3GPP TSG-RAN WG3 #119bis-e R3-231880

E-meeting, 17th – 26th April 2023

Agenda Item: 12.2.2.2

Source: NEC (moderator)

Title: Summary of email Discussion on CB: # AIRAN3\_ME

Document for: Discussion and Approval

# Introduction

**CB: # AIRAN3\_ME**

**- The presence of time stay of UE, optional or mandatory?**

**- Whether predicted UE Trajectory spans across multiple NG-RAN nodes?**

**- Whether the actual UE trajectory is needed between NG-RAN node, the details of the solution.**

**- Capture agreements and open issues**

**- Provide TP if agreeable**

(moderator - NEC)

Summary of offline disc [R3-231880](https://ericsson-my.sharepoint.com/personal/angelo_centonza_ericsson_com/Documents/Documents/3GPP%20Related/3GPP_ETSI/RAN3/RAN3-120/EmailDiscussions/CB%20%23%20AIRAN3_ME/Inbox/R3-231880.zip)

This email discussion will comprise two phases:

* Phase 1 Deadline: Thursday April 20th, 10pm UTC
* Phase 2 Deadline: Monday April 24th, 8am UTC

In the second phase, we will try to obtain TPs

# For the Chairman’s Notes

Propose the following:

**The presence of time stay of UE, optional or mandatory is FFS:**

**Predicted UE Trajectory conveyed in the Handover Request can span across multiple NG-RAN nodes, assuming the actual UE trajectory in those multiple NG-RAN nodes can be collected.**

**To support an AI model for UE trajectory prediction in other NG-RAN node(s), the source NG-RAN node needs to understand the actual (relevant) UE trajectory in the other NG-RAN node(s), and it is upon implementation if it is used for training/monitoring/etc. It needs to be further discussed if the actual trajectory consists of historical information obtained before the prediction is generated or trajectory measurements collected after the prediction is generated.**

**The source NG-RAN cannot collect actual UE trajectory in the future cross multiple NG-RAN nodes.**

**There is no consensus regarding how the source NG-RAN node understands the actual UE trajectory in the future, either:**

**Option 1) by means of the UE History Information reported from (other) UEs to the source NG-RAN node. Independent from handover procedure. No specification impacts.**

**Option 2) by collecting the actual UE trajectory from the target NG-RAN node(s) (FFS whether the format of UHI can be reused) using the agreed class1/2 procedure. Similar as the UE performance collection after handover.**

# Discussion

## The presence of time stay of UE, optional or mandatory?

In the last meeting RAN3 discussed the presence of predicted time of stay of a UE in a cell in the predicted UE trajectory information, but we have no conclusion:

*The presence of the predicted time of stay of a UE in a cell is FFS.*

Some companies thinks that this is up to the RAN node capability, if some of the RAN nodes can’t support prediction of time of stay, then the presence of predicted time of stay of a UE in a cell should be optional (e.g., [1206],[1608], [1650], [1683], [5588]). On the other hand, some companies think that the presence of predicted time of stay of a UE in a cell should be mandatory (e.g., [1799], [1376], [1514]), as without the time of stay, the value to inform target NG-RAN node about the predicted cell list only with cell ID is quite limited. Since the target node does not have accurate information of the UE´s mobility pattern, and anyway needs to process further on when/how to perform handover towards the cell in the list.

