**3GPP TSG RAN Meeting #105 RP-242393**

**Melbourne, Australia, September 9-12, 2024**

**Source: OPPO (rapporteur)**

**Title: Revised SID on AIML for mobility in NR**

**Document for: Approval**

**Agenda Item: 9.2.5**

3GPP™ Work Item Description

Information on Work Items can be found at <http://www.3gpp.org/Work-Items>
See also the [3GPP Working Procedures](http://www.3gpp.org/specifications-groups/working-procedures), article 39 and the TSG Working Methods in [3GPP TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm)

# Title: Study on AI (Artificial Intelligence)/ML (Machine Learning) for mobility in NR

## Acronym: FS\_NR\_AIML\_Mob

## Unique identifier : 1020084

NOTE: For new WIs/SIs leave the Unique identifier empty and make a proposal for an Acronym.

 For a revised WI/SI: Take Unique identifier and acronym as shown in 3GPP workplan.

 If this is a RAN WID including Core and Perf. part, then Title, Acronym and Unique identifier refer to the feature WI.

 Please tick (X) the applicable box(es) in the table below:

 Either:

|  |  |
| --- | --- |
| **This WID includes a Core part** |  |
| **This WID includes a Performance part** |  |

 or:

|  |  |
| --- | --- |
| **This WID includes a Testing part** |  |
| **and it addresses the following 3GPP work area:** | **Radio Access** |  |
| **Core Network** |  |
| **Services** |  |

Potential target Release: Rel-19

Note that this field above indicates the proposed Release at the time of submission of the WID to TSG approval. It can later be changed without a need to revise the WID. The updated target Release is indicated in the Work Plan. NOTE: In case of contradiction with the target dates of clause 5, clause 5 determines the target release.

## 1 Impacts

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Affects:** | UICC apps | ME | AN | CN | Others (specify) |
| **Yes** |  | X | X |  |  |
| **No** | X |  |  | X |  |
| **Don't know** |  |  |  |  |  |

## 2 Classification of the Work Item and linked work items

### 2.1 Primary classification

This work item is a …

|  |  |
| --- | --- |
|  | Feature |
|  | Building Block |
|  | *Work Task* |
| X | Study Item |

NOTE: Normally, Core/Perf./Testing parts in RAN WIDs are Building Blocks. Only if they are under an SA or CT umbrella, they are defined as work tasks. If you are in doubt, please contact MCC.

### 2.2 Parent Work Item

|  |
| --- |
| Parent Work / Study Items  |
| Acronym | Working Group | Unique ID | Title (as in 3GPP Work Plan) |
|  |  |  |  |

NOTE: RAN agreed some time ago, that it describes the feature WI + Core/Perf. part WI or Testing part WI in one WID. Therefore the table above should just include the feature WI data (In case the feature covers Core and Perf. part, please list under Working Group the leading WG of the Core part).

### 2.3 Other related Work Items and dependencies

|  |
| --- |
| Other related Work Items (if any) |
| Unique ID | Title | Nature of relationship |
| 941110 |  Artificial Intelligence (AI)/Machine Learning (ML) for NG-RAN | normative work on mobility in network side |
| 940084 | Study on Artificial Intelligence (AI)/Machine Learning (ML) for NR air interface | Study on AI/ML over radio interface and focus on physical layer use cases, where evaluation on e.g.BM case-1/-2 is closely related to AI mobility |
| 1021093 | Artificial Intelligence (AI)/Machine Learning (ML) for NR air interface | Normative work on LCM framework could be reused as much as possible for SID on AI mobility |

NOTE: Also related or dependent WIs/SIs in other TSGs should be indicated.

## 3 Justification

With existing L3 handover mechanism, handover is triggered and executed based on reported historical measurement result and/or measurement event(s) i.e., it is kind of reactive scheme by its nature. It may work well among macro cells when UE’s mobility is low for existing services. But it could be problematic when either UE’s mobility is high or among micro cells of high density or both for existing services or future services e.g. XR, where such reactive scheme may result in more unintended event e.g., handover failure, radio link failure, Ping-Pong phenomenon, throughput loss or too early/late handover etc. To improve handover robustness conditional handover is introduced in Rel-16. And to reduce interruption time of frequent handover among small cells LTM HO is introduced in Rel-18. However, these two mechanisms are not sufficient because they are still reactive scheme by design. On the other hand, mechanism based on AI/ML algorithm has the potential to enable proactive scheme.

