mismatch between CDRX cycle and XR traffic periodicity for each flow
* High priority Issue 1-2: C-DRX enhancements to handle jitter
* Medium priority Issue 1-3: CDRX enhancements for multiple XR traffic flows [Note 2]
* Low priority Issue 1-4: CDRX enhancements to adjust to variable burst sizes and frame rate
	+ Note: Some companies think the adjustment for variable burst sizes can be realized by existing spec already
* Low priority Issue 1-5: low latency handling
* Low priority Issue 1-6: SFN wraparound mismatch (if handled in RAN1)

FFS: how the solutions or the combination of the solutions can handle all the identified issues.

Note 1: Other considerations are not precluded

Note 2: It can also be adopted for addressing issue 1-1

Note 3: Companies are encouraged to clarify or provide more details of the proposed solutions, for addressing concerns from the group.

Additional details can be found in R1-2205411.

**Agreement**

For power saving study of Rel-18 XR SI, PDCCH monitoring enhancements to evaluate in this study item are to be selected from the following

* Low priority Issue 2-1: Alignment between PDCCH monitoring and XR traffic to resolve the mismatch between PDCCH monitoring periodicity and XR traffic periodicity.
	+ Note: some companies think Rel-17 PDCCH monitoring adaptation can solve issue 2-1 or achieve similar intended outcome
	+ Note: Solutions proposed for Issue 2-1 and those proposed for Issue 1-1 are motivated by the same issue, namely non-integer XR traffic periodicity. It is to be studied how they compare in in terms of power saving gain and capacity, (a) solutions proposed for Issue 1-1; (b) solutions proposed for Issue 2-1.
* Low priority Issue 2-2: XR-dedicated PDCCH monitoring window to supplement CDRX for multi-flow traffic.
	+ Note: some companies think Rel-17 PDCCH monitoring adaptation can solve issue 2-2 or achieve similar intended outcome
	+ Note: Solutions proposed for Issue 2-2 and those proposed for Issue 1-3 are motivated by the same issue, namely multiple XR traffic flows. It is to be studied how they compare in in terms of power saving gain and capacity, (a) solutions proposed for Issue 1-3; (b) solutions proposed for Issue 2-2.
* High priority Issue 2-3: Enhancements to Rel-17 PDCCH monitoring adaptation.
	+ Note: Discussion on some enhancements may depend on the outcome of Rel-17 PDCCH monitoring adaptation maintenance
	+ Note: The study on enhancement to R17 PDCCH monitoring adaptation should focus on the techniques that are used for addressing XR-specific issues, e.g., jitter

Note 1: Other considerations are not precluded

Note 2: Companies are encouraged to clarify or provide more details of the proposed solutions, for addressing concerns from the group.

**Agreement**

For Rel-18 XR power saving enhancements, RAN1 further discusses by RAN1 #110 whether the issues below are to be addressed, and if so, which solutions should be selected for evaluation in this study item. These issues are low priority.

* Issue 3-1: Misaligned UE transmission and reception.
* Issue 3-2: Power saving by XR-aware scheduling.
	+ Note 1b: XR SI objective has XR-awareness in RAN listed as a specific topic of RAN2 study
* Issue 3-3: Unnecessary data transmission in allocated resources.

Note 1: Rel-18 XR SI objective only has CDRX enhancements and PDCCH monitoring enhancements explicitly listed as focus of RAN1 study

Note 2: Other considerations are not precluded

**Conclusion**

* If no evaluation result is provided by any company for an issue, the issue is deprioritized. The issue and proposed enhancements for the issue will not be captured by RAN1 in TR 38.835.
* If no evaluation result is provided by the proponent company for a proposed enhancement, the proposed enhancement is deprioritized. The proposed enhancement will not be captured by RAN1 in TR 38.835.
* If multiple enhancement techniques are proposed for the same issue, there can be down selection among them for the consideration of candidate enhancement for study item recommendation by RAN1 at least based on performance (power saving and capacity), spec impact, signaling overhead and implementation complexity.
* Companies are encouraged to provide detailed information for both the proposed enhancement and the existing power saving features used as the performance reference so that the evaluation results for both can be reproduced by other companies.
* When using existing power saving features as the performance reference, companies are encouraged to configure the existing power saving features to achieve the best performance.
* For evaluation of a proposed enhancement and evaluation of the existing power saving features as performance reference, companies are encouraged to provide the high load case (as defined in TR 38.838, Section A.2) results. Results for low load case can also be reported optionally.