**Q1: Do companies think the presence of time stay of UE should optional or mandatory?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Optional /Mandatory** | **Comments, if any** |
| Ericsson | Optional | The furthest in time a trajectory prediction is carried out the less accurate is the prediction of the time of stay. However, a cell based UE trajectory may still be derived in a fairly accurate way as in many cases UE´s movements are recursive. Hence, we see the value of providing a UE trajectory where Time of Stay is included, if possible. Namely Time of Stay should be optional.  The information on which cell the UE will move along its trajectory is still useful if Time of Stay is not included, as it indicates where load will move and help planning for resource optimisation. |
| Nokia | Mandatory | Predicted time of stay of a UE in a cell depends on UE mobility. In our view, different UE mobility patterns would give rise to different possible values of predicted time of stay in a cell (and hence to different possible trajectories) emanating from a network node. If a node cannot calculate predicted time of stay in a cell, then it does not need to send the corresponding predicted trajectory to a neighbouring node in a Handover Request. In our view, the reasons to send predicted UE trajectory from a source to a target node are to enable the target node to perform:   * Resource reservation, namely, to allocate resources accordingly depending on how long a UE is expected to stay in its cells. * Training or Retraining of a cell-based trajectory prediction AI/ML Model using neighbour information in the training input.   In the absence of a predicted time of stay of a UE in a cell, a target node will not be able to know for how long to reserve resources for an incoming handover. In addition, if timing information is missing a source node may not know whether to trigger a normal handover or a conditional handover. It therefore appears that the (predicted) time angle is essential to provide benefits to a target node by receiving predicted UE Trajectory information. Therefore, we think that if this cannot be calculated a node does not need to provide a neighbour just with a predicted list of cells a UE may follow. |
| CATT | Mandatory | We think the predicted time of stay of a UE in a cell is necessary information which shall be provided to target node. If UE trajectory prediction includes only a list of cell, it is hard for target node to use it. We could understand the scenario that source node may have not sufficient information to predict the stay time of a UE in a cell. Then it is no needed to provide the UE trajectory prediction with only cell list to target node since it could not provide enough information to the target node. |
| Lenovo | Prefer Mandatory | Tend to agree with Nokia and CATT. It makes big difference if UE is predicted to stay for 1min or for 1hour. |
| China Telecom | Mandatory | The timing information about UE stayed in a cell is very useful for the target node to make access control and prepare the resource, especially for the CHO. |
| Huawei | Optional | Even providing the UE’s trajectory prediction only as a list of cells that the UE is expected to visit could be a valuable indication of the fact that the UE is following a certain path with a high level of accuracy. If we signal both the predicted list of visited cell and corresponding Time of Stay, and if the latter information is not accurate enough, the subsequent HO could be a wrong action for the UE (hence negatively impacting UE performance) and a waste of Xn signalling resources.  Moreover, predicting the Time of Stay in a Cell is strictly related to the capabilities of the AI/ML model being used and, especially for fast moving UEs, it could be challenging to predict the Time of Stay in a Cell with sufficient accuracy, resulting in the fact that the target NG-RAN node may not be able to prepare radio resources in a timely manner |
| Samsung | Optional | It depends on the model design. And the common understanding is that the predicted trajectory is for target cell selection. When there are two cells with similar measurement results, the trajectory prediction can help the node to select one of them as the target cell. So if providing a list of cell that the UE will camp on without time of staying, it can realize the above effect for mobility optimization. Time of stay is an additional info for node, which is beneficial. Due to highly model design related, it is better to set as an optimal IE. |
| Intel | Optional | In our understanding, whether the time of stay can be considered as one output for Mobility optimization use case highly depends on the algorithm that used by the source NG-RAN node.  Furthermore, we also doubt that how the target NG-RAN node will take this predicted UE trajectory information into account for further UE’s mobility. As discussed many times, the handover decision of a UE may be impacted by many factors. The target NG-RAN node should have the flexibility to not follow the received predicted UE trajectory information for UE’s handover and decide on its own. Hence, in our understanding, all information in this predicted UE trajectory information is “nice to have” rather than “must to have”. Whether time of stay can be provided is highly depend on the algorithm implementation. Hence, we prefer it to be optional. |
| Qualcomm | Optional | As mentioned in our paper, the “predicted time of stay” is dependent on the input data availability for prediction. If the data is available, source node can provide “time of stay” information.  There is no use or providing incorrect or default data for mandatory “time of stay” when sufficient input information is unavailable for prediction.  Predicted Cell list alone can also be a useful information at the target. |
| NEC | Mandatory | The target node needs to know when the UE is predicted to move to the target cell so as to prepare the radio resource. |
| ZTE | Optional | The predicted UE trajectory is a valuable reference information that the target NG-RAN node can use for subsequent optimization. Since this information is only a reference, it is beneficial for the target NG-RAN node to receive only the predicted UE trajectory information.  Additionally, the predicted stay time of the UE is also valuable but is also only an additional reference of the predicted UE trajectory. Whether or not this information can be generated depends on the capability of the AI/ML model, so we prefer it to be optional.  Regarding the comments provided by companies, half support making this information optional while the other half support making it mandatory. To address this discrepancy, we suggest making this information optional. If some companies believe it is essential, the time information element can be included with the predicted UE trajectory.  We believe that making predicted stay time optional would be the most reasonable approach to satisfy the needs of all companies. |
| InterDigital | Optional | We think it is dependent on the capabilities of the model being used |
| CMCC | Mandatory | The value to inform target NG-RAN node about the predicted cell list only with cell ID is quite limited. Since the target node does not have accurate information of the UE´s mobility pattern, and anyway needs to process further on when/how to perform handover towards the cell in the list. |
| LGE | Optional | Among the AI/ML model for the prediction of UE trajectory, as mentioned in some companies, some models may not provide the predicted time of stay of a UE in a cell as output.  Moreover, if the source NG-RAN node perceives that the predicted time of stay of a UE in a cell is wrong, it may not provide this value to the target NG-RAN node because the target NG-RAN node may likely allocate the improper radio resource to the HO-ed UE. |

Summary of Q1:

8 companies support **Optional**

6 companies support **Mandatory**

Conclusion 1: There is no consensus on the presence of time stay of UE, optional or mandatory.

