

3GPP TSG RAN Meeting #94-e

RP-213483

Electronic Meeting, December 6 - 17, 2021

**Agenda Item:** 8.6.1

**Source:** Moderator (Qualcomm)

**Title:** Moderator's summary for discussion [94e-03-R18-AIML-Air]

**Document for:** Report

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## 1 Introduction

The summary of the June/July Rel-18 RAN workshop can be found in [1] where AI/ML for Air-Interface was identified as one of the candidate areas.

The previous two rounds of NWM discussions on a candidate project for AI/ML for Air-Interface are captured in [2] and [3]. The corresponding Draft SID proposal resulting from the October NWM discussions can be found in [4].

According to RAN Chair's guidance in [5], the SID objectives have been modified as captured in [6].

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## 2 Initial Round

### 2.1 Justification

The Justification section of the Draft SID is deemed to be stable. However, please, add here if you have any suggestion for revision of the draft Justification text in [6].

#### Feedback Form 1: Feedback on Justification of Draft SID

1 – vivo Mobile Communication Co.

Support the justification part.

<p><b>2 – ZTE Corporation</b></p> <p>We are okay with the current justification.</p>
<p><b>3 – CATT</b></p> <p>We are ok with the justification.</p>
<p><b>4 – Xiaomi Communications</b></p> <p>We support the current version</p>
<p><b>5 – NTT DOCOMO INC.</b></p> <p>We support the current justification part.</p>
<p><b>6 – Qualcomm Incorporated</b></p> <p>We support the current version.</p>
<p><b>7 – SHARP Corporation</b></p> <p>We are fine with the justification.</p> <p>Some editorial comments:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Since “reduced complexity/overhead” has been mentioned in the paragraph, suggest modification like “e.g., improved throughput, robustness, accuracy, or reliability, <del>or reduced overhead,</del> etc.”</li> <li><input type="checkbox"/> Align expressions “Air-Interface” and “air-interface” to “air interface”.</li> </ul>
<p><b>8 – Futurewei</b></p> <p>Futurewei supports the current text in the justification section.</p>
<p><b>9 – CAICT</b></p> <p>We are fine with the justification part.</p>
<p><b>10 – Apple Hungary Kft.</b></p> <p>OK with the proposed text.</p>
<p><b>11 – Intel Technology India Pvt Ltd</b></p> <p>Justification section is fine for us</p>
<p><b>12 – MediaTek Inc.</b></p> <p>We support the current version.</p>
<p><b>13 – VODAFONE Group Plc</b></p> <p>Justification is OK for us</p>

<p><b>14 – Fujitsu Limited</b></p> <p>We support the justification part.</p>
<p><b>15 – ROBERT BOSCH GmbH</b></p> <p>Fine with the justification</p>
<p><b>16 – Deutsche Telekom AG</b></p> <p>Fine with justification.</p>
<p><b>17 – Ericsson LM</b></p> <p>We support the justification. The latency due to inference (and compared to performing similar operation in baseline) is of interest, so we suggest the following minor extension:</p> <p><i>In this study, we explore the benefits of augmenting the air-interface with features enabling improved support of AI/ML based algorithms for enhanced performance and/or reduced complexity/overhead. Enhanced performance here depends on the use cases under consideration and could be, e.g., improved throughput, robustness, accuracy or reliability, <b>latency</b> or reduced overhead, etc</i></p>
<p><b>18 – Nokia Corporation</b></p> <p>The current justification text is ok in our view.</p>
<p><b>19 – InterDigital Germany GmbH</b></p> <p>We support the current justification</p>
<p><b>20 – Verizon UK Ltd</b></p> <p>Support the justification. Also like Ericsson’s suggestion to include latency.</p>

### 2.1.1 Moderator’s replies

A revised version of the Draft SID (r1) is available at the same location with the changes according to the comments received:

[www.3gpp.org/ftp/tsg\\_ran/TSG\\_RAN/TSGR\\_94e/Inbox/Drafts/\[94e-03-R18-AIML-Air\]/](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_94e/Inbox/Drafts/[94e-03-R18-AIML-Air]/)

The Moderator considers the Justification section of the Draft SID stable for the final version.

## 2.2 Objective: Use cases to focus on

The Use cases in the Objectives section of the Draft SID have been modified according to the Chair’s guidance in [5]. Please add here if you have any suggestion for revision of the draft **Objective: Use cases to focus on** text in [6].

## Feedback Form 2: Feedback on Use Cases

### 1 – vivo Mobile Communication Co.

Our preference is to at least keep RS overhead reduction as the use cases in initial set. AI/ML is targeting for long term commercial needs and require careful check on where the largest possible gains lie. If removing use cases even before we do any study, it would be risky and unwise that we corner ourselves by the restrictions we put on our own.

Another point is the target of RRM mobility enhancement should be more generic and also include higher experience throughput/system efficiency.

Moreover, for other use cases, we would like to clarify more specifically as the following:

Use cases to focus on:

•Initial set of use cases includes:

•CSI feedback enhancement, e.g., **RS and payload** overhead reduction, improved accuracy, prediction [RAN1]

•Beam management, e.g., beam prediction in time, and/or spatial domain for overhead and latency reduction, **RS overhead reduction**, beam selection accuracy improvement [RAN1]

•Positioning accuracy enhancements **and RS overhead reduction** for different scenarios ~~including, e.g., those with heavy NLOS conditions~~ [RAN1]

•**DM-RS** overhead reduction [RAN1]

•RRM Mobility, e.g., prediction in time or frequency for robustness, interruption and overhead reduction, **higher experienced throughput/system efficiency** [RAN2]

•Finalize representative set of use cases (reduced from the initial set and minimizing sub use cases) for characterization and baseline performance evaluations

### 2 – ZTE Corporation

We support to remove the last two use cases due to the limit of TU in Rel-18 study. We can leave these two use cases to future releases.