XR-specific capacity enhancements techniques

**Agreement**

Rel-17 evaluation methodology for XR capacity enhancement captured in TR 38.838 is used as the baseline evaluation methodology for XR capacity enhancement of Rel-18 SI on XR enhancements.

**Conclusion**

Study of network coding for capacity enhancements during Rel-18 XR SI is down prioritized in RAN1.

**Agreement**

* For each candidate capacity enhancement technique for XR traffic, companies are encouraged to consider the following *common principle for assessment of the candidate capacity enhancement technique*:
	+ Identify the XR-specific issue(s) that the enhancement technique is addressing
	+ Identify the necessity of the enhancement technique to address the issues
	+ Identify whether/how the enhancements provide benefit/performance capacity gain.
		- Consider at least feasibility, complexity, and system level performance evaluations in comparing the enhancement techniques. Power saving gains for a given enhancement technique can optionally be evaluated and considered in addition to these other aspects.
* The baseline scheduling scheme when comparing the proposed capacity enhancements techniques is:
	+ Dynamic scheduling and/or
	+ Semi-persistent scheduling / Configured grant scheduling
		- Note: Companies are encouraged to additionally use DG scheduling as the baseline scheduling scheme when showing the capacity performance gain

**Agreement**

* To support a candidate capacity enhancement technique for XR traffic, capacity performance gain by the technique as compared to baseline should be shown.
	+ Capacity performance gain by the candidate technique as compared to baseline is a necessary condition to consider supporting the candidate technique.

**Conclusion**

Companies are encouraged to use the capacity Excel sheet attached with TR 38.838 in RP-213652 for recording the simulation results that are provided in their contributions.

**Agreement**

To study whether/how to support a candidate capacity enhancement technique for XR traffic based SPS/CG transmissions, companies are encouraged to consider the following studies:

* Study enhancements related to ~~support of~~ multiple PDSCHs SPStransmission occasions in a period
* Study enhancements related to multiple PUSCHs CG transmission occasions in a period
* Study enhancements related to dynamic adaptation of SPS/CG parameters/configurations
* Study enhancements related to non-integer periodicity for SPS/CG transmissions.
* Note: Other studies are not precluded, as well as the combination of the above studies.

Follow the common principle for assessment of the candidate capacity enhancement technique

**Agreement**

To study whether/how to support a candidate capacity enhancement technique for XR traffic based dynamic scheduling/grant transmissions, companies are encouraged to consider the following studies:

* Study enhancements related to extending capability of single DCI scheduling multi-PDSCHs/PUSCHs for FR2-2 to FR1/FR2.
* Note: whether and how to discuss enhancements may depend on the outcome of Rel-17 B52.6G UE feature discussion
* Study enhancements related to HARQ-ACK and/or CBG transmissions for single DCI scheduling one or multi PDSCH(s).
* Study enhancements related to allowing different configurations per PDSCH/PUSCH
* Study enhancement related to scheduling request and/or BSR with the focus on L1 enhancements.
* Note: Other studies are not precluded as well as the combination of the above studies.
* Follow the *common principle for assessment of the candidate capacity enhancement technique.*

**Conclusion**

It is common understanding that studying of RAN2 proposed techniques for XR-awareness information to improve XR capacity can be studied in RAN1 upon request from RAN2.

**Agreement**

The following lists the candidate enhancements techniques for link adaptation to improve XR capacity that are proposed by companies RAN1#109-e.

