**3GPP TSG RAN Meeting #107 RP-25xxxx**

**Incheon, South Korea, March. 10-14, 2025**

## Status Report to TSG

**Agenda item:** 9.2.4

|  |  |
| --- | --- |
| **WI / SI Name** | Study on AI (Artificial Intelligence)/ML (Machine Learning) for mobility in NR |
| included in this status report | Study Item: Yes | Core part: No | Performance part:No | Testing part:No |
| **Acronym** | FS\_NR\_AIML\_Mob |
| **Unique ID** | 1020084 |
| **TSG Tdoc of latest approved WI/SI description (if any)** | RP-242393 |
| **Target Completion Date****(indicate if changed)** | Study Item: 09/2025 | Core part: N/A | Performance part: N/A | Testing part: N/A |
| **Overall Completion level** | Study Item: 62.5 % | Core part: N/A | Performance Part: N/A | Testing part: N/A |

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

* xx%: 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** | RAN WG2 |
| **Rapporteur** | **Name** | Zhongda Du |
| **Company** | OPPO |
| **Email** | duzhongda@oppo.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)

 NOTE: Agreements and Open issues impacted cross-TSG aspects shall be explicitly highlighted

## 2.1 RAN1

#### 2.1.1 Agreements

#### 2.1.2 Remaining Open issues

## 2.2 RAN2

#### 2.2.1 Agreements

RAN2#129 agreements:

Text proposal in R2-2500287 is endorsed

Agreements on priority

* RLF prediction will not be studied in Rel-19
* Further RRM prediction simulations are not expected. For next specification general impact study phase we will consider spatial, temporal, and frenquency domain cell level prediction. FFS if L3 beam level needs to be considered. For now, temporal and frequency domain prediction will be considered with higher priority for detailed study (if needed).
* Continue with generalization across cell configurations for RRM prediction
* Continue with measurement events

**Agreements**

1. For Case B temporal domain prediction, RAN2 to capture that AI can provide gain (i.e., lower L3 cell-level RSRP difference) compared to Non-AI (i.e., Sample and Hold) and the gain increases as MRRT increases.
2. Regarding temporal domain prediction case B, the gain that AI can provide is more obvious in high speed scenario when compared to sample and hold.
3. Regarding the temporal domain prediction case A, the gain that AI can provide increases with the increase of prediction window length (up to a certain window length) when compared to sample and hold.
* We will capture something about model complexity. FFS how and what to capture it
* Average L3 cell RSRP difference and last predicted point L3 cell RSRP difference of measurement results within PW is captured in TR
* For both temporal domain case A and case B, simulation result with different filtering approach is listed separately.
* Take the optimal result, e.g., the one with the lowest RSRP difference, from each company.

**Agreements on generalization over UE speed**

1. For intra-frequency temporal domain prediction in FR1/FR2, generalization performs well across all UE speeds
2. Using a mixed dataset (GC#2) slightly improves the accuracy of the AI/ML model compared to GC#1 cases, while offering comparable accuracy as the baseline case (for the same data set size).
3. For GC#1, as the difference between the UE speed that an AI/ML model trained at and the UE speed that the inference is being made decreases, the AI/ML achieves a closer performance to the baseline.

**Agreements on generalization over frequency**

* Generalization using GC#2 always outperform that of GC#1
* Training and generalization using the knowledge about the input & output frequency (or even an indication) outperforms the case where the model cannot recognize which frequency at the input or output.
* Considering the generalization parameter of different predicted frequencies in inter-freq prediction, the GC#1 case without any preprocessing based on the information of predicted frequency suffers from significant performance loss.
* For GC#2 case, the prediction accuracy is acceptable and close to the baseline

**Agreements**

1: two sets of parameters (ISD, BS antenna height, BS Tx power) are used for the generalization across cell configurations study.

2: FR1 is the primary focus, companies can also submit results for FR2 (however, each set of generalization results covers either FR1 or FR2).