In Rel-18 SID called FS\_NR\_AIML\_air was studied extensively on physical layer centric use cases including spatial and temporal beam prediction. Temporal prediction within serving cell is mainly to predict the best or top-K beam(s) or beam pair(s) in time domain in order to improve UE throughput. While predict the best or top-K beam(s) or beam pair(s) among a set of beams by measuring a smaller set of beams could help reduce RS signalling overhead, measurement efforts and UE power consumption etc. By extended L1 beam measurement from serving cell to neighbouring cell, majority of the RAN1 work can be reused. Since L3 measurement is based on filtering of L1 measurement, the study of AI/ML for air can be leveraged for mobility purpose e.g., temporal prediction can also be used to predict beam(s)/cell(s) becoming worse so that unintended event like radio link failure or short-stay handover can be avoided.

Mobility enhancement was also studied in RAN3 in Rel-17 in SID called FS\_NR\_ENDC\_data\_collect and is now specified in Rel-18 WID NR\_AIML\_NGRAN-Core. In these RAN3 items the study and normative work on mobility enhancement is based on information available in network side e.g. handover and stay of time in history among cells to predict UE’s trajectory in single hop and hence potential candidates. In Rel-19 RAN3 will further work on UE’s trajectory for multiple hops. The predicted UE’s trajectory could be helpful for study on AI/ML mobility over air interface to some extent.

Based on progress made in RAN1 and RAN3 so far and assumption on UE’s trajectory it is feasible to predict RRM measurement and/or event and hence candidate target cell in UE side. In network side new assistant information, if necessary, and statistics information based on measurement report from UE and/or neighbouring nodes can be also used for smart prediction. If some prediction information could be known by network, handover and/or RRM performance can be improved by proactive measures to either make a better decision or avoid unintended event.

## 4 Objective

### 4.1 Objective of SI or Core part WI or Testing part WI

The study will focus on mobility enhancement in RRC\_CONNECTED mode over air interface by following existing mobility framework, i.e., handover decision is always made in network side. Mobility use cases focus on standalone NR PCell change. UE-side and network-side AI/ML model can be both considered, respectively.

Study and evaluate potential benefits and gains of AI/ML aided mobility for network triggered L3-based handover, considering the following aspects:

* AI/ML based RRM measurement and event prediction,
	+ Cell-level measurement prediction including intra and inter-frequency (UE sided and NW sided model) [RAN2]
		- Inter-cell Beam-level measurement prediction for L3 Mobility (UE sided and NW sided model) [RAN2]
	+ HO failure/RLF prediction (UE sided model) [RAN2]
	+ Measurement events prediction (UE sided model) [RAN2]
* Study the need/benefits of any other UE assistance information for the network side model [RAN2]
* The evaluation of the AI/ML aided mobility benefits should consider HO performance KPIs (e.g., Ping-pong HO, HOF/RLF, Time of stay, Handover interruption, prediction accuracy, and measurement reduction) etc.) and complexity tradeoffs [RAN2]
	+ NOTE: Simulation assumption and methodology can leverage TR 38.901, 38.843 and 36.839. And leave the detail discussion to RAN2
* Potential AI mobility specific enhancement should be based on the Rel19 AI/ML-air interface WID general framework (e.g. LCM, performance monitoring etc) [RAN2]
	+ NOTE: This would only be treated after sufficient progress is made in the Rel-19 AI/ML air interface WID
* Potential specification impacts of AI/ML aided mobility [RAN2]
* Evaluate testability, interoperability, and impacts on RRM requirements and performance [RAN4]
	+ Study the impacts on requirements based on RAN2 assumptions, and coordinate with RAN2 if needed
	+ Study the testability and interoperability based on RAN2 framework (e.g., number of cells to measure, beams etc.)
	+ NOTE 4: Leverage the work from “AI/ML for NR air interface” led by RAN1 and avoid the duplicate study for testability and interoperability.
	+ NOTE 5: Avoid the overlaps with RAN2 work for evaluation
* NOTE 1: RAN1/3 work can be triggered via LS

NOTE 2: To avoid duplicate study with “AI/ML for NG-RAN” led by RAN3

NOTE 3: Two-sided model is not included

### 4.2 Objective of Performance part WI

NOTE: Leave empty if the WI proposal does not contain a RAN performance part.