* At least the proponents are encouraged to justify the corresponding capacity benefits for XR traffic for considering potential study of these candidate enhancements techniques.
	+ Delta MCS
	+ Soft HARQ-ACK feedback
	+ Cooperative MIMO scheme via precoding technique - bi-directional training
	+ Enhanced link adaptation for CBG-based transmission
	+ CSI report enhancements to address the different BLER requirements of different XR flows
* Follow the *common principle for assessment of the candidate capacity enhancement technique.*

**Agreement**

The following lists the candidate enhancements techniques based on measurement-gap link to improve XR capacity that are proposed by companies RAN1#109-e.

* At least the proponents are encouraged to justify the corresponding capacity benefits for XR traffic for considering potential study of these candidate enhancements techniques.
	+ Dynamic L1 based MG activation/deactivation.
	+ Reuse current R16/R17 RRM relaxation condition to allow scheduling in MG to transform the R16/R17 RRM power saving gain into capacity gain.
* Follow the *common principle for assessment of the candidate capacity enhancement technique.*

**Agreement**

The following lists the candidate enhancements techniques to improve XR capacity that are proposed by companies RAN1#109-e.

* At least the proponents are encouraged to justify the corresponding capacity benefits for XR traffic for considering potential study of these candidate enhancements techniques.
	+ Inter-UE/intra-UE multiplexing techniques, including e.g. finer granularity preemption indication
* Follow the *common principle for assessment of the candidate capacity enhancement technique.*

#### 2.1.2 Remaining Open issues

In accordance of the SID:

- Discuss & evaluate XR-specific power saving and capacity improvements

- Identify most potential candidate enhancements and capture them in the TR.

- Provide conclusions on beneficial candidate enhancements for XR-specific power saving and capacity improvements to RAN2.

## 2.2 RAN2

The work has not yet started, as planned.

#### 2.2.1 Agreements

#### 2.2.2 Remaining Open issues

## 2.3 RAN3

#### 2.3.1 Agreements

#### 2.3.2 Remaining Open issues

## 2.4 RAN4

#### 2.4.1 Agreements

#### 2.4.2 Remaining Open issues

## 2.5 RAN5

#### 2.5.1 Agreements

#### 2.5.2 Remaining Open issues

#### 2.5.3 Remaining Open issues with cross-WG dependencies

## 2.6 RAN6

#### 2.6.1 Agreements

#### 2.6.2 Remaining Open issues

## 3. Detailed progress in SA/CT WGs since last TSG meeting (for all involved WGs)

NOTE: This section only needs to be filled in for WI/SIs where there is a corresponding relevant WI/SI in SA/CT.

## 3.1 SAx/CTs

#### 3.1.1 Agreements with cross-TSG impacts

#### 3.1.2 Remaining Open issues with cross-TSG impacts

NOTE: This section should also flag any critical dependencies that need TSG attention.

## 4. References

NOTE: This can be e.g. a list of all related Tdocs in the affected WGs since last TSG, references to LSs, produced TRs/TSs, the work/study item description or status reports of previous TSGs.