3: agree on the two sets of configurations as in tables 2 and 3 (for FR1 and FR2).

|  |  |  |
| --- | --- | --- |
| Parameter | Configuration #1 | Configuration #2 |
| Deployment scenario  | UMi | UMa |
| ISD | 200m | 500m |
| BS antenna height | 10m | 25m |
| BS Tx power | 40dBm | 44dBm |

*Table 2: generalization parameters for FR1*

|  |  |  |
| --- | --- | --- |
| Parameter | Configuration #1 | Configuration #2 |
| Deployment scenario | UMi | UMa |
| ISD | 200m | 500m |
| BS antenna height | 10m | 25m |
| BS Tx power | 40dBm | 44dBm |

*Table 3: generalization parameters for FR2*

**Agreements on Measurement event case A**

1. Most of the results show that the F1 score for prediction of measurement event is very good.
2. For handover decision option 3 and 2 AI/ML performs better than baseline (legacy) in terms of HO failure rate.

**Agreements on Measurement event case B**

1. Measurement event case B can have very good F1 score depending on filtering approach/PW
2. F1 score is good for the PW window for case B (i.e. low PW)
3. F1 score decreases with an increasing MRRT value
4. We will focus on finding cases that bring benefits to the system rather than trying to compare
5. With indirect measurement event prediction based on temporal domain Case B (MRRT=50%), the AI-based HO has a minor/no system-level performance (i.e., HOF rate and HO number) decrease compared with the legacy HO mechanism.

**Other agreements**

Inter-frequency measurement event prediction will be considered for the specification impact study but no explicit simulations will be required.

**Agreements on direct measurement event prediction**

- F1 score for direct measurement is very good based on the current simulation results.

#### 2.2.2 Remaining Open issues

For RRM measurement use case:

1, To collect simulation results based on updated template and conclude further statistics observation based on collected simulation result

2, Generalization study on cell configuration

For Measurement event use case:

1, Evaluation based on Simulation result by clarifying the F1 score methodology for temporal domain case A

Issues covered by following objectives in the SID:

* Potential specification impacts of AI/ML aided mobility [RAN2]

## 2.3 RAN3

#### 2.3.1 Agreements

#### 2.3.2 Remaining Open issues

## 2.4 RAN4

#### 2.4.1 Agreements

RAN4#114 meeting agreements:

**Issue 1-1-1: Measurement event prediction use case**

Agreement:

* RAN4 will start the discussion on measurement event prediction use case in RAN4#114bis meeting.

**Issue 2-1-1a: Relative RSRP Prediction Accuracy**

Agreement:

* Predicted relative RSRP accuracy = (reported predicted RSRP of cell 1/beam1 – reported RSRP of cell 2/beam2) – (ground truth of RSRP of cell 1/beam1 – ground truth of RSRP of cell 2/beam2)
	+ FFS: Beam 1 and Beam 2 can be from same cell or different cells.
	+ FFS: whether ground truth can be reported or ideal
	+ FFS: whether the reported RSRP of cell2/beam2 can be predicted or measured or a combination of both predicted and measured samples.

**Issue 2-1-2: Ground Truth Definition for RSRP accuracy**

Agreement:

* The way the ground truth is extracted in the testing may differentiate between FR1 and FR2.

**Issue 2-1-2: Ground Truth Definition for RSRP accuracy**

Agreement:

Take Option 1-1-FR2 as baseline, and further discuss any additional aspects need to be considered.

* Option 1-1-FR2: The ground truth of L3 RPRP is the reported L3 RSRP measurement under sufficient high SNR in FR2.

**Issue 2-1-2: Ground Truth Definition for RSRP accuracy**

* Agreement:
	+ Alt 1: Ground truth for FR1 will be based on the transmitted or reception power
	+ Alt 2: Ground truth for FR1 will be based on the reported measurement value under certain conditions
	+ Further discuss the advantages and disadvantages for Alt 1 and Alt 2 considering the aspects such as:
		- The information at the TE side, on the timing UE performs and/or finishes the measurement and/or prediction
		- Impact of L3 filtering
		- Number of samples for L1 filtering
		- Timing window, if it exists, where UE can’t measure the ground truth in Alt2
		- channel condition
		- Avoid UE cheat in the test
		- S(I)NR variations in the test at different time instances (for Alt2)
		- Other aspects are not precluded
	+ Companies are encouraged to provide analysis on all or some of the aspects in the list

**Issue 2-1-4: Impacts of measurement error on prediction accuracy**

Agreement:

For AI based RRM measurement prediction in the SI, while RAN4 has not agreed yet on the exact error model(s) in the SI phase, RAN4 think RF and baseband errors on the measurements would impact the prediction accuracy.