## Whether predicted UE Trajectory spans across multiple NG-RAN nodes?

The second issue is the scope of predicted UE trajectory. Some companies ([1206], [1514]) thinks that as the aim of predicted UE trajectory transferring is for subsequent mobility decision, it is better to span across the multiple NF-RAN node and does not to limit it into one node. On the other hand, some other companies ([1650]) assume that the second predicted cell in the list of cells is controlled by the neighbour NG-RAN node rather than the target node. In that case, the prediction UE Trajectory cannot be provided to the neighbour NG-RAN node because it is provided using the XnAP HANDOVER REQUEST message, and the neighbour NG-RAN node is not the target NG-RAN node. In addition, [1467] supports it is up to the capability of AI/ML module in source NG-RAN to decide whether the predicted UE Trajectory spans across multiple NG-RAN nodes or it is limited within a single target NG-RAN node and it has no impact on specification. The moderator assumes [1467] supports predicted UE Trajectory spans across multiple NG-RAN nodes.

**Q2: which option do you prefer regarding whether the predicted UE Trajectory spans across multiple NG-RAN nodes or single NG-RAN node?**

**Option 1: predicted UE Trajectory spans across multiple NG-RAN nodes.**

**Option 2: The predicted UE Trajectory should be limited within a single target NG-RAN node.**

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| --- | --- | --- |
| **Company** | **Option1/2** | **Comments, if any** |
| Ericsson | See comments (moderator assumes Ericsson supports option 1) | This discussion is strictly related to the Trajectory Feedback discussion. Prediction and feedback need to be of the same kind. Namely, if the UE Trajectory Prediction is a multi node prediction, the UE Trajectory Feedback is a multi node feedback. If this rule is not followed, feedback cannot be used to improve predictions.  We support a multi-node trajectory prediction because we believe that a single node trajectory prediction will often result in a single cell trajectory prediction (e.g. for cases of target NG-RAN nodes serving small cells, high/mid frequency cells, etc, where the second mobility hop implies a change of NG-RAN node). However, we also realise that multi-node UE Trajectory Feedback can only be achieved by using the Mobility History Information, as feedback. This is because of the various issues encountered when a multi-node trajectory feedback wants to be provided, such as:   * Lack of Xn connectivity * Lack of context at source node * Cell deployment changes between prediction and feedback   Hence, the only workable option we see for a multi-node trajectory feedback is to use the Mobility History Information as feedback.  With this assumption we support multi-node trajectory predictions. |
| Nokia | Option 1 | We think that we should not limit the predicted UE Trajectory to a single target NG-RAN node. In general, it may span across multiple NG-RAN nodes, depending on the availability of data to train a model for cell-based UE Trajectory prediction. |
| CATT | Option 1 | It is up to the capability of AI/ML module in source NG-RAN to decide whether the predicted UE Trajectory spans across multiple NG-RAN nodes or it is limited within a single target NG-RAN node and it has no impact on specification. |
| Lenovo | Option 1 if simple solution can be agreed, otherwise Option 2 since it is anyway needed to support option 1 in the future | Ideally, we agree it will be very useful to support cross multi-hop UE future trajectory collection and prediction.  Only for the sake of progressing, we can first discuss the solution for one-hop since it is anyway needed for the multi-hop discussion. Then, if the same solution for one-hop can be reused for multi-hop without much additional complex, we can support multi-hop as well in this release. Otherwise, we can leave the multi-hop scenario for future release due to limited time. |
| China Telecom | Option 1 | With high-quality input data, the AI model can output multiple subsequent cells which UE may access cross multiple NG-RAN nodes. |
| Huawei | Option 1, but see comment | We believe that the UE trajectory prediction should include an appropriate amount of multi-hop cell data, which however depends also on the capabilities of the AI/ML model being used.  The granularity of the prediction depends also on the mean to be used for the feedback of the actual UE trajectory after HO: if the UHI is used, then the UE trajectory prediction can also span multiple NG-RAN (i.e., the prediction from the source can go beyond the next-hop target gNB); on the contrary, if the source node requests the actual UE trajectory, then the problems already listed by Ericsson needs to be solved (not to mention the case when the UE goes to idle mode, where the number of the actual UE trajectory hops may be less than the number of hops in the UE trajectory prediction). In the latter case it could be beneficial to limit the UE trajectory prediction to the next-hop target gNB only (which could also manage multiple cells in the trajectory) |
| Samsung | Option 1 | As the aim of predicted UE trajectory transferring is for subsequent mobility decision, it is better to span across the multiple NF-RAN node and does not to limit it into one node. |
| Intel | Option 2 | In our understanding, the main question is the max number of cell in predicted UE trajectory information. Note that the UE mobility history report only includes maximum of 16 most recently visited primary cells. It should be also noted that, with limited information as input, the inference output (i.e. cell-level UE trajectory prediction) cannot be made valid and accurate for up to e.g. next 100 cells that the UE is expected to visit in future. To guarantee the accuracy of prediction result, it is better to predict at most next two cells that the UE is expected to visit. The first cell is the target cell for handover, while the second one is the next expected target cell after first handover, i.e. the cell that the UE is expected to be handed over after handover to the target cell. And also with the limitation commented by Ericsson, e.g. lack of direct Xn interface, etc, it’s hard to consider multiple NG-RAN nodes. Hence, spanning across NG-RAN nodes or multiple hop cell prediction may not be realistic in real deployment. |
| Qualcomm | Option 1  Option 2 is not valid. No need for discussing this. | Single node trajectory prediction does not have Xn impact. We don’t have to discuss this option at all. |
| NEC | Option 1 | We shall not limit the hop to one hop only. The cases proposed by E/// is a special case of one hop only. |
| ZTE | Option 1 | It has not specification impact.  We think why this is a question is relevant to how to collect the UE trajectory feedback information. |
| InterDigital | Option 1 |  |
| CMCC | See comments | Similar view as Lenovo.  We prefer to support UE Trajectory spans one-hop in this release. |
| LGE | Option 2, but see comment | Whether the predicted UE Trajectory spans across multiple NG-RAN nodes or a single NG-RAN node can be determined depending on what feedback information (e.g., the UHI or the actual UE trajectory) is used. If the UHI is used, the predicted UE Trajectory spans across multiple NG-RAN nodes, though there is a problem to be solved, as mentioned in Ericsson. On the other hand, if the actual UE trajectory is used as feedback, the predicted UE Trajectory is limited within a single NG-RAN node to guarantee the accuracy of the prediction result. |