### 4.3 RAN time budget request (not applicable to RAN5 WIs/SIs)

NOTE: For all new RAN related WIs/SIs which are not led by RAN WG5 the WI/SI rapporteur has to fill out the attached Excel table to request time budgets for corresponding RAN WG meetings.
The Excel table has to be filled out for all affected RAN WGs and up to the target date of the WI/SI.
One time unit (TU) corresponds to ~ 2 hours in the meeting.
If no TU is needed, then leave the field empty otherwise enter a number >0 in the field.

 For revisions of already approved WI/SI descriptions: Please remove the Excel table from the WID/SID's zip file. The time budgets are already recorded. If you want to modify them, then this has to be done via the status report and not via a revised WID/SID.

 If this WID is covering Core and Performance part, then please fill out one line for each part in the attached Excel table.

**additional comments to the time budget request in the attached Excel table:**

## 5 Expected Output and Time scale

|  |
| --- |
| **New specifications** *{One line per specification. Create/delete lines as needed}* |
| Type  | TS/TR number | Title | For info at TSG#  | For approval at TSG# | Remarks |
| Internal | TR38.744 | Study on Artificial Intelligence (AI)/Machine Learning (ML) for mobility in NR | RAN#108 | RAN#109 | Zhongda, Du, OPPO, duzhongda@oppo.com |

*{Note 1: Only TSs may contain normative provisions. Study Items shall create or impact only TRs.
"Internal TR" is intended for 3GPP internal use only whereas "External TR" may be transposed by OPs.}*

NOTE: If this is a RAN WI including Core and Perf. part, then all new Core part specs have to be listed first and then all new Perf. part specs. Indicate "Core part" or "Perf. part" under Remarks for each spec.
By default a new specs can only be new for one of both parts.

|  |
| --- |
| **Impacted existing TS/TR** *{One line per specification. Create/delete lines as needed}* |
| TS/TR No. | Description of change  | Target completion plenary# | Remarks |
|  |  |  |  |

NOTE: If this is a RAN WI including Core and Perf. part, then all new Core part specs have to be listed first and then all new Perf. part specs. Indicate "Core part" or "Perf. part" under Remarks for each spec.
If an existing spec is affected by both (Core part and Perf. part), then it has to be listed twice with appropriate approval dates.

## 6 Work item Rapporteur(s)

Zhongda, Du, OPPO, duzhongda@oppo.com

Dimitri, Gold, Nokia, dimitri.gold@nokia.com

YuanYuan, Zhang, MediaTek, yuany.zhang@mediatek.com

## 7 Work item leadership

Primary: RAN WG2

Secondary: RAN WG4

## 8 Aspects that involve other WGs

None.

NOTE: For RAN WIs: Section 8 applies only to WGs outside of TSG RAN because RAN WG aspects have to be covered in section 4.

## 9 Supporting Individual Members

*{At least 4 supporting Individual Members are needed. There is an expectation that these companies will provide resources to progress the work. Note that having 4 supporting companies is a necessary but not sufficient condition: the usual TSG approval process by consensus is needed for the WID approval.}*

|  |
| --- |
| Supporting IM name |
| Apple |
| CAICT |
| CATT |
| CMCC |
| China Telecom |
| China Unicom |
| Ericsson |
| Fujitsu |
| Futurewei |
| IIT Madras |
| Honor |
| III |
| ITRI |
| Intel |
| Interdigital |
| KDDI |
| Lenovo |
| LG Electronics |
| Motor Mobility |
| NEC |
| NTT DOCOMO |
| OPPO |
| Qualcomm |
| Keysight |
| Kyocera Corporation |
| KT Corp |
| MediaTek |
| NEC |
| Nokia |
| Nokia Shanghai Bell |
| Nvidia |
| Sony |
| Samsung |
| Sanechips |
| Semtech |
| Sharp |
| SK Telecom |
| Spreadtrum |
| Verizon |
| vivo |
| Xiaomi |
| ZTE |
| Huawei |
| HiSilicon |
| Lekha Wireless Solutions |
| TCL |
| Telecom Italia |