**Issue 2-1-9: Impacts from observation and prediction windows**

Agreement:

* RAN4 to consider the impact of UE speed, MRRT and OW and PW lengths on prediction accuracy requirements for temporal predictions.
	+ RAN4 to also consider number of measurements performed during OW and its impacts on the prediction accuracy.

#### 2.4.2 Remaining Open issues

For General Aspects: Assessments of sub-use-case priorities.

For RAN4 requirements: Analyses on performance metrics and factors that potentially impact core/performance requirements.

For Testability aspects: Evaluations on the testing setup, further study new testability aspects, e.g., FR1/FR2, consistency in time domain, and the influence of inter-carrier scenarios.

## 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.

**Contributions submitted to RAN2#129 meeting:**

R2-2500161 Simulation results on RRM measurement prediction Spreadtrum, UNISOC, BUPT

R2-2500167 Discussion on RRM measurement predictions and prediction-based mobility events Sharp

R2-2500214 Simulation results of RRM measurement prediction vivo

R2-2500215 Simulation results of model generalization for RRM measurement prediction vivo

R2-2500216 Simulation results of measurement event prediction and SLS vivo

R2-2500243 Simulation results of Model Generalization CATT, Turkcell

R2-2500244 Simulation results of event A3 prediction CATT, Turkcell

R2-2500245 Simulation results of AI based Handover performance CATT, Turkcell

R2-2500287 Text proposal of 38.744 OPPO

R2-2500288 Discussion on work plan of AI mobility SI OPPO,MediaTek,Nokia,Interdigital

R2-2500289 Discussion on model generalization of RRM measurement prediction OPPO

R2-2500290 Analysis on simulation results of RRM measurement prediction OPPO

R2-2500291 Discussion on simulation results of measurement event prediction OPPO

R2-2500299 Simulation assumption for Measurement event prediction NEC

R2-2500313 Discussions on simulation results of the RRM measurement prediction NTT DOCOMO, INC.

R2-2500314 Discussions on generalization of RRM measurement prediction NTT DOCOMO, INC.

R2-2500315 Discussions on measurement event prediction NTT DOCOMO, INC.

R2-2500318 Model Generalization for AIML RRM Prediction MediaTek Inc.

R2-2500319 Preliminary results of indirect prediction and simulation assumption for direct prediction MediaTek Inc.

R2-2500324 Simulation result for RRM prediction and system level simulation MediaTek Inc.

R2-2500327 AI-ML based RLF/HO failure prediction Rakuten Mobile, Inc

R2-2500399 Simulation results for measurement event prediction Xiaomi

R2-2500406 Simulation results for RRM measurement predictions Interdigital Inc.

R2-2500407 Generalization of AIML models for RRM measurement prediction Interdigital Inc.

R2-2500408 Measurement event predictions Interdigital Inc.

R2-2500520 Simulation results for RRM measurement prediction China Telecom Corporation Ltd.

R2-2500542 Discussion on Generalization Issues for AI/ML Mobility Samsung

R2-2500559 Email discussion summary for [Post128][018][AI Mob] generalization (Apple) Apple

R2-2500560 On measurement event prediction Apple

R2-2500601 Simulation results on Model Generalization for RRM measurement prediction Spreadtrum, UNISOC, BUPT

R2-2500639 Discussion on simulation results for RRM measurement prediction Samsung

R2-2500640 Simulation results for measurement event prediction and system level performance Samsung

R2-2500734 Discussion on simulation metric for RLF prediction KDDI Corporation

R2-2500800 Discussion on generalization performance over UE speed of GC1 Xiaomi

R2-2500801 Discussion on generalization performance over UE speed of GC2 Xiaomi

R2-2500851 Generalization of the AI/ML models for RRM prediction Ericsson

R2-2500852 Simulation results for spatial domain RRM measurement predictions Ericsson

R2-2500890 Additional simulation results for RRM measurement prediction Huawei, HiSilicon

R2-2500891 Model generalization evaluation for RRM measurement prediction Huawei, HiSilicon

R2-2500892 Simulation results for measurement event prediction Huawei, HiSilicon

R2-2500899 Discussion on RRM measurement prediction ZTE Corporation

R2-2500900 Discussion on model generalization of RRM measurement prediction ZTE Corporation