RAN1#109-e

1. R1-2204673, TR 38.835 Skeleton for Study on XR enhancements for NR, Rapporteur (Nokia)
2. R1-2205053, Work plan for Rel-18 SI on XR enhancements for NR, Qualcomm Incorporated
3. R1-2205329, TR 38.835 Skeleton for Study on XR enhancements for NR, Rapporteur (Nokia)
4. R1-2205419, [Draft] LS on draft TR 38.835 skeleton, Nokia
5. R1-2205420, LS on draft TR 38.835 skeleton, RAN1, Nokia
6. R1-2205443, LS on draft TR 38.835 skeleton, RAN1, Nokia
7. R1-2203131, Discussion on XR-specific power saving techniques, Huawei, HiSilicon
8. R1-2203348, Discussion on XR specific power saving techniques, Spreadtrum Communications
9. R1-2203484, UE Power saving techniques for XR, CATT
10. R1-2203585, Discussion on XR specific power saving enhancements, vivo
11. R1-2203606, Discussion on XR specific power saving techniques, ZTE, Sanechips
12. R1-2203638, Discussion on power saving enhancements for XR, Ericsson
13. R1-2203666, Discussion on XR enhancement for NR, China Telecom
14. R1-2203744, Considerations on power saving techniques for XR, Sony
15. R1-2203927, Considerations on XR-specific Power Savings, Samsung
16. R1-2203940, Discussion on XR specific power saving techniques, NEC
17. R1-2204028, Discussion on XR specific power saving techniques, OPPO
18. R1-2204123, Discussion on XR specific power saving enhancements, InterDigital, Inc.
19. R1-2204177, XR specific power saving techniques, TCL Communication Ltd.
20. R1-2204264, Views on XR specific power saving techniques, Apple
21. R1-2204326, Discussion on XR-specific power saving techniques, CMCC
22. R1-2204400, Discussion on XR specific power saving techniques, NTT DOCOMO, INC.
23. R1-2204414, XR-specific power saving techniques, Lenovo
24. R1-2204444, Discussion on XR specific power saving techniques, ITRI
25. R1-2204633, Discussion on XR-specific power saving techniques, LG Electronics
26. R1-2204655, Discussion on power saving techniques for XR, ETRI
27. R1-2204674, Discussion on XR-specific power saving enhancements, Nokia, Nokia Shanghai Bell
28. R1-2204698, On XR specific power saving techniques, MediaTek Inc.
29. R1-2204818, Discussion on power saving enhancements for XR applications, Intel Corporation
30. R1-2205054, Power saving techniques for XR, Qualcomm Incorporated
31. R1-2205055, Moderator Summary#1 on XR specific power saving techniques, Qualcomm Incorporated
32. R1-2205176, Power saving techniques for XR, Qualcomm Incorporated
33. R1-2205410, Moderator Summary#2 on XR specific power saving techniques, Moderator (Qualcomm)
34. R1-2205411, Moderator Summary#3 on XR specific power saving techniques, Moderator (Qualcomm)
35. R1-2205412, Final Moderator Summary on XR specific power saving techniques, Moderator (Qualcomm)
36. R1-2205413, Draft Reply LS on UE Power Saving for XR and Media Services, Moderator (Qualcomm)
37. R1-2205530, Draft Reply LS on UE Power Saving for XR and Media Services, Moderator (Qualcomm)
38. R1-2205531, Reply LS on UE Power Saving for XR and Media Services, RAN1, Qualcomm
39. R1-2203065, XR Capacity Evaluation and Enhancements, FUTUREWEI
40. R1-2203132, Discussion on XR-specific capacity enhancements techniques, Huawei, HiSilicon
41. R1-2203349, XR capacity consideration, Spreadtrum Communications
42. R1-2203485, NR enhancement for XR capacity improvement, CATT
43. R1-2203586, Discussion on XR specific capacity enhancements, vivo
44. R1-2203607, Discussion on XR specific capacity enhancements techniques, ZTE, Sanechips
45. R1-2203639, Discussion on capacity enhancements for XR, Ericsson
46. R1-2203689, Discussion on XR-specific capacity enhancements, NEC
47. R1-2203745, Considerations on capacity enhancements techniques for XR, Sony
48. R1-2203928, Considerations on XR Capacity Improvements, Samsung
49. R1-2203934, Discussion on XR specific capacity improvement techniques, Panasonic
50. R1-2204029, Discussion on XR specific capacity enhancements techniques, OPPO
51. R1-2204124, Discussion on XR specific capacity enhancements, InterDigital, Inc.
52. R1-2204129, Discussion on XR specific capacity enhancements techniques, III
53. R1-2204178, XR-specific capacity enhancements techniques, TCL Communication Ltd.
54. R1-2204265, Views on XR specific capacity enhancements techniques, Apple
55. R1-2204327, Discussion on XR-specific capacity enhancements techniques, CMCC
56. R1-2204401, Discussion on XR specific capacity improvement enhancements, NTT DOCOMO, INC.
57. R1-2204415, XR-specific capacity enhancement techniques, Lenovo
58. R1-2204634, Discussion on XR-specific capacity enhancement techniques, LG Electronics
59. R1-2204656, Discussion on capacity enhancements techniques for XR, ETRI
60. R1-2204675, Discussion on XR-specific capacity enhancements, Nokia, Nokia Shanghai Bell
61. R1-2204699, On XR specific capacity improvement enhancements, MediaTek Inc.
62. R1-2204759, Discussion on potential SPS enhancements for XR, CEWiT
63. R1-2204819, Discussion on capacity enhancements for XR applications, Intel Corporation
64. R1-2205056, Capacity enhancement techniques for XR, Qualcomm Incorporated
65. R1-2205072, Discussion on XR-specific capacity enhancements techniques, FGI
66. R1-2205265, FL Summary#1 – Study on XR Specific Capacity Improvements, Moderator (Ericsson)
67. R1-2205266, FL Summary#2 – Study on XR Specific Capacity Improvements, Moderator (Ericsson)
68. R1-2205267, FL Summary#3 – Study on XR Specific Capacity Improvements, Moderator (Ericsson)
69. R1-2205268, FL Summary#4 – Study on XR Specific Capacity Improvements, Moderator (Ericsson)
70. R1-2203486, XR awareness scheduling and QoS control, CATT
71. R1-2203587, Discussion on other aspects for XR specific RAN enhancements, vivo
72. R1-2203608, Consideration about XR services, ZTE, Sanechips
73. R1-2203640, Discussion on XR-Awareness, Ericsson
74. R1-2204125, Discussion on XR-Awareness, InterDigital, Inc.
75. R1-2204266, Considerations on enhancements for XR, Apple
76. R1-2204635, Other aspects of XR enhancements for NR, LG Electronics
77. R1-2204676, Performance results of XR-related enhancements, Nokia, Nokia Shanghai Bell
78. R1-2204820, Views on XR specific RAN enhancement in QoS, III
79. R1-2204908, Discussion on XR-specific capacity and power issues based on SA2 outcome, Huawei, HiSilicon