Summary of Q2:

12 companies support option 1)

2 companies support option 2)

Conclusion 2: Predicted UE Trajectory conveyed in the Handover Request can span across multiple NG-RAN nodes, assuming the actual UE trajectory in those multiple NG-RAN nodes can be collected.

## Whether the actual UE trajectory is needed between NG-RAN node.

RAN3 has agreed to support gNB (e.g., source gNB) to train an AI model that predicts the future UE trajectory in a neighbor gNB (e.g., target gNB) which can be further provided to the neighbor gNB during handover procedure. Some companies ([1435], [1376], [1683], [1467]) think that for a gNB to properly train an AI model to predict the UE trajectory at a neighbour gNB (the prediction result can be transferred during handover procedure), the training data set should include the actual UE trajectory at the target gNB. So it is necessary that actual UE trajectory should be provided to the source NG-RAN.

On the other hand, some other companies ([1608]) identified some issues to support the actual UE trajectory collection from future NG-RAN nodes:

* After UE mobility the source NG-RAN removes the UE context;
* If a trajectory prediction covers the *n* future cell hops, it is very likely that the NG-RAN node serving the *n*th cell will not be Xn connected to the source node that produced the prediction;
* By the time a measured prediction is made available to the source node, the layout of cells in a neighbourhood might have changed.

Moderator clearly see the issues identified by [1608], and kindly ask companies who support the actual UE trajectory feedback to provide some response and solutions regarding these three issues raised from [1608].