Meanwhile, since we have only 3 use cases to focus on, there is no need to have a two-step approach to select a subset from the 3 use cases in WG-level study. All the three use cases should be studied and evaluated to see whether there is potential gain. Hence we suggest the following revision on the last bullet:

*Finalize representative initial set of use cases (~~reduced from the initial set and minimizing sub use cases~~) for characterization and baseline performance evaluations.*

For vivo's comments to add RS overhead reduction in the first three use cases, we think it is quite hard to do so. RS overhead reduction requires careful study of channel estimation details, which has totally different methodology compared with the original three use cases (CSI, beam, positioning). Hence to add RS overhead to the first three use cases still requires dedicated study of channel estimation, which is not helpful to reduce workload.

### 3 – CATT

We support deleting the last two use cases from the initial set. Too many use cases in the initial set makes the scope of the study too broad. These use cases involve various aspects of air interface, and it will cost a large amount of TU to complete the study. The RS overhead reduction is mainly receiver algorithm optimization in our view. It would not bring much value to the understanding of AI/ML framework within 3GPP. The mobility related optimization would be included in the RAN3-led WI (AI/ML for NG-RAN). We should not repeat the study.

We share similar view as ZTE that adding RS overhead reduction to the first three use cases would dramatically increase the overload.

#### **4 – T-Mobile USA Inc.**

Operators benefit most from spectral efficiency enhancements, yet this group wants to delete RS overhead reduction and RRM mobility from the list of use cases to be studied. From T-Mobile USA's perspective positioning is far lower priority than RRM Mobility and RS overhead reduction. Therefore positioning must be eliminated.

#### **5 – Xiaomi Communications**

We prefer to keep the RS overhead reduction and the RRM mobility. In the AI study, we'd better to justify the potential gains of AI in various fields. And some contributions also show the potential gain of these two use cases. From our perspective, It is unreasonable and unfair to remove these two use cases without any study. As for the work load concern, we notice there are many sub-use cases in some use case, we could select one representative sub-usecase to control the work load.

#### **6 – NTT DOCOMO INC.**

We can accept the removal of two additional use cases from the SID draft respecting the scope size concern and the proposals from chairs. Additionally, we think that further down-selection or prioritization among listed three use-cases may be beneficial for workload management especially considering unpredictable COVID-19/e-meeting duration. In our view, positioning can be deprioritized as "second priority use-case" for Rel-18 since it would require different evaluation methodologies from other target use cases and Rel-17 already has some positioning enhancements that could be useful for AI/ML based improvements. We can first focus on the other two use-cases for the study, and the second priority use-case can be addressed if good progress is achieved for the two use-cases.

#### **7 – Qualcomm Incorporated**

We support removing the last two use cases due to the workload concern, given that the first three use cases have the most overall support among companies and that they should sufficiently cover the study objectives of identifying common AI/ML frameworks and assessing air-interface impact.

#### **8 – SHARP Corporation**

We share the view that the final set of use cases should be representative and minimized, e.g., three most representative use cases. However, the down-selection seems controversial. Since we have 18 months for the SI, is it possible to divide it into, for example, two phases, and study one subset in each phase (e.g., 3 + 2)?

#### **9 – LG Electronics Inc.**

Though we think that it would be good to study as many use cases as possible, we can accept the down-scoping suggested by the chair considering the expected work load, with the understanding that more use cases can be included in WI phase. If we reduce the initial set of use cases, we think that the text in round brackets can be removed, i.e. '(reduced from the initial set and minimizing sub use cases)' can be deleted as commented by ZTE.

## 10 – Spreadtrum Communications

We support the proposal to remove the last two use cases. In our understanding, the most important thing for us is to exploit and proof the value of AI/ML enabled air interface for the SID. Since the first three use cases have achieved extensive support, to some degree it implies that the benefit of AI/ML enabled air interface can be most likely reflected by the three use cases. Furthermore, considering workload and TU budget, we think it is fine to only keep the first three use cases in Rel-18, and other use cases can be studied and specified in future release.

## 11 – Futurewei

- In general, Futurewei agrees to select a smaller set of use cases to focus on and give each use case the time and effort it deserves. The first 3 use cases received support from most companies; thus, we are ok with the updated list.
- Regarding whether the last bullet is still needed, i.e., “Finalize representative set of use cases...”, our recommendation is to keep the bullet but add “**if needed**” at the end of the sentence. Adjustment of the use cases or sub use cases may still be beneficial and can be discussed in the SI phase depending on the solution complexity and standards impact.

## 12 – Apple Hungary Kft.

We would like to add back RS for overhead reduction and mobility (RAN2) in the initial set. For BM, CSI and positioning, sub-use cases need to be identified and agreed in the final sets. So further down-selection of use cases/sub-use cases can be done after initial study.

## 13 – Intel Technology India Pvt Ltd

Removing RS overhead reduction and RRM mobility is fine for us. In the same spirit we should not add items to the first 3 use-cases. We can keep the “Finalize representative set of use cases...” bullet for further discussion in RAN1 with respect to sub use-cases.

## 14 – China Mobile Com. Corporation

In our view, we prefer to only keep two use cases. Given this is the first study of AI/ML for Air Interface in 3GPP, we have to say that the scope to be discussed for each use cases is not totally clear. Even for each use case, there may be different sub use cases and categories.

We think CSI feedback and positioning are two important use cases. For beam management, it is not essential, especially for FR1. For RS overhead reduction, we think other use cases, for example CSI feedback enhancement, may include RS overhead reduction, hence it is unnecessary to study RS overhead reduction as a standalone use case. For RRM Mobility, it is a RAN-2 lead study, and RAN2 already has a WI on mobility enhancement in Rel-18. Therefore, we think **CSI feedback enhancement and Positioning accuracy enhancement can be selected** for detailed study and evaluations for the project of AI/ML for Air Interface.

## 15 – CAICT

We also prefer to keep RS overhead reduction in initial set. Some down-selection works for finalize representative set could be operated after clear definition of each use case or sub use case.

### 16 – Lenovo (Beijing) Ltd

We support to remove the last two use-cases (i.e., RS overhead reduction and RRM mobility) for the heavy and possible redundant workload for the objectives (e.g., evaluation methodology, framework, potential specification impact).

Furthermore, though there are only three *main* use-cases, it is still necessary to consider selecting reasonable number of ‘*sub* use-cases’ per use-case, i.e., key issues to be solved via AI/ML. Thus, we suggest the following update on the sentence of “Finalize ...” as:

- Determine the representative sub use-cases by identifying the key issues to be solved via AI/ML per use case, e.g., selecting and clarifying the topics from the provided examples above.