 10.01.2022 minor adaptations for RAN #95e

 04.10.2021 minor adaptations for RAN #94e

 08.08.2021 minor adaptations for RAN #93e

 17.05.2021 minor adaptations for RAN #92e

 28.01.2021 minor adaptations for RAN #91e

 09.11.2020 minor adaptations for RAN #90e

 31.08.2020 minor adaptations for RAN #89e

 20.04.2020 minor adaptations for RAN #88e

 18.02.2020 minor adaptations for RAN #87e

 14.11.2019 minor adaptations for RAN #86

 18.08.2019 minor adaptations for RAN #85

 12.05.2019 minor adaptations for RAN #84

 27.02.2019 minor adaptations for RAN #83

 21.11.2018 completion levels with colours added (for RAN #82)

v04.81 31.07.2018 simplification of template and addition of cross-TSG aspects (for RAN #81)

v04.80 21.05.2018 minor adaptations for RAN #80

v04.79 26.02.2018 minor adaptations for RAN #79

v04.78 18.11.2017 minor adaptations for RAN #78

v04.77 06.08.2017 minor adaptations for RAN #77

v04.76 15.05.2017 minor adaptations for RAN #76

v04.75 31.01.2017 minor adaptations for RAN #75

v04.74 28.10.2016 minor adaptations for RAN #74

v04.73 01.09.2016 adaptations for RAN #73 (time units in extra Excel table, RAN6 reporting included)

v04.72 26.05.2016 adaptations for RAN #72 (introduction of NR & GERAN TUs)

v04.71 10.02.2016 minor adaptations for RAN #71

v04.70 30.10.2015 minor adaptations for RAN #70

v04.69 12.08.2015 minor adaptations for RAN #69

v04.68 21.05.2015 minor adaptations for RAN #68

v04.67 01.02.2015 minor adaptations for RAN #67

v04.66 16.11.2014 minor adaptations for RAN #66

v04.65 16.08.2014 minor adaptations for RAN #65

v04.64 22.05.2014 minor adaptations for RAN #64

v04.63 24.01.2014 restructuring for RAN #63 to cover Core & Perf. in one doc file

v03.62 11.11.2013 section 1.2.3 adapted for RAN #62

v03 11.08.2013 section 1.2.3 added on time budget

v02 07.05.2010 history added, some spelling corrections

v01 13.11.2009 First version of the template