**Q3: To predict UE trajectory in the future NG-RAN node(s), whether the actual UE trajectory at the future NG-RAN node(s) is needed at the source NG-RAN node (upon implementation if it is used for training/monitoring/etc.)? If yes, please comment on the issues mentioned above.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments, if any** |
| Ericsson | See comments (moderator assumes Ericsson’s answer is “No”) | The actual UE trajectory can be derived from the UE´s Mobility History Information. It is not important for training purposes whether the UE Trajectory feedback is derived from the Mobility History Information or other measurements of the UE Trajectory. All that is important is to have training data samples that revealed a measured trajectory for UEs.  Indeed, the issues mentioned by the moderator exist and we do not see any easy solution to fix them. Hence, we see the need to collect actual UE Trajectories, but in the form of UE´s Mobility History Information rather than UE Trajectory Feedback from future serving nodes. |
| Nokia | No | We think that a node computing predicted UE Trajectory can utilize training data to monitor the performance of the computed predicted UE Trajectory. A node that is predicting a UE Trajectory needs to receive input information reflecting sequences of cells into the future and a time spent in those cells for different UEs, namely UE History Information and UE History Information from UE. To continuously (re)train the UE Trajectory prediction model this information needs to be provided from future cells that a UE may visit to the node making the prediction. The node can use this information together with its calculated prediction to determine whether it has accurately predicted different trajectories emanating from its cells. We acknowledge the above identified issues and we do not think that other feedback information is needed in light of those.  [Lenovo] Our understanding of Nokia’s comment is actually a mild yes to this question 😊, i.e., the source gNB can request neighbour gNBs to send (in the form of) UE history information to the source gNB which contains the future UE trajectory for certain UEs, only that such request is decoupled from the HO procedure and thus not related to a particular handed over UE. Those details we can further discuss after we can first agree that future UE trajectory information is needed for at least AI training/etc. |
| CATT | Yes | UE trajectory feedback is useful for further AI model retuning. If the source NG-RAN node would like to collect feedback information to refine AI model, keeping UE context for a while is what the NG-RAN node need to do to improve the accuracy of AI inference. When/whether to keep the UE context as well as request the feedback towards the target node is completely implementation related |
| Lenovo | Yes | As explained in our paper R3-231435, we believe collecting future UE trajectory is fundamental for predicting future UE trajectory given that:   * To properly train an AI model predicting future UE trajectory at given cells, the measured UE trajectory at those give cells is required as part of the training data. * In order to validate/test/monitor the AI model predicting future UE trajectory at given cells, gNB needs to compare the predicted UE trajectory with the measured UE trajectory at given cells.   Regarding the concerns raised by some companies:  UE context maintenance:   * First of all, the same issue exists in UE performance collection discussion as well. Besides, source gNB only needs to maintain some identification information of the concerned UE, instead of full UE context, in order to understand the future UE trajectory provided by the target gNB. We don’t think it will be burden on the gNB comparing to the capability it needs to supporting the AI training/etc.   No Xn interface between gNBs after multi-hops:   * Any prediction or data collection has a limit, this could be considered as one of them. Another alternative could be that the source gNB only receives the future UE trajectory from the target gNB and it is upon the target gNB to decide to further collect from the next hop gNB (e.g., if it has Xn interface). We can further discuss solution details.   Change of the cell layout:  In our understanding the prediction of UE trajectory only works under the assumption that the cell layout is semi static. |
| China Telecom | Yes | We believe that it is beneficial for the source node which performs UE trajectory prediction to know the actual UE trajectory for model monitoring/updating. |
| Huawei | Yes, but see comment | As commented above, it depends on the granularity of the UE trajectory prediction: if the prediction spans multiple NG-RAN nodes (beyond the next-hop target gNB), then it is difficult to provide the actual UE trajectory to the source gNB (i.e., the node that made the prediction). We see some benefit in providing the actual UE trajectory only if the prediction is for the next-hop target gNB only (i.e., prediction spanning a single gNB), which alleviates the well-known issues of lack of Xn, UE context alignment/propagation across multiple gNBs, cell deployment changes, UE RRC state transitions. |
| Samsung | (Moderator assumes Samsung’s answer is “Yes”) | For training data collection:  The model is not UE-specific. It is a general model to predict the trajectory for all the UEs in one area. Thus, for the training data collection, it collects massive records from multiple UEs via UHI. Based on massive records, UE has the trajectory records of cell A in the UHI, so the node can get the future camped cell info from cell A.  For model performance feedback:  UE trajectory of other UEs can help to evaluate the performance. Even without UE trajectory information, the UE performance feedback can help to do the evaluation. The trajectory prediction is for node to select the target cell. The UE performance feedback can help to evaluate whether the target cell selection is correct or not. |
| Intel | See comment (moderator assumes Intel’s answer is “Yes”) | Technically, yes, the future actual UE trajectory needs to be considered as feedback. As we commented earlier, we think the predicted UE trajectory information only includes next predicted handover cell after the UE's handover to the target NG-RAN node. Hence, the limitation raised by Ericsson could be manageable. However, if the predicted trajectory information will span across NG-RAN nodes, we agree with the issues raised by Ericsson and actual UE trajectory may not be provided back to the source. |
| Qualcomm | NO | We acknowledge the issues pointed out by Moderator.  Another main issue is that the predicted UE trajectory is applicable only as long as UE in connected mode. Once the UE goes to Idle, the UE is unidentifiable in RAN.  All these issues are limitations in RAN and we think providing feedback for UE Trajectory prediction is complex and technically may not be feasible. |
| NEC | Yes | UE trajectory feedback is useful for further AI model retuning. |
| ZTE | Yes | Based on the processing flow of an AI/ML framework, after the model has performed its inference or prediction task, it requires feedback information to evaluate its performance. This evaluation step is an essential part of the cycle for AI/ML functions. Without it, the model cannot improve its accuracy and may not perform optimally in future tasks. Similarly, after the source node provide the predicted UE trajectory to the target node, the source node needs feedback information to evaluate the accuracy of the predicted UE trajectory after it has been provided to the target node.  Several companies expressed their concern that it may not be technically feasible. The main issue discussed was whether the predicted trajectory of the UE would span across multiple NG-RAN nodes or if it would be limited to a single target NG-RAN node. Actually, in the case that the predicted trajectory of the UE would span across multiple NG-RAN nodes, we need consider other solution (which may have NG, Uu impact) rather simply using the agreed new procedure to transfer the actual feedback information.  So, we suggest to **focus the scenario that the actual UE trajectory feedback information is limited in the first target NG-RAN node for now.**  For the UE context release issue, it up to gNB implementation to keep the UE context between the source NG-RAN node and the target NG-RAN node, if the UE trajectory feedback is requested from the source NG-RAN node. |
| InterDigital | ` | Agree with Ericsson’s reasoning |
| CMCC | Yes | The feedback of actual UE Trajectory is useful to test and update AI model. A minimum set of UE context, e.g, *UE XnAP ID,* could be kept for the UE. |
| LGE | Yes | We have a similar view to Huawei. |