### 17 – NEC Corporation

In the previous SID (RP□212708) discussion, the use cases include RS overhead reduction and RRM Mobility have been supported by many companies. We think the motivation is reasonable. Although it will increase the evaluation and analysis workload, it will definitely show the insight that AI/ML can make the air interface more efficient. In addition, the SID also mentioned that the finalized representative set of use cases can be decided based on the SI output. So, we propose to include the 2 use cases in the SID.

### 18 – Samsung Electronics Polska

(1) RAN chair’s guidance of the down-selection to 3 specific use cases for initial set are good to facilitate meaningful working-group level discussion. Specifically,

- “RS overhead reduction [RAN1]”: we agree this bullet is needed to be removed since the objective is not focused enough which can trigger companies’ input in many relevant field. If there is a strong need to study the overall gist of how AI/ML would impact RS overhead reduction, RS overhead reduction can be included in the study for some of use-cases 1-3.

- “RRM Mobility, e.g., prediction in time or frequency for robustness, interruption and overhead reduction [RAN2]”: we agree to not include RRM mobility in this study item, because the AI/ML-based method to reduce RRM performance (e.g., as mentioned by companies’ input, to reduce failure of relevant RRM procedure) is a distinct functions from other listed RAN1-led PHY optimization.

- We have concern that the many different use cases may lead to divergence in the SID discussion. it is very difficult to reach the expected and concrete outcome (i.e., to enable the identification of a common AI/ML framework), therefore, downscoping to three relevant RAN1-led use cases for initial set are preferred by us.

(2) We suggest RAN-P to provide the timeline guidance for the completion of evaluation on “initial set of use cases” and the start of discussion on “representative set of use cases (reduced from the initial set and minimizing sub use cases)”.

### 19 – VODAFONE Group Plc

Similar comment as T-Mobile, we would prefer keep RS overhead reduction (2nd priority) and RRM mobility (1st priority) and remove positioning in the objectives. With the understanding of the workload, we are OK if just RRM mobility is kept and positioning is removed.

### 20 – MediaTek Inc.

We understand the reason to down-scope to keep the workload reasonable, however, if we can only choose 3 use cases, our preference is CSI feedback enhancement, Beam management, and RRM Mobility. These use cases are commonly used in all existing commercial deployment and the potential improvement they can bring is most promising.

In addition, we have commented before and would like to emphasize again that a use case for R2 to study is essential to establish a solid foundation for AI integration in the long run.

We do not agree with CATT on the overlap with RAN AI, the scope of MRO is different from the current air interface AI study.

## **21 – Fujitsu Limited**

We prefer to keep RS overhead reduction in the initial set:

1. The gain of AI/ML for air interface is from neural network being capable of learning channel features. As a typical supervised learning use case, AI/ML based channel estimation had been widely studied in academia for long time with many prior arts as reference. With this use case, it would be easier to reach common understanding among companies in following up study and discussion, wrt. terminology, evaluation methodology and simulation calibration.
2. The workload for its evaluation is even smaller than a sub use of CSI feedback or beam management. It is not reasonable to remove this case from the workload concern.

## **22 – Sony Group Corporation**

The study should include [at least] the original 5 use cases. i.e. the use cases to study should include:

- CSI feedback enhancement, e.g., overhead reduction, improved accuracy, prediction [RAN1]
- Beam management, e.g., beam prediction in time, and/or spatial domain for overhead and latency reduction, beam selection accuracy improvement [RAN1]
- Positioning accuracy enhancements for different scenarios including, e.g., those with heavy NLOS conditions [RAN1]
- RS overhead reduction [RAN1]
- RRM Mobility, e.g., prediction in time or frequency for robustness, interruption and overhead reduction [RAN2]

The use cases that we study should include sufficient diverse use cases that RAN gains an understanding of the general implications of supporting AI/ML within the air interface. By including RS overhead reduction, we would include an air interface aspect that is close to the signal processing functions. The RRM mobility use case is fairly essential as it studies how AI/ML might affect the RAN2 protocol: note that the other four use cases are focused on RAN1.

The finalised representative set of use cases should not be a subset of the initial use cases. The final representative set should be the set that covers the broadest range of AI implications (e.g. the final set of use cases should include use cases that have implications on online training, offline training, inference issues, model transfer, federated learning etc. We would not want to choose a finalised set of use cases that can all be supported by offline training: we would not learn much in general about the usage of AI/ML in the air interface with such a finalised set of use cases).

## **23 – ROBERT BOSCH GmbH**

In our understanding, the diverse view of the possible use-cases and the understandable concerns about the workload could result mainly from the fact that the actual definition of the use-cases itself is not very precise.

In our understanding, the vague definition of use cases in the study phase should not justify the exclusion of other use cases.

In our opinion, the consideration of RRM Mobility is an essential use case and should not only be deleted because of the expected effort for CSI feedback, beam management and positioning. Some companies have noted that there can be similarities and differences between the use-cases. We therefore propose to leave the use-cases RRM Mobility and RS overhead reduction in the set of initial use-cases.

Instead, we propose the bullet:

”Finalize representative set of use cases (reduced from the initial set and minimizing sub use cases) for characterization and baseline performance evaluations.”

to be replaced by sth. like:

”The final set of use cases (reduced from the initial set and minimizing sub use cases) for characterization and baseline performance evaluations should be defined once the initial use cases are defined properly and possible overlaps are identified.”

#### 24 – HUAWEI TECHNOLOGIES Co. Ltd.

1. “RS overhead reduction” should be put back to the initial set of use cases. Based on the previous discussions, “RS overhead reduction” achieved broad interest also, just similar as the first 3 use cases. In addition, companies have already shown that the potential gain achieved for RS overhead reduction can be similar as other 3 use cases also. In general, the most important thing for this study is to identify the use case that would really bring gain by AI/ML, therefore it is not good to preclude any case that gains are already shown by companies.

2. For mobility, we are OK to remove it, since we do not see any simulation result to shown the gain by using AI/ML for this use case yet.

