3GPP TSG-RAN WG2 Meeting #121bis-e R2-230xxxx

Elbonia, 17 – 26 April 2023

**Agenda item: 7.16.2.2**

**Source: Nokia (Rapporteur)**

**Title: Report of [AT121bis-e][024][AIML18] on Data Collection Table (Nokia)**

**WID/SID: FS\_NR\_AIML\_air - Release 18**

**Document for: Discussion and Decision**

# Introduction

This document is the report of the following email discussion:

R2-2302650 AIML data collection Nokia, Nokia Shanghai Bell discussion Rel-18 FS\_NR\_AIML\_air

DISCUSSION P1 P2

- OPPO wonder what is the Inference (output),

- Intel also wonder this, and think training data may be a large data set com to inference. Thnk inference output and input doesn’t need to be split.

- ZTE think use case shall be considered as well.

- CATT support to split input and output as we need to collect for labelling, and we need to add use case info.

- Nokia example: can collect radio measurement e.g. RSRP, which may be used as input, but is not the output of the model.

* Extend the previously endorsed table with 3 columns: Inference, Monitoring and Training, and explain in free text the applicability of the data collection method to the LCM purpose and the use case(s).

Go offline with this (Nokia)

* [AT121bis-e][024][AIML] Data Collection Table (Nokia)

Scope: Extend the previously endorsed table with 3 columns (3 LCM purposes): Inference, Monitoring and Training, and explain in free text the applicability of the data collection method to the LCM purpose and the use case(s).

Intended outcome: Report with agreeable (or almost agreeable) table update

Deadline: CB W2 Wednesday.

**The deadline for comments is Monday, 24 April, 2023 at 23:59 UTC.**

The RAN2#121-bis-e agenda items [1] for AIML Methods related to data collection are captured below.

**7.16.2 AIML methods**

Explore AIML methods that are expected applicable to this SI and their expected or potential architecture (allocation of functionality to entities), Identification of Models, other framework aspects, impact on RAN2. Most of LCM is in RAN2 scope.

Both general aspects and use-cases specific aspects are applicable (for use cases in scope). Aspects of on-line/real-time training are deprioritized at current meeting. Please input to 7.16.2.x

**7.16.2.2 Data Collection**

Expect to continue evaluation, e.g. evaluation of cases / methods wrt different LCM purposes. Determine which tangible issues if any (e.g. performance aspects) should/could be considered for later decisions on data collection.

The purpose of this email discussion is to determine which additional columns and/or details should be captured for the comparison of data collection frameworks, and whether these should be captured in the pre-existing table [2] as agreed during RAN2#121 [3] or if they should be captured in a new table. Additionally, it will be discussed whether details about model inputs consumed by the model for the purpose of inference and monitoring should be discussed separately from details about model outputs that are reported to the network.

# Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

|  |  |  |
| --- | --- | --- |
| Company | Name | Email Address |
| Nokia, Nokia Shanghai Bell (Rapporteur) | Jerediah Fevold | jerediah.fevold@nokia.com |
| Huawei, HiSilicon | Jun Chen | jun.chen@huawei.com |
| Qualcomm | Rajeev Kumar | rkum@qti.qualcomm.com |
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# Discussion

The following proposals from the data collection email discussion [4] were loosely agreed during RAN2#121 [3]. Points for discussion from the loosely agreed proposals are highlighted below. Note that according to the agenda for this meeting [1], that “aspects of on-line/real-time training are deprioritized at current meeting.”

**Proposal 1** RAN2 to simultaneously focus on studying data collection solutions for both NW- and UE-sided AIML models, including assistance signalling and (dataset) reporting from the concerning entity.

**Proposal 3** RAN2 to separately analyse the data collection requirements and solutions for the different LCM purposes. FFS if general frameworks/solutions could be adopted.

The main topic of the email discussion is to determine the appropriate categories, and potential contents for each, for the analysis of data collection frameworks for AIML. During the second online session for AIML during this meeting, the following was agreed.

Extend the previously endorsed table with 3 columns: Inference, Monitoring and Training, and explain in free text the applicability of the data collection method to the LCM purpose and the use case(s).