Summary of Q3:

10 companies think the actual UE trajectory from the future NG-RAN node(s) is needed at the source NG-RAN node.

4 companies don’t think the actual UE trajectory from the future NG-RAN node(s) is needed at the source NG-RAN node.

There is no consensus regarding whether the actual UE trajectory from the future NG-RAN node(s) is needed at the source NG-RAN node.

Conclusion 3: To support an AI model for UE trajectory prediction in other NG-RAN node(s), the source NG-RAN node needs to understand the actual (relevant) UE trajectory in the other NG-RAN node(s), and it is upon implementation if it is used for training/monitoring/etc. It needs to be further discussed if the actual trajectory consists of historical information obtained before the prediction is generated or trajectory measurements collected after the prediction is generated.

If the answer is **Yes** in Q3, [1376] gives the scenario that if multiple NG-RAN nodes are included in the predicted UE trajectory, it is necessary to obtain the actual UE trajectory in the future. But in [1435], [1799], [1683], companies have concerns that even though it is technically possible that the source gNB collects UE trajectory measurements from gNBs beyond the target gNB, it would require additional enhancements/complexity to align the UE related context cross multiple gNBs.

**Q4: do you think the source NG-RAN can collect actual UE trajectory in the future cross multiple NG-RAN nodes?**

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| --- | --- | --- |
| **Company** | **Yes / No** | **Comments, if any** |
| Ericsson | No | As explained above, and as highlighted by the moderator, there are several obstacles that make collection of a multi-node trajectory feedback from future serving nodes unfeasible.  Absence of UE context: even under the assumption that some minimum context can be kept after mobility, it should be local to assume that such context will have to be removed at some point. Given that a multi-node trajectory may take a long time to accomplish, it is likely that any UE context in source MNG-RAN node will not be present any longer.  Absence of Xn connectivity: RAN3 agreed that there are no impacts to the NGAP to support AI/ML. Hence lack of Xn connectivity between source and last UE trajectory serving node implies that the UE trajectory cannot be signalled back to the source.  Cell deployment changes: given that the accomplishment of a multi-node UE trajectory may take a long time, there is the possibility that some cells will be activated/deactivated since the UE Trajectory Prediction was issued. Hence the UE Trajectory Feedback would include information that will never match the prediction |
| Nokia | No | We think that collecting actual UE Trajectory information that a particular UE followed in the future is overly complex. We agree with the moderator’s summary and with the points provided by Ericsson. |
| CATT | No | In this release we propose to support UE trajectory feedback within single NG-RAN for the same reason as Eric. |
| Lenovo | See comment | Maybe, but we need to support future UE trajectory collection from one hop first.  And similar comment as for Q2 and Q3. |
| China Telecom | No | We share similar view with Ericsson, collecting actual UE trajectory cross multiple NG-RAN nodes is too complex to implement. |
| Huawei | No | Issues exist (see above comments) and are not straightforward to solve them; such kind of feedback could be allowed only if the UE trajectory prediction spans a single gNB only (i.e. the next-hop target gNB). Otherwise, use UHI as feedback for (re-)training purposes |
| Samsung | No | It is so complex to collect UE trajectory across multi nodes. |
| Intel | No | We agree with Ericsson’s comment. |
| Qualcomm | NO | Please see our response to Q3 |
| NEC | Yes | If single hop is supported, some issues were identified like the UE context maintenance. The solution can be used to multi-hop feedback as well. If there is no Xn interface between the multiple hop NG-RAN node, the feedback can be sent across multiple hop NG-RAN nodes. |
| ZTE | Not for now | In the case that the predicted trajectory of the UE would span across multiple NG-RAN nodes, we need consider other solution (which may have NG, Uu impact) rather simply using the agreed new procedure to transfer the actual feedback information.  So, we suggest to **focus the scenario that the actual UE trajectory feedback information is limited in the first target NG-RAN node for now.** |
| InterDigital | No | Agree with Ericsson, Intel |
| CMCC | No | Similar view as for Q2. We propose to support UE Trajectory spans one-hop in this release. So the source NG-RAN should collect actual UE trajectory from the single target NG-RAN node. |
| LGE | No | We have a similar view to Ericsson. |