3. We also have some comments for the description of the first 3 use cases, details can be find in our contributions RP-213163. In short, we suggest the following revision to the use case:

Use cases to focus on:

- Initial set of use cases includes:

n CSI feedback enhancement, e.g., overhead reduction, improved accuracy, ~~prediction~~ [RAN1]

n Beam management, e.g., beam prediction in time, and/or spatial domain for overhead and latency reduction, ~~beam selection~~ and accuracy improvement [RAN1]

n Positioning accuracy enhancements for different scenarios including, e.g., those with ~~heavy~~ NLOS conditions **under different percentage** [RAN1]

n **RS overhead reduction** [RAN1]

n ~~RRM Mobility, e.g., prediction in time or frequency for robustness, interruption and overhead reduction~~ [RAN2]

Finalize representative set of use cases (reduced from the initial set and minimizing sub use cases) for characterization and ~~baseline~~ performance evaluations

#### 25 – CableLabs

We prefer to keep RRM mobility

**26 – Ericsson LM**

This SI will deal with new issues related to evaluation methodologies (incl. data), performance evaluations (incl. computational complexity, overhead, power consumption, robustness, memory, and hardware), specification impacts (incl. UE-gNB interaction for data collection, training, testing, and inference), AI model lifecycle management, data privacy, and liability – the scope is large and there is much to discuss.

It is our understanding that the pilot use cases will simply help concretize discussions, assess potential specification impacts, and lay the foundation for future AI-based air interface use cases. The exclusion of a use case from this SI does not preclude it from future study- or work-items in, e.g., Rel-19.

The RRM mobility is already taken care of in RAN3-led WI for NG-RAN (RP-212719): “Specify data collection enhancements and signaling support within existing NG-RAN interfaces and architecture) for AI/ML-based Network Energy Saving, Load Balancing and Mobility Optimization (RAN3). Hence it should not be part of this SI as it will create double work in WG seen from RAN level.

We, therefore, propose to agree on three use cases: channel state information, beam management, and positioning).

**27 – Nokia Corporation**

In our view the use cases should be been decided based on technical analyses and what provide most learnings for the framework to introduce AI/ML for air interface. Different type of use cases are expected to provide better learnings how AI/ML for air interface may impact different radio specifications and how to take these aspects into account when designing the framework. Therefore, we do not see need to remove the Mobility and RS overhead reduction use cases now but rather allow technical analyses first.

**28 – InterDigital Germany GmbH**

Given the limited TU’s we support studying at most 3 use cases. We are ok with the removal of RS overhead and RRM mobility use cases.

**29 – Verizon UK Ltd**

We are OK with choosing the 3 to fit the TUs

2.2.1 Moderator’s replies

The majority of companies providing feedback were fine with the removal of the last two use cases to help with the associated workload of the project. As a few companies commented, there is no point in trying to embed RS overhead reduction as part of other use cases, as it does not help in reducing the workload.

The Moderator would like to remind delegates that the selection of use cases is for pilot purposes to identify what 3GPP will need to do to enable specification of AI/ML-based techniques in assisting with air-interface problems. To that end, the Moderator has added the following Note under the bullet list of use cases:

**Table 1:**

Note: the selection of use cases for this study solely targets the formulation of a framework to apply AI/ML to the air-interface for these and other use cases. The selection itself does not intend to provide any indication of the prospects of any future normative project.

Hopefully, this Note helps in the reduction of use cases to a representative and sufficient set.

A revised version of the Draft SID (r1) is available at the same Inbox/Drafts location with the changes.

## 2.3 Objective: AI/ML model and description

The AI/ML model and description portion of the Objectives section of the Draft SID is deemed to be stable. However, please add here if you have any suggestion for revision of the draft **Objective: AI/ML model and description** text in [6].

### Feedback Form 3: Feedback on AI/ML model and description related objectives

<b>1 – vivo Mobile Communication Co.</b> Fine with this part.
<b>2 – ZTE Corporation</b> We are okay with the current formulation of AI/ML model and description.
<b>3 – Xiaomi Communications</b> We are OK with this part
<b>4 – NTT DOCOMO INC.</b> We support the AI/ML model and description part
<b>5 – Qualcomm Incorporated</b> We support the current version.
<b>6 – SHARP Corporation</b> We are fine with this part. Only one editorial comment: - Consider the work done for <i>FSNRENDCollect</i> as baseline and when appropriate
<b>7 – Spreadtrum Communications</b> We are OK for this part.
<b>8 – LG Electronics Inc.</b> One minor comment. ‘Consider the work done for FS_NR_ENDC_data_collect as and when appropriate’ is not part of SI objective. Rather, it can be a note.

## 9 – Futurewei

In general, Futurewei is ok with the text with a few comments:

- “Identify various levels of collaboration between UE and gNB”: As there are only few use cases to focus on under the Rel-18 SI, our suggestion is to put our effort on the collaboration level(s) applicable to the identified use cases first vs. as a blanket item to cover all the potential collaboration levels as it may take significant amount of time and effort while changes may deem needed in later releases when additional use cases are identified. Thus, we suggest to modify this item to “Identify various levels of collaboration between UE and gNB **pertinent to the selected use cases**”.
- 4th bullet: we suggest to reword this bullet to “**Data set(s) for training, validation, testing and inference**” to be consistent with the sequence of procedures in the AI/ML development cycle.
- The last bullet: “Consider the work done for *FSNRENDCdatacollect* ~~as and~~ when appropriate” as the 2 are usually used interchangeably.

## 10 – Apple Hungary Kft.

OK with the proposed text.

## 11 – Intel Technology India Pvt Ltd

This section is fine for us

## 12 – CAICT

We are fine with the proposed version.

## 13 – Lenovo (Beijing) Ltd

We are fine with this section, and one clarification:

- Various levels of UE/gNB collaboration targeting at separate or joint ML operation **per use case**.

## 14 – Samsung Electronics Polska

(1) For lifecycle management of AI/ML model, we need to further identify offline training and online training that have been widely used, since the definition of these terminologies are unclear in AI/ML air interface.

- Identify lifecycle management of AI/ML model: e.g., model deployment (initiation/configuration), model monitoring, model updating, model transfer, offline training, and online training

## 15 – VODAFONE Group Plc

WE support the current version

## 16 – Fujitsu Limited

We are fine with this part.