**Observation 1**: It was agreed to at least extend the previously endorsed table with 3 additional columns: inference, monitoring, and training.

Furthermore, we think the topic of the termination point of each data collection framework should be analysed. To focus the discussion, it is suggested to consider models as one-sided, even if they are part of a two-sided model because for data collection, each side of the model can be uniquely identified by its location (UE or NW) and by the LCM purpose. For example, a two-sided CSI compression model includes a UE-side model that will report inference output toward the gNodeB, and a gNodeB-side model which will collect the UE-side model inference output as an input to its model to perform inference. These models and their sides can be considered separately.

It was also raised by several companies that the legacy reporting frameworks function well for configuring the UE to send measurement reports toward the network, but further study is required for configuring the UE to make measurements for the purpose of model input.

**Observation 2**: When studying the applicability of a legacy data collection framework, the termination point(s) of the framework can be used to map their applicability to a particular sidedness per LCM purpose, e.g., UE-side, gNodeB-side, LMF-side, etc., and inference, monitoring, and offline training.

## Capturing LCM Purpose

Creating a mapping between the legacy data collection frameworks will help determine where there are missing elements in the legacy system and will help determine for which LCM purposes the limitations of the data collection frameworks are impactful or not. To this end, we should first discuss how to best present the analyses we are trying to capture.

**Observation 3**: The purpose of the comparison table [2] is to aid in determining the applicability of each data collection framework for use in LCM for AIML models. As-is, the table describes the frameworks, but does not approach any conclusions on when each framework should or could be used.

**Question 1: Should a table be developed to capture the mapping of LCM purpose to data collection frameworks?**

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| --- | --- | --- |
| Answers to Question 1 | | |
| Company | Yes/ No | Technical Arguments |
| Nokia, Nokia Shanghai Bell | Yes | The existing table for comparing data collection frameworks is useful to help justify each for a use case or LCM purpose, but it is clear from TDocs in this meeting and the last that we need a way to capture the views. For example, data volume and data type requirements differ for inference, monitoring, and offline training. |
| Huawei, HiSilicon | No | We are confused. RAN2 has agreed to extend the previously endorsed table with 3 columns: Inference, Monitoring and Training. What is the point of creating a new table?  In addition, we suggest to discuss the requirements a bit in RAN2, and our paper R2-2303894 provided some inputs. And more RAN1 inputs will be helpful. |
| Qualcomm | Yes | We believe that the existing table for comparing data collection frameworks is **not** useful to help justify each for a use case or LCM purpose. |
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**Summary 1**: TBD

**Proposal: TBD**

The current data collection framework comparison table does not capture the suitability of each data collection framework for the use cases

**Observation 4:** Each of the AIML use cases, beam management, CSI feedback enhancement, and positioning enhancement may have different data collection requirements.

**Question 2: Should the analysis of each of the use cases be captured in separate tables?**

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| Answers to Question 2 | | |
| Company | Yes/ No | Technical Arguments |
| Nokia, Nokia Shanghai Bell | Yes | As in the answer to Q1, many companies have provided use-case specific views that could be captured per use case for each data collection framework. The table could allow us to capture, for example, the strong views that LPP can satisfy requirements for the positioning use case. |
| Huawei, HiSilicon | Yes, but not needed for this meeting | In the previous RAN2 meeting, this was heavily discussed.  On one hand, most of companies are fine to look at requirements on data collection for each use case, which means we will have concrete analysis at some point in time.  On the other hand, it is quite difficult to do that at that time because it depends on RAN1 progress (they may have made some agreements, but still lots of things are under discussions). In other words, we can keep it in mind, but it may not be fesibile for RAN2 to do it in this meeting. |
| Qualcomm | Maybe | We would prefer to do it step-by-step. Initially, we can try to capture per LCM, thereafter we can do per use-case (maybe till then we can have more clarity from RAN1 on use case-specific data collection). |
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Summary 2:

**Proposal: TBD**

From the rapporteur’s point of view, there are two viable options for capturing LCM purpose-specific analyses. The first option (Table 1) is to extend the existing table with new columns for each LCM purpose to be analysed: inference; monitoring; and offline training. The second option (Table 2) is to create a new table, which maps each LCM purpose to be analysed: inference; monitoring; and offline training, to capture specific requirements and feasibility analyses. The characteristics of each data collection framework captured in the original table [2] could be used to formulate inputs to the new table.