Summary of Q4:

1 company support the source NG-RAN can collect actual UE trajectory in the future cross multiple NG-RAN nodes.

1 company is not so sure whether the source NG-RAN can collect actual UE trajectory in the future cross multiple NG-RAN nodes.

12 companies don’t support the source NG-RAN can collect actual UE trajectory in the future cross multiple NG-RAN nodes.

Conclusion 4: the source NG-RAN cannot collect actual UE trajectory in the future cross multiple NG-RAN nodes.

How is the actual UE trajectory collected?

In [1608], companies think that UE History Information received from (other) UEs may imply future trajectory for a given UE with similar moving pattern. However, in [1683], [1435] companies think from a technical standpoint, this issue cannot be resolved by having the UE return to the original NG-RAN node that generated the predicted trajectory. This is because there is no guarantee that the same UE will be connected to the original NG-RAN node again. One simple way to collect future UE trajectory is to extend the agreed class1/2 procedures for retrieving UE performance to retrieve future UE trajectory from the target NG-RAN node as well.

**Q5: which option do you prefer for the source NG-RAN node to understand the actual UE trajectory in the future?**

**Option 1: use UE History Information reported from (other) UEs to the source NG-RAN node.**

**Option 2: use the agreed class1/2 procedure (AI/ML INFORMATION REQUEST/RESPONSE/UPDATE, the name needs further discussion) to retrieve the future UE trajectory from the target NG-RAN node to the source NG-RAN node.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1/2** | **Comments, if any** |
| Ericsson | 1) | Until it is not explained technically how a multi node UE trajectory is signalled back to the source, Option 2 cannot be discussed. Hence, we suggest that a note is added for option 2, stating that Option 2 can be considered valid if there is consensus on how to fix the issues affecting it, e.g. Absence of UE context, Absence of Xn connectivity, impacts of cell deployment changes. |
| Nokia | See comments (Moderator assumes Nokia supports option 1) | Using UE History information is a simple way to provide information to the source node about UE trajectories over different cells in the future. Monitoring the actual UE Trajectory after a HO would overly complicate the system because it would require maintaining of the UE context for a typically long period of time. The newly introduced Class 1/Class 2 procedures could be used to trigger UE history information of future cells back to the source node, but we do not think that this should be related to a specific Handed over UE. |
| CATT | 2) | For 1), it is harmful to rely only on the UEs that move back for training or model performance monitoring. The training result for example will be e.g. “all UEs will move back here soon” (since all data it collects are this type), which is definitely wrong in many typical cases.  Besides the agreed class1/2 procedure , we think HO request message shall also be used to trigger UE trajectory feedback after successful handover. |
| Lenovo | 2) | Option 2 is what we can think of to support the future UE trajectory collection with minimal spec impact considering the discussion so far.  Besides, it can be extended in the future for multi-hop scenario as well, e.g., the source gNB only receives the future UE trajectory from the target gNB and it is upon the target gNB to decide to further collect from the next hop gNB (e.g., if it has Xn interface).  In any case, we are open to discuss other reasonable solutions as well. |
| China Telecom | 2) | Option 2 is aligned with what we have agreed for UE performance feedback procedure. |
| Huawei | 1), but see comment | UHI is fine for us and allows to have feedback information related to a UE trajectory prediction that spans multiple gNBs beyond the next-hop target gNB. If we also agree to derive UE trajectory predictions spanning a single gNB only (i.e., the next-hop target gNB), then solutions and signalling options for retrieving the actual UE trajectory can be discussed |
| Samsung | Option 1 | Same comment as Q3. The model is not UE-specific. It is a general model to predict the trajectory for all the UEs in one area. Thus, for the training data collection, it collects massive records from multiple UEs to realize the data diversity. Based on massive records, UE has the trajectory records of cell A in the UHI, so the node can get the future camped cell info from cell A. |
| Qualcomm | See Comments (Moderator assumes Qualcomm supports option 2) | Option 1 UHI can be used as input for Prediction of UE Trajectory but not for feedback.  If UHI needs to be used as feedback in Class 2 AI/ML message, then the source node has to maintain the context (not sure for how long). It is not just the source node, but all the nodes in the trajectory path has to maintain the context. Once the UE goes to Idle all the nodes in the trajectory path has to be informed to remove context.  Moreover, at each target node the UE Trajectory predicted at source will get updated. So, which is the node which expects feedback to validate against the prediction is also questionable.  Transferring of UHI as feedback is like reverse HO 😊 which we think is not worth the complexities involved. |
| NEC | 2) | Option 2 can be used for multi-hop scenario in Q4. |
| ZTE | Option 2) | If we focus the scenario that the actual UE trajectory feedback information is limited in the first target NG-RAN node now, the new AI/ML information procedure could be used for actual UE trajectory feedback between NG-RAN nodes. |
| InterDigital | Option 1 | Agree with Ericsson |
| CMCC | 2) | We prefer to use the same procedure for UE performance feedback collection and the future UE trajectory collection by the source node. |