**17 – Sony Group Corporation**

These objectives look reasonably stable.

Note, with reference to our answer to 2.2, that the study needs to consider a sufficiently diverse set of use cases in order to be able to explore the issues of AI model and description.

**18 – MediaTek Inc.**

We support the current version.

**19 – ROBERT BOSCH GmbH**

fine

**20 – HUAWEI TECHNOLOGIES Co. Ltd.**

In general, the necessary procedure of an AI/ML model should contain data collection, model training, model deployment and model inference. These terminologies are also aligned with the functional framework defined in TR37.817. Model transfer can be contained within model deployment, and thus no need to be listed separately. In addition, there is no need to further describe model deployment, since it may include other potential functions as well, e.g. model activation/de-activation. We suggest the following revision to the AI/ML model and description:

AI/ML model and description to identify common and specific characteristics for framework investigations:

- Identify lifecycle management of AI/ML model: e.g., **data collection, model training**, model deployment (~~initiation/configuration~~), **model inference**, model monitoring, model updating, ~~and model transfer~~

**21 – Deutsche Telekom AG**

We are fine with the proposed text with one exception:

At bullet point "Identify lifecycle management of ...", **and model transfer**" should be deleted as this is already covered by "model deployment" and "model updating".

**22 – Ericsson LM**

Support.

**23 – Nokia Corporation**

The current SID objectives for AI/ML model and description are acceptable for us.

**24 – InterDigital Germany GmbH**

The description is quite stable and we are ok with the proposal

**25 – Verizon UK Ltd**

Fine with it.

### 2.3.1 Moderator’s replies

The Moderator took into account most of the comments. Regarding comment #6, there is no need to mention baseline as the work in *FS\_NR\_ENDC\_data\_collect* has to be taken into consideration when appropriate.

A revised version of the Draft SID is available at the same Inbox/Drafts folder.

## 2.4 Objective: Evaluations

The AI/ML evaluations portion of the Objectives section of the Draft SID is deemed to be stable. However, please add here if you have any suggestion for revision of the draft **Objective: Evaluations** text in [6].

### Feedback Form 4: Feedback on Evaluations related objectives

#### 1 – vivo Mobile Communication Co.

Not sure where the following terminology of ”offline training” and ”online training” is defined. If there is no common understanding, prefer to remove the ambiguity as following.

§ Consider adequate model training strategy and associated implications, ~~e.g., offline training vs. online training of models.~~

#### 2 – ZTE Corporation

1) It’s still unclear to us how field data can help to verify the performance or robustness as it can only show a particular realization of the channel. We think whether to use field data or not should be up to companies’ decision. Hence we suggest the following change to this sub-bullet:

*Whether ~~f~~Field data may be optionally used ~~are needed to further assess the performance and robustness in real-world environments should be discussed as part of the study~~*

2) We think collaboration levels should also be considered in the evaluation discussion. Even for one particular use case, different collaboration levels in training or interference can lead to different performance, esp. considering training/model update should also consider collaboration levels. Hence we suggest the following change to this sub-bullet:

*Consider adequate model training strategy, collaboration levels and associated implications, e.g., offline training vs. online training of models*

#### 3 – CATT

We suggest to make clear that performance evaluation shall only be conducted on the use cases in the final representative set. The following revision is suggested.

1) Evaluate performance benefits of AI/ML based algorithms for the agreed use cases in the final representative set:

We are supportive of vivo’s suggestion of remove ’online training’ and ’offline training’.

#### 4 – NTT DOCOMO INC.

We support the Evaluation part

#### 5 – Qualcomm Incorporated

We support the current version.

## 6 – SHARP Corporation

We are fine with this part.

## 7 – Spreadtrum Communications

We are OK for this part.

## 8 – LG Electronics Inc.

Fine in general. Two minor comments

- Not sure whether user data privacy related text is really necessary since it seems to have no impact on LLS/SLS evaluation.
- To us, it is not crystal clear how to document hardware requirements associated with enabling AI/ML scheme. It may be safer to delete ‘and documented’ in the second sub-bullet of KPI part.

## 9 – Futurewei

In general, Futurewei is ok with the high-level items related to the evaluation section with a few comments:

- The last sub-bullet under “Methodology based on statistical models“: instead of saying offline training vs. online training (as it may also be hybrid/mixed), we suggest rephrasing this bullet to “**Consider various realization scenarios of AI/ML-based approaches for each use case and their associated implications**”.
- “KPIs”: while there are use case-specific KPIs, there may also be some common/applicable KPIs that are not use case-dependent (e.g., confusion matrix may be commonly used across classification-type of AI/ML models); thus, we suggest reword the second sentence to “**For each selected use case, determine the applicable KPIs and benchmarks for evaluation**”.
- The wording of “Typical AI model(s)” in the last sentence is very confusing as there is no definition for “typical AI model” and we haven’t officially discussed this term in the past discussions. Thus, we suggest using more general wording like “**The need to determine agreed-upon base AI model(s) to facilitate the study can be discussed as part of this SI**”.

## 10 – Apple Hungary Kft.

To reduce the workload, focusing on offline training is preferable in R18 study. Clear definition of online training is needed if included in the objective.

## 11 – Intel Technology India Pvt Ltd

This section is generally ok but we support comment from Vivo

## 12 – CAICT

We are fine with the latest version.

## 13 – China Mobile Com. Corporation

We think we should focus on offline training in R18. The definition and evaluation methodology of online training is not clear.

#### 14 – Lenovo (Beijing) Ltd

We think it is hard (or even impossible) to judge the ‘field data set’ to be meaningful or not for the evaluation, though the field data could be used to evaluate the generalization capacity of AI/ML-based approaches. For the uncertainty, we suggest only using the 3GPP methodology without the field data set in this study.

#### 15 – Samsung Electronics Polska

(1) For evaluation, although AI/ML algorithm should be implementation-dependent, but the key information should be shared for information and result alignment purpose. In addition, how to construct dataset for training, validation, and test for the selected use cases will depend on AI/ML algorithms and training strategies, so it might consume a lot of time for companies to align to the common dataset construction. It also might be huge limitation of designing AI/ML algorithms and training strategies. Since data set should be generated from the common channel model for the selected uses cases, the common dataset is unnecessary as well. Additionally, we share similar view as vivo. We are not sure about the definition of offline and online training. Since we have not discussed about definition of offline and online training, we would like to remove them. Therefore, we propose the following revision:

- o Methodology based on statistical models (from TR 38.901 and TR 38.857 [positioning]), for link and system level simulations.