The structure for the existing table [2] with new columns (Option 1) is shown below.

Table 1 – Existing Data Collection Framework Comparison Table with Columns Added for LCM Purpose

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Involved Network entity | RRC state to generate data | Max payload size per reporting\* | Contents to be collected | End-to-End report latency\*\* | Report type | Security and Privacy | Inference | Monitoring | Offline Training |
| Framework |  |  |  |  |  |  |  |  |  |  |

The structure of a new table (Option 2) could use the following format originally suggested in [5].

Table 2 – New Table to Map LCM Purposes to Data Collection Frameworks and their Analyses

|  |  |  |  |
| --- | --- | --- | --- |
| LCM purpose | Data collection requirements | Framework | Feasibility analysis |
| Inference |  | L3 Measurements |  |
| Other Frameworks |  |

**Question 3**: Which of the following options is preferred to capture LCM purpose in our comparison of data collection frameworks?

* **Option 1:** Add a new column to discuss the applicability of each data collection framework to the table [2] for each of the identified LCM purposes: inference, monitoring, and (offline) training. (Table 1)
* **Option 2:** Create a new table that maps each of the identified LCM purposes: inference, monitoring, and (offline) training to the data collection frameworks, using the pre-existing table [2] as a reference for filling in the new table to discuss the applicability of each data collection framework. (Table 2)

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| Answers to Question 3 | | |
| Company | Option | Technical Arguments |
| Nokia, Nokia Shanghai Bell | 2 | To add additional columns to the existing data collection frameworks comparison table could make it quite illegible as it gains even more columns. We suggest that the existing table could be used to formulate inputs to the table suggested by option 2. The data collection requirements could discuss topics suggested by companies such as latency or data quantity, and feasibility analysis would compare the requirement to the capabilities of each data collection framework. |
| Huawei, HiSilicon | 1 | Option 1 is sufficient, we do not see a need for option 2. |
| Qualcomm | 2 | Agree with Nokia |
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**Summary 3**: TBD

**Proposal**: TBD

It has been noted by several companies [6, 7, 8, 10, 15, 17, 19, 20, 21] that the target of the data collection for each LCM purpose has an impact on whether each legacy data collection framework is suitable. For example, data collection of inputs for inference for a gNodeB-side or LMF-side model might be able to directly reuse measurements reported in RRC measurement reports or LPP location information, while data collection of inputs for inference for a UE-side model might only require the UE to know where particular RSes are being transmitted, but not to directly report those measurements.

**Observation 5: The suitability of each data collection framework might depend on the location of the AIML model (e.g., UE-side, gNodeB-side, LMF-side, etc.).**

**Question 4**: For each LCM purpose: inference; monitoring; and offline training, should model sidedness be considered per data collection framework?

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| Answers to Question 4 | | |
| Company | Yes/No | Technical Arguments |
| Nokia, Nokia Shanghai bell | Yes | Depending on the sidedness of the model (UE-side, NW-side, etc.), some data collection frameworks might not be well suited. For example, L3 RRC measurement reporting could work well for transmitting DL measurements to the gNodeB for a gNodeB-side model, but for a UE-side model that makes use of the same measurements, the reporting of the measurements is not required. |
| Huawei, HiSilicon | Yes, but | In the previous table, the column “Involved Network entity” is listed and the target is to further check the gaps, so we suggest to take model sidedness into considerations.  However, this model sideness discussion is part of architecture discussion (agenda item 7.16.2.1 Architecture General), and it seems more discussions are needed for that. From Huawei point of view, we have some preferences based on our paper, e.g. for CSI/BM, we can focus on UE/gNB (maybe OAM) for data collection, and for Positioning, we can focus on UE/PRU/gNB/LMF (maybe OAM) for data collection. But other companies may have different views, so RAN2 may further discuss it.  So we think the discussion of model sidedness for data collection can be postponed, and we can wait for more progress for architecture discussion. |
| Qualcomm | Yes with comment | Model training of UE-sided models can happen outside the 3GPP systems. Therefore, the data collection requirement for supporting model training outside the 3GPP system should also be considered. |
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Although a few companies listed examples of functionality mapping per LCM purpose or per LCM purpose and use case, it is the rapporteur’s view that companies should be given the opportunity to provide inputs in the next meeting.