R2-2500919 Evaluation of measurement event prediction Ericsson

R2-2500946 Simulation results for RRM measurement predictions Nokia

R2-2500947 On the measurement event prediction Nokia

R2-2500948 Generalization of ML mobility use-cases Nokia, Nokia Shanghai Bell

R2-2501040 Potential specification impact for RRM measurement prediction CMCC

R2-2501041 Simulation results for Measurement event predictions CMCC

R2-2501052 Discussion on model generalization CMCC

R2-2501070 Measurement Event prediction and handover modelling Qualcomm Incorporated

R2-2501071 Simulation Results for Model Generalization Qualcomm Incorporated

R2-2501072 Simulation Results for Measurement Event Predictions Qualcomm Incorporated

R2-2501241 Discussion on system level simulation ETRI

R2-2501293 Discussion on measurement event prediction ZTE Corporation

**Contributions submitted to RAN4#114 meeting:**

R4-2500231 On Testability and Interoperability Issues for AIML Mobility in NR Apple

R4-2500232 General aspects on AI/ML for mobility in NR Apple

R4-2500233 Study of impacts on RAN4 requirements for AIML Mobility in NR Apple

R4-2500533 Topic summary for [114][219] FS\_NR\_AIML\_Mob Moderator (Nokia)

R4-2500594 Discussions on RAN4 requirement impacts of AIML for mobility NTT DOCOMO, INC.

R4-2500619 Discussion on impacts on RAN4 requirement for AI mobility Xiaomi

R4-2500628 Discussion on study of testability and interoperability for AIML mobility Xiaomi

R4-2500696 Discussion impacts on requirements of AI/ML mobility ZTE Corporation, Sanechips

R4-2500697 Discussion on the Interoperability and testability aspects ZTE Corporation, Sanechips

R4-2500890 Discussion on impact on RRM requirements of AI mobility MediaTek Inc.

R4-2500891 Discussion on testability and interoperability of AI mobility MediaTek Inc.

R4-2501040 Discussion on impacts of AIML mobility on RRM requirements CATT

R4-2501041 Discussion on testability and interoperability issues for AIML mobility CATT

R4-2501099 Discussion on general part for AI/ML for mobility CMCC

R4-2501100 Discussion on impacts on RAN4 requirements for AI/ML for mobility CMCC

R4-2501101 Discussion on testability and interoperability for AI/ML for mobility CMCC

R4-2501133 Study of impacts on RAN4 requirements for AI mobility OPPO

R4-2501134 Study of testability and interoperability for AI mobility OPPO

R4-2501233 Discussion on genereal aspects in AIML mobility Huawei, HiSilicon

R4-2501234 Discussion on impacts of RAN4 requirements in AIML mobility Huawei, HiSilicon

R4-2501235 Discussion on testability and interoperability issues in AIML mobility Huawei, HiSilicon

R4-2501339 Discussion on general aspects for AI mobility vivo

R4-2501340 Discussion on impacts on RAN4 requirements for AI mobility vivo

R4-2501341 Discussion on testability and interoperability for AI mobility vivo

R4-2501674 Discussion on general aspects and requirements impact Samsung

R4-2501675 General discussion on AI mobility regarding testability and interoperability Samsung

R4-2501694 Study of impacts on RAN4 requirements for AIML Mobility in NR Tejas Network Limited

R4-2501759 General discussion on AI/ML for mobility Ericsson

R4-2501760 On requirements for AI/ML based mobility Ericsson

R4-2501761 On testability issues related to AI/ML for mobility Ericsson

R4-2501961 General aspects of AIML Mobility Nokia

R4-2501962 On RRM Requirement Impacts of AIML Mobility Nokia

R4-2502072 Testability and Interoperability Issues for AI/ML Mobility Nokia

R4-2502219 (FS\_NR\_AIML\_Mob) Impact of AI based mobility on RRM requirements Qualcomm Incorporated

R4-2502220 (FS\_NR\_AIML\_Mob) Testability and data consistency Qualcomm Incorporated

R4-2502574 Ad-hoc minutes for FS\_NR\_AIML\_Mob SI Nokia

R4-2502594 WF on FS\_NR\_AIML\_Mob Nokia