- § Extensions of 3GPP evaluation methodology for better suitability to AI/ML based techniques should be considered as needed.

- § Whether field data are **optionally** needed to further assess the performance and robustness in real-world environments should be discussed as part of the study.

- § User data privacy needs to be preserved.

- ~~§ Need for common dataset construction for training, validation and test for the selected use cases~~

- ~~§ Consider adequate model training strategy and associated implications, e.g., offline training vs. online training of models.~~

- § Key information and definitions about neural network design and training methodology should be shared for information and alignment purpose

#### 16 – Fujitsu Limited

We also have strong concern on how to utilize ‘field data’ to assess AI/ML performance. If it is necessary to be studied, it maybe RAN4’s task to study how to design the test case for AI/ML-based modules. Therefore, we suggest to delete ‘field data’ issue in this SI:

~~Whether field data are needed to further assess the performance and robustness in real-world environments should be discussed as part of the study.~~

#### 17 – Sony Group Corporation

The objectives are reasonably stable.

Performance evaluation is not the primary goal of this SI. We see several issues with performance evaluations:

- AI/ML technology is advancing rapidly. Performance evaluations in Rel-18 can be out of date by Rel-19

- What is the baseline for performance evaluations? For example, for CSI feedback enhancements, would the study be considering AI/ML methods for prediction against non-AI/ML-type methods for prediction that could alternatively be introduced as Rel-18 enhancements? Or would the study consider AI/ML methods for prediction against a legacy system that did not implement prediction?

Avoid using KPI to down-select use cases and the ways that AI functionalities are utilized in RAN. Rather consider the most popular (among contributing companies) and most efficient AI functionalities that bring the maximum potential (maybe not showing maximum benefit at the moment for limited use cases) of RAN. This leads to the definition of functions, interface, messages for adding common AI functionalities in RAN for most use cases.

#### 18 – MediaTek Inc.

We support the current version.

#### 19 – ROBERT BOSCH GmbH

fine

#### 20 – Deutsche Telekom AG

We are fine with current text with one exception under "KPIs":

We propose the following deletion in bullet point "Performance and computational complexity of AI/ML based algorithms should be compared to that of a state-of-the-art (non-AI/ML ~~and/or implementation-based AI/ML~~) baseline." as it will be not feasible to define an implementation-based AI/ML baseline as reference for comparisons.

In contrast to some other companies we support to keep "e.g., offline training vs. online training of models." as this has some impact on the solution to be selected/evaluated.

#### 21 – Ericsson LM

AI-based solutions will need to achieve certain latency and complexity requirements during inference. It may also be so that latency is an advantage of AI based inference compared to baseline and is thus a relevant KPI to measure. We thus propose explicitly adding "inference latency" to the highlighted KPIs:

- *"Performance and inference latency and computational complexity of AI/ML based algorithms should be compared to that of a state-of-the-art (non-AI/ML and/or implementation-based AI/ML) baseline"*

Otherwise, we support these objectives.

#### 22 – Nokia Corporation

The current SID objectives for evaluations are acceptable for us.

#### 23 – InterDigital Germany GmbH

We are ok with the objectives. We support adding inference latency of AI/ML algorithms as an additional KPI for comparison.

#### 24 – Verizon UK Ltd

The current version looks fine.

#### 25 – VODAFONE Group Plc

We're fine with the objectives and agree with Ericsson comment on inference latency of AI/ML algorithms. We prefer to keep online and offline training of models

### 2.4.1 Moderator's replies

Some companies are concerned with how field data can be taken into consideration. The current text is result of multiple rounds of fine-tuning and the Moderator has added "optionally" to the corresponding bullet. Note that, as stated, this aspect can be discussed as part of the study.

Some companies would like to focus on offline training only. This was also debated in the past and there were concerns about the fact that companies' models may come too well or too little trained to the evaluations. As a result, it was concluded to leave online and offline training within the scope of the project.

A revised version of the Draft SID is available at the same Inbox/Drafts folder.

## 2.5 Objective: Specification impact

The specification impact portion of the Objectives section of the Draft SID is deemed to be stable. However, please add here if you have any suggestion for revision of the draft **Objective: Specification impact** text in [6].

### **Feedback Form 5: Feedback on Specification impact related objectives**

#### 1 – vivo Mobile Communication Co.

Understand the moderator's motivation to give more guidance to the following study work. Since the group's understanding would keep evolving during the study (with 3GPP as the platform to training and learning), it may be more appropriate to word it more generic and non-exclusive as following.

Another comment is regarding the last RAN4 bullet, can anyone point out what needs to be studied in RAN4 with the listed considerations?

Assess potential specification impact, specifically for the agreed use cases in the final representative set and for a common framework:

- o PHY layer aspects ~~including~~, e.g., (RAN1)

- § Consider aspects related to, e.g., the specification of the AI Model lifecycle management, and dataset construction for training, validation and test for the selected use cases

- § Use case and collaboration level specific specification impact, such as new signalling, assistance information, measurement, and feedback

- o Protocol aspects ~~including~~, e.g., (Except use case study, RAN2 only start following general assessment after there is sufficient progress on use study in RAN1)

- § Consider aspects related to, e.g., capability indication, configuration procedures (training/inference),

validation and testing procedures, and management of data and AI/ML model

§ Collaboration level specific specification impact per use case including signalling design to support the collaboration identified in RAN1

o Interoperability and testability aspects, *e.g.*, (RAN4 only start the work after there is sufficient progress on use case study in RAN1 and RAN2)

§ UE and gNB requirements and testing frameworks to validate AI/ML based performance enhancements and ensuring that UE and gNB with AI/ML meet or exceed the existing minimum requirements

~~§ Consider the need and implications for AI/ML processing capabilities definition~~

## 2 – ZTE Corporation

For the RAN2 part:

1) As we have removed the only RAN2-related use case study, there is no use case study in RAN2. Hence the main bullet of RAN2 part should be revised as follows.