**Summary 4**: TBD

**Proposal: TBD**

The next question applies to both table options in Q3. To help determine whether each data collection framework will be suitable for each LCM purpose and model location, the LCM purpose columns could be split into two parts: UE-side; and NW-side. Because there are many options, which are not relevant for every use case, for where the NW-side model could reside, the column could be kept general, but the details could discuss specific NW entities.

**Question 5**: Following up on Q4, should each column for LCM purpose be split in two parts: UE-side; and NW-side, where specifics about each relevant NW entity captured in the NW-side column?

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| Answers to Question 5 | | |
| Company | Yes/No | Technical Arguments |
| Nokia, Nokia Shanghai Bell | Yes | We think that the feasibility analysis portion column of the table proposed in option 2 of Q3 could be split into two pieces, or the LCM-specific columns could be split into two pieces to capture UE-side and NW-side aspects of each. An example of the difference in applicability of a data collection framework for gNodeB-side model vs. a UE-side model is provided in our answer to Q4 above. |
| Huawei, HiSilicon | FFS | On one hand, we agree that different sided types may lead to different requirements, which are worth studying. On the other hand, there will be more and more categories to be considered, and this category (UE/NW-side) may correspond to new categories.  So we suggest to just put FFS to Q5, and we may come back it in later meetings. |
| Qualcomm | Yes with modification | Discussion should cover RAN1 agreed classification of training, i.e., UE-side, network-side, and neutral-sid. |
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**Summary 5:**

**Proposal: TBD**

For inference, there are two aspects to data collection that need to be considered: collection of data as input to the model; and collection of data that is the output of the model. Figure 1 below uses as an example that the input to the model would be measurements, and the output of the model would be a report. Note that every data collection framework being discussed, except for LPP, is only used to configure the UE to perform certain measurements, process them, and then send a report to the network.

**Observation 6: The data collection frameworks being discussed, except for LPP, are only used to configure the UE to perform certain measurements, process them, and then send a report to the network.**

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Figure 1 - A generic example of flow of data in machine learning (ML) model.

In order to analyse whether the existing data collection frameworks could be suitable, we must be able to identify for which LCM purposes, model sidedness, and use cases the current solutions are deficient. Therefore, it may also be useful to separately analyse data collection for model input and model output, at least for inference and monitoring.

**Observation 7: The legacy data collection frameworks might not be sufficient to support collecting input and/or output for each of the LCM purposes, model sidedness, and use case combinations.**

**Question 6**: Should the analysis of data collection for each model sidedness and use case combination separately consider data collection for the input and output for inference? FFS on how to capture the details.

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| Answers to Question 6 | | |
| Company | Yes/No | Technical Arguments |
| Nokia, Nokia Shanghai Bell | Yes | We think that data collection can be configured by indicating to a UE which physical layer resources are associated with cell-specific or UE-specific reference symbols, without the requirement to report those measurable quantities, and that the report that is generated by the UE could be a different type of content. For example, in the CSI compression use case, the UE might measure CSI-RS whose positions are signalled to the UE by the gNodeB, but report compressed CSI, which doesn’t exist in the legacy system today. |
| Huawei, HiSilicon | No | The question is not clear. What does it mean by “should the anlaysis of XXX combination separately”?  For “data collection for the input and output for inference”, we think the following questions should be considered first:   * what is the input or output for the inference for a specific use case, and is it needed to collect them for some purposes?   If the requirements can be identified, it is natural to study the gaps and possible enhancements. Without looking into the requirements, it is hard to judge whether to definitely consider something. |
| Qualcomm | No  With comment | For UE-side model inference   * The network does not need to define measurements or the input. Only the output of the model should be defined (e.g., periodicity, events, etc.)   For NW-side model inference   * The network can configure the required input to the model (for example, input needed for the model side model). Similarly, UE does not need to know the output. |
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**Summary 6**: TBD.