Summary of Q5:

5 companies support option 1.

7 company support option 2.

Conclusion 5: there is no consensus regarding how the source NG-RAN node understands the actual UE trajectory in the future, either:

Option 1) by means of the UE History Information reported from (other) UEs to the source NG-RAN node. Independent from handover procedure. No specification impacts.

Option 2) by collecting the actual UE trajectory from the target NG-RAN node(s) (FFS whether the format of UHI can be reused) using the agreed class1/2 procedure. Similar as the UE performance collection after handover.

# References

|  |  |  |
| --- | --- | --- |
| [**R3-231206**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231206.zip) | Discussion on Xn impact of ME | Samsung |
| [**R3-231376**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231376.zip) | AIML Mobility Enhancement | NEC |
| [**R3-231435**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231435.zip) | Discussion on future UE trajectory collection | Lenovo, Intel Corporation, ZTE |
| [**R3-231436**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231436.zip) | (TP for TS38.423) on future UE trajectory collection | Lenovo |
| [**R3-231467**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231467.zip) | Discussion on XnAP impacts of AI/ML for UE associated metrics | CATT |
| [**R3-231468**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231468.zip) | (TP for 38.423) Support of AI/ML based mobility optimization | CATT |
| [**R3-231514**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231514.zip) | Discussion on AI/ML based mobility optimization | China Telecommunication |
| [**R3-231538**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231538.zip) | Mobility Optimization Outputs | InterDigital |
| [**R3-231539**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231539.zip) | (TP for AIML BLCR for TS 38.423) Mobility Optimization Outputs | InterDigital Finland Oy |
| [**R3-231608**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231608.zip) | Cell based UE trajectory prediction exchange | Ericsson, InterDigital, Qualcomm |
| [**R3-231609**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231609.zip) | (TP for AIML BLCR for TS 38.423) Cell based UE trajectory prediction exchange | Ericsson, InterDigital, Qualcomm |
| [**R3-231619**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231619.zip) | Open points on validity time and prediction accuracy | Ericsson |
| [**R3-231650**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231650.zip) | Discussion on cell based UE trajectory prediction | LG Electronics Inc. |
| [**R3-231651**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231651.zip) | (TP for NR\_AIML\_NGRAN-Core BL CR for TS 38.423) Discussion on cell based UE trajectory prediction | LG Electronics Inc. |
| [**R3-231657**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231657.zip) | (TP for TS 38.423) AI/ML Mobility Optimization | Nokia, Nokia Shanghai Bell |
| [**R3-231658**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231658.zip) | (TP for TS 38.423) Cell-based UE Trajectory Prediction | Nokia, Nokia Shanghai Bell |
| [**R3-231683**](https://www.3gpp.org/ftp/TSG_RAN/WG3_Iu/TSGR3_119bis-e/Docs/R3-231683.zip) | Discussion on left issues of AI based mobility optimization | ZTE |
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| [**R3-231825**](https://www.3gpp.org/ftp/tsg_ran/WG3_Iu/TSGR3_119bis-e/Docs/R3-231825.zip) | (TP for AIML BLCR for TS 38.423) Remaining open issues for mobility enhancements | Huawei |

# Conclusion, Recommendations [if needed]

If needed.