~~Except use case study, RAN2 only start following general assessment after there is sufficient progress on use study in RAN1~~

2) It's quite strange to study aspects like capability signaling, configuration procedures (training/inference), validation and testing procedures, and management of data and AI/ML model in RAN2 SI for RAN1-centric use cases. These aspects are normally discussed in WI phase directly. Hence we suggest to either remove these signalling/procedure details in RAN2 or revise it as following.

*Consider aspects related to, e.g., capability indication, configuration procedures (training/inference), validation and testing procedures, and management of data and AI/ML model, per RAN1 input*

## 3 – CATT

AI model lifecycle management is beyond the expertise of RAN1 and duplicates with RAN2 objectives. It should be deleted from the RAN1 objectives. Each of the selected representative use case belongs to one specific category and collaboration level. Studying use case specific specification impact would be sufficient. The following revision is suggested.

o PHY layer aspects including (RAN1)

§ Consider aspects related to, e.g., the specification of ~~the AI Model lifecycle management, and dataset construction for training, validation and test for the selected use cases~~

Use case and collaboration level specific specification impact, such as new signalling, assistance information, measurement, and feedback

## 4 – NTT DOCOMO INC.

Since RAN2 led use case (RRM mobility) is removed from initial set of use cases in the current SID draft, the following modification should be made.

## 5 – Xiaomi Communications

Since the lifecycle management of AI/ML model involve the model deployment, model monitoring, model updating and model transfer, it seems more related to RAN2's scope. Thus, we share similar view with CATT that the AI model lifecycle management should be removed from RAN1 scope.

For the dataset construction for each selected use cases, we don't think it would bring any specification impact. So, this part could be removed as well.

## 6 – Qualcomm Incorporated

We support the current version.

## 7 – SHARP Corporation

We are fine with this part.

## 8 – LG Electronics Inc.

Current list seems to have quite an overlap in scope between RAN1 and RAN2. For example, collaboration level specific specification impact is captured in both RAN1 and RAN2. In addition, we are curious how to discuss AI Model lifecycle management in RAN1 while AI related capability indication and configuration procedures (training/inference), validation and testing procedures are discussed in RAN2. It would be more efficient to discuss them in one WG.

## 9 – Futurewei

In general, Futurewei is ok with the high-level items identified (i.e., PHY layer, Protocol aspect and Interoperability and testability aspects) and appreciate the moderator effort of including some details under each item. We have a few comments:

- As we are in the SID item description phase, it may be premature to identify the details (sub-items), however, they can serve as examples. Thus, we suggest adding “, for example:” after EACH high-level item, e.g., “**PHY layer aspects (RAN1), for example:**” for PHY layer.
- “Protocol aspect”: consider rewording the sentence inside the parentheses to “**RAN2 only starts the work after there is sufficient progress on the use case study in RAN1**” if companies agree on the updated list of use cases.
- “Interoperability and testability aspects”: “RAN4 only **starts** the work ...”

## 10 – Apple Hungary Kft.

Agree in general.

## 11 – Intel Technology India Pvt Ltd

For RAN2 and RAN4 objectives we propose to consider high-level objectives appropriate for a SID (some details in the current version seem more appropriate for a WID). ”Interoperability” from RAN4 perspective is unclear to us. similar comment for ”gNB requirements” and ”implications for AI/ML processing capabilities”. Here is our proposal:

Protocol aspects including (Except use case study, RAN2 only start following general assessment after there is sufficient progress on use study in RAN1)

- Consider aspects related to, e.g., capability indication, configuration procedures (training/inference), validation and testing procedures, and management of data and AI/ML model
- ~~Collaboration level specific specification impact per use case including signalling design to support the collaboration identified in RAN1~~

~~Interoperability and testability aspects (RAN4 only start the work after there is sufficient progress on use case study in RAN1 and RAN2)~~

- ~~UE and gNB~~ requirements and testing frameworks to validate AI/ML based performance enhancements and ensuring that UE and gNB with AI/ML meet or exceed the existing minimum requirements
- ~~Consider the need and implications for AI/ML processing capabilities definition~~

## 12 – CAICT

We are fine with the latest version.

## 13 – Samsung Electronics Polska

(1) For RAN4 objective as below, it should be noted that the use case under considerations are not all linked with “existing minimum requirements”, e.g., in RAN4 requirement till now, there is no explicit requirement or test for beam prediction, and the beam selection accuracy is achieved only based on Layer-1 measurement accuracy. Therefore, we propose the following revision:

o “Interoperability and testability aspects (RAN4 only start the work after there is sufficient progress on use case study in RAN1 and RAN2)

§ UE and gNB requirements and testing frameworks to validate AI/ML based performance enhancements and ensuring that UE and gNB with AI/ML meet or exceed the existing minimum requirements **if applicable**

§ Consider the need and implications for AI/ML processing capabilities definition”

## 14 – Fujitsu Limited

We are fine with this part.

## 15 – Sony Group Corporation

The specification impact section is reasonably stable.

For the protocol aspects, RAN2 can consider the protocol implications of introducing AI/ML for RRM Mobility straight away and RAN2 does not have to wait for RAN1 on this use case.

## 16 – MediaTek Inc.

We are fine with the current version, but also expect there will be some minor updates related to the conclusion of use case discussion.

## 17 – ROBERT BOSCH GmbH

we agree with the current proposal.

## 18 – HUAWEI TECHNOLOGIES Co. Ltd.

1. Add an additional note 2 as below to clarify that this study is based on the current RAN architecture and interfaces.

Note 1: specific AI/ML models are not expected to be specified and are left to implementation.

**Note 2: The study is based on the current RAN architecture and new interfaces shall not be introduced.**

Firstly, assuming the existing RAN architecture and no new interface introduced is one of the key principles agreed for RAN3 study for AI/ML, just similar as other two key principles like leaving AI/ML algorithms and models for implementation and preserving user data privacy. The other two key principles are already captured by the current SID, therefore the principle on RAN architecture should be reflected as well.