**Proposal**: TBD.

It has not yet been decided which methods (for instance, UE/NW/hybrid-side or input/output-based monitoring) of model monitoring will be used, so the following question is with respect to data collection for model monitoring. Because only offline training is being discussed, this question will not apply to training during this meeting.

**Question 7**: Should the analysis of data collection for each model sidedness and use case combination separately consider data collection for the input and output for monitoring? FFS on how to capture the details.

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| Answers to Question 7 | | |
| Company | Yes/No | Technical Arguments |
| Nokia, Nokia Shanghai Bell | Yes | Please see the answer to Q6 above. While more study is required to determine what types of model monitoring could be considered, we think that the concept of data collection for input for model monitoring should at least be considered if model monitoring requires that a dataset is transmitted to the UE for the purpose of monitoring. |
| Huawei, HiSilicon | No | Same comments to Q6.  In addition, for monitoring, we think RAN1 has spent lots of time on discussing (almost everything including solutions). We are not sure whether to wait for more RAN1 progress. In our opinion, if RAN1 can figure out the requirements and some principles, it will not be difficult for RAN2 to continue our study. |
| Qualcomm | No | Wait for RAN1 progress. One of the purposes of this study item is to reduce data reporting over the uU interface. Therefore, the overhead of data collection for monitoring should be examined first by RAN1. |
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**Summary 7**: TBD.

**Proposal**: TBD.

The following are examples of data collection for which the data collection frameworks being discussed might be deficient.

1. Downlink cell-specific and UE-specific reference symbol configuration (CSI-RS, POS-RS, etc.) as input to a model. For which LCM purposes is FFS.
2. Uplink physical layer transmission configuration (SRS, etc.)
3. Provision of data as model input for network-side or hybrid model monitoring

**Question 8**: If Q6 and/or Q7 are agreed: for data collection as input to a model for the purpose of inference and/or monitoring, could the list above be used as a starting point? Please provide comments on additional types of data collection for input that should be considered.

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| Answers to Question 8 | | |
| Company | Option(s) | Technical Arguments |
| Nokia, Nokia Shanghai Bell | All | We think these are a good starting point and that considering these could help better understand the scope of data collection that is required, even if some of these are not part of the final list, or if more types of data collection for inference, monitoring, and/or offline training are added to the list. |
| Huawei, HiSilicon | No | We have some questions as well as comments for Q6 and Q7. |
| Qualcomm | No | The question is not clear. Furthermore, for 2, the network knows the SRS configuration. Therefore, no need for reporting from UE. |
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**Summary 8**: TBD

**Proposal**: TBD

## New Content

Based on inputs from [6-22], the following table (Table 3) captures the majority views provided by companies for each LCM purpose and use case to data collection framework mappings.

Table 3 – Predominant Views of Data Collection Frameworks Mapped to LCM Purpose

|  |  |  |  |
| --- | --- | --- | --- |
|  | CSI | BM | Positioning |
| Inference | L1 Measurement Reports | L1 Measurement Reports (CSI), L3 Reporting (RRM) | LPP |
| Monitoring | L1 Measurement Reports (CSI), L3 Reporting (RRM) | L1 Measurement Reports (CSI), L3 Reporting (RRM) | LPP |
| Offline Training | Logged MDT, Immediate MDT | Logged MDT, Immediate MDT | LPP, Logged MDT, Immediate MDT |

For the following question, please limit the discussion to whether the individual contents of Table 3 are agreeable or disagreeable. Then, in the next meeting, proposals to add further mappings of LCM purpose and use case to data collection frameworks can be discussed.

**Question 9**: Regardless of the eventual table structure(s), could the data in Table 3 be used as a starting point for mapping LCM purpose and AIML use case to data collection frameworks?

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| --- | --- | --- |
| Answers to Question 9 | | |
| Company | Yes/No | Technical Arguments |
| Nokia, Nokia Shanghai Bell | Yes | From our understanding, these are the majority views. |
| Huawei, HiSilicon | No | Firslty, we are not convinced by Table 3, as it is related to the preivous question. We think RAN2 has already agreed to extend the previous table, so what is the point of creating a new table?  Secondly, we have the following comments:  For inference+CSI, for CSI prediction use case (UE-sided model), we assume that the UE just uses its information and does the inference, so why it needs L1 reports?  For inference+CSI/BM, L1 Measurement Reports is confusing, and it is better to list the concrete functionalities.  For inference+Positioning, LPP is too general.  For monitoring+CSI/BM, what is L3 Reporting? And what is “(RRM)”?  For offline training, we are ok to consider loggd MDT but it may need to put a FFS as the RRC states are idle/inactive for it (while CSI/BM is for connected state).  In general, we think there are lots of issues for the content for this table. |
| Qualcomm | No | Before discussing Table 3, we would prefer to conclude the discussion on Table 2 to capture the requirements of LCM and how different data collection frameworks can meet these requirements or not. |
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**Summary 9**: TBD

**Proposal**: TBD

Companies are encouraged to provide their views. During this offline session there may not be sufficient time to capture all the views from different companies, therefore views can be captured in the next Tdocs and can be discussed in the upcoming meeting. To help focus the discussion, companies can provide views below on the types of information that should be added to the table.

**Question 10**: What type of content is missing from the tables that should be considered to help build a complete view of the data collection requirements and the capabilities and characteristics of each existing data collection framework?

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| --- | --- |
| Answers to Question 10 | |
| Company | Technical Arguments |
| Huawei, HiSilicon | Based on our paper:  **R2-2303894 Discussion on data collection Huawei, HiSilicon discussion**  We will like to identify two issues for RAN2 study:  **Issue 1: data size issue**  *Observation 1: For logged MDT, the UE is required to support 64KB for the buffer, and the logMeasAvailable-r16 and UEInformation procedure are used for transferring the whole report. There may be multiple procedures for the transferring.*  *Observation 2: The segmentation of UL RRC message is only applicable to UECapabilityInformation and MeasurementReportAppLayer, and it is not applicable to other UL RRC messages (related to data collection mechanisms).*  And our proposal is:  *Proposal 1: For data collection mechanisms (i.e. the UE generates and transfers data only in RRC connected state), if the data size is more than 9KB, the current mechanisms can not work, and some enhancements can be considered, e.g. the segmentation of UL RRC message.*  **Issue 2: understand more about requirements for data collection for different LCM aspects**  Have some discussions on the requirements for data collection for offline training/inference/monitoring. E.g. |
| Qualcomm | Note that for each sub-use case, RAN1 may define data collection requirements based on nominal inputs and outputs of the sub-use case. However, the actual inputs/outputs to/from the models used at the device may be different from the nominal inputs and outputs. For example, a model at UE may take auxiliary inputs such as SNR, Doppler, sensor measurements, etc. that do not need to be standardized.  Therefore, we believe that data collection of non-standardized data for UE side model should be considered. |
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**Summary 10**: TBD.

**Proposal**: TBD.

# References

[1] R2-2302400 “Agenda for RAN2#121bis-e”, Chairman, April 2023

[2] R2-2302286 “Summary of [AT121][025]: Progress table of analyzing data collection framework (Apple)”, Apple, March 2023

[3] R2-2302401 “RAN2#121 Meeting Report”, MCC, April 2023

[4] R2-2301440 “Outcome of [Post120][054][AIML18] Data Collection (Ericssion / vivo)”, Ericsson, vivo, March 2023

[5] R2-2302954 “Discussion on data collection”, vivo, April 2023

[6] R2-2302489 “AIML Data Collection”, NEC, April 2023

[7] R2-2302548 “Data Collection for LCM Purposes”, OPPO, April 2023

[8] R2-2302650 “AI/ML Data collection”, Nokia, April 2023

[9] R2-2302747 “Further analysis on data collection framework”, Intel, April 2023

[10] R2-2302954 “Discussion on data collection”, vivo, April 2023

[11] R2-2303018 “Considerations on data collection of AI/ML for NR air-interface”, CATT, Turkcell, April 2023

[12] R2-2303121 “Discussion on data collection”, Xiaomi, April 2023

[13] R2-2303241 “Qualitative analysis on data collection requirements”, Lenovo, April 2023

[14] R2-2303373 “Further discussion on data collection for AI/ML”, Apple, April 2023

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# Conclusion

TBD.