Secondly, we need to ensure that the study for AI/ML for physical layer is focused in RAN1. AI/ML is a new area for RAN1, it is expected that the study would be slow since many new things to be studied. To ensure that we can achieve reasonable progress, it is better to make the study more focused by reducing the uncertain aspects, we believe limiting the study to the current RAN architecture would help much from work load and progress perspective.

2. The sub-bullets under the objectives for RAN1, RAN2 and RAN4 should be removed. Firstly, some of the descriptions are not appropriate from a study phase perspective, e.g. signaling design in RAN2 to support mechanisms identified in RAN1 for AI/ML. Secondly, the work split among different working groups may not be accurate, e.g. it is difficult to say at this stage that lifecycle management only needs to involve RAN1. Thirdly, without detailed study, it is not clear whether the aspects listed there is complete or not. Therefore, it is better to remove those for now, and we can come up with a more complete/accurate list based on the further study in the study phase.

We can understand the intention from the moderator to provide some guidance for the future work by these detailed sub-bullets, however it might be difficult for us to come up with a clearer and more complete list without detailed study in the study phase. If people really want to list something here, it is preferred to soften the tone for these aspects, i.e. to make it clear that these are just listed as some examples for further consideration. An example of the changes can be as below:

2) Assess potential specification impact, specifically for the agreed use cases in the final representative set and for a common framework:

- o PHY layer aspects ~~including~~ (RAN1), e.g.

- § Consider aspects related to, e.g., the specification of the AI Model lifecycle management, and dataset construction for training, validation and test for the selected use cases

- § Use case and collaboration level specific specification impact, such as new signalling, assistance information, measurement, and feedback

- o Protocol aspects ~~including~~ (~~Except use case study~~, RAN2 only start following general assessment after there is sufficient progress on use study in RAN1), e.g.

- § Consider aspects related to, e.g., capability indication, configuration procedures (training/inference), validation and testing procedures, and management of data and AI/ML model

- § Collaboration level specific specification impact per use case ~~including signalling design to support the collaboration identified in RAN1~~

- o Interoperability and testability aspects (RAN4, only start the work after there is sufficient progress on use case study in RAN1 and RAN2), e.g.

- § UE and gNB requirements and testing frameworks to validate AI/ML based performance enhancements and ensuring that UE and gNB with AI/ML meet or exceed the existing minimum requirements

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## 19 – Deutsche Telekom AG

We are fine with present text.

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## 20 – Ericsson LM

Support.

**21 – Nokia Corporation**

The current SID objectives for the specification impact are quite acceptable for us. Though RAN2 and RAN4 should be allowed to progress work on mobility use case before RAN1 as RAN2 and RAN4 have expertise on mobility area.

**22 – InterDigital Germany GmbH**

We support the current version

**23 – VODAFONE Group Plc**

We're fine with current version

**24 – Verizon UK Ltd**

Fine with the current version

**2.5.1 Moderator's replies**

A revised version of the Draft SID is available at the same Inbox/Drafts folder.

**2.6 Other comments**

Please add here if you have any other comment or suggestion for the Draft SID in [6],

## Feedback Form 6: Other comments

### 1 – HUAWEI TECHNOLOGIES Co. Ltd.

Add an additional note 2 as below to clarify that this study is based on the current RAN architecture and interfaces.

Note 1: specific AI/ML models are not expected to be specified and are left to implementation.

**Note 2: The study is based on the current RAN architecture and new interfaces shall not be introduced.**

Firstly, assuming the existing RAN architecture and no new interface introduced is one of the key principles agreed for RAN3 study for AI/ML, just similar as other two key principles like leaving AI/ML algorithms and models for implementation and preserving user data privacy. The other two key principles are already captured by the current SID, therefore the principle on RAN architecture should be reflected as well.

Secondly, we need to ensure that the study for AI/ML for physical layer is focused in RAN1. AI/ML is a new area for RAN1, it is expected that the study would be slow since many new things to be studied. To ensure that we can achieve reasonable progress, it is better to make the study more focused by reducing the uncertain aspects, we believe limiting the study to the current RAN architecture would help much from work load and progress perspective.

#### 2.6.1 Moderator's replies

The Moderator does not see the need to add Note 2 as the contents of the Note are not in the scope of the project. Indeed, RAN3 is not even listed as secondary WG for this project.

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## 3 Intermediate Round

A revised version of the Draft SID is available at the following location (r1):

[https://www.3gpp.org/ftp/tsg\\_ran/TSG\\_RAN/TSGR\\_94e/Inbox/Drafts/\[94e-03-R18-AIML-Air\]](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_94e/Inbox/Drafts/[94e-03-R18-AIML-Air])

The main remaining topic appears to be finalizing the Use Cases. The current version of the Draft SID contains the three most popular ones which balance well the workload and the breadth and depth that they will enable for WG investigations.

Companies are welcome to provide input on the Use cases for consideration and express if they have a strong view against what is currently captured in the Draft SID along with the Note explaining what the Use cases are meant to serve the purpose for.

## Feedback Form 7: Company inputs on Use cases

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The rest of the Draft SID appears stable but companies are welcome to provide any other comments they may have on any part of the Draft SID:

## Feedback Form 8: Company inputs on Other items

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### 4 Final Round

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### 5 References

[1] RWS-210659, “Summary of RAN Rel-18 Workshop”, RAN Chair.

[2] RP-211662, “Moderator’s summary for discussion [RAN93e-R18Prep-12] AI/ML”, Moderator (Qualcomm).

[3] RP-212668, “Moderator’s summary for discussion [RAN94e-R18Prep-08] AI/ML for Air Interface”, Moderator (Qualcomm)

[4] RP-212708, “New SID on AI/ML for NR Air Interface”, Qualcomm (Moderator)

[5] RP-213469, “Summary for RAN Rel-18 Package”, RAN Chair, RAN1 Chair, RAN2 Chair, RAN3 Chair, RAN4 Chair

[6] [www.3gpp.org/ftp/tsg\\_ran/TSG\\_RAN/TSGR\\_94e/Inbox/Drafts/\[94e-03-R18-AI/ML-Air\]/RP-21xxxx SID on AI-ML for Air Interface.docx](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_94e/Inbox/Drafts/[94e-03-R18-AI/ML-Air]/RP-21xxxx SID on AI-ML for Air Interface.docx)