

Email discussion summary for [RAN-R18-WS-crossFunc-Ericsson] - Version 0.0.5
RAN

3GPP TSG RAN Rel-18 workshop RWS-210617

Electronic Meeting, June 28 - July 2, 2021

Agenda Item: 4.3

Source: Ericsson

Title: Email discussion summary for [RAN-R18-WS-crossFunc-Ericsson]

1 Introduction

This email discussion summary covers the first 2 rounds of Q&A of the following Ericsson documents:

Table 1: Ericsson tdocs covering features/enhancements driven by cross domain functionality

tdoc number	tdoc title
RWS-210295	On Full Duplex
RWS-210315	Discussion on Positioning in Release 18
RWS-210382	Study on AI/ML for PHY enhancements
RWS-210383	Motivation for AI/ML for PHY enhancements
RWS-210490	SA items which may impact RAN
RWS-210510	Considerations on AI/ML for Rel-18 (for Radio Access Networks)

2 AI/ML for PHY enhancements

2.1 1st round questions to the proposals on AI/ML for PHY enhancements

Please provide your 1st round questions to RWS-210382 and RWS-210382 in the below feedback form:

Feedback Form 1: 1st round questions to the proposals on AI/ML for PHY enhancements

1 – Lenovo (Beijing) Ltd

Thanks for the quality contribution. We share the similar views on the AI/ML for PHY enhancement and agree with your proposal to have a pilot study to identify the impacts on the standardizations once the methodologies are studied. We have a question that do you think the functional frameworks for RAN intelligence is enough for the PHY study? And is a physical layer-specific framework better for the evaluation as indicated in our proposal (RWS-210260)?

2 – vivo Mobile Communication Co.

Thanks for your effort on this. We share similar views that AI/ML for PHY enhancement is one of the most important directions for NR 5.5G enhancement.

Several detailed questions from our side.

Q1: The study is proposed to be with two phases. The first question is for how to conduct the phase I study on evaluation methodology and performance requirement. If there is no specific use case in mind, would the study on evaluation methodology and performance requirement be hard to achieve on common understanding? Or would a sub-phase be needed to align on expected scope of use cases during the methodology study?

Q2: For Part II study, are there any criteria to downselect some use cases? Do we need to select only one pilot use case, or can we select multiple use cases potentially with similar expected framework for AI/ML application?

3 – Intel Corporation (UK) Ltd

Thank you for the contribution. One question.

1) Does the proposed CSI use-case broadly include L1-RSRP/SINR/PMI/RI/CQI or focused on RI/PMI only?

4 – CATT

Thanks for the contribution, and we have following questions for clarification:

Q1: For the high-resolution CSI use case, how does the network and UE synchronize the parameters of the AI/ML-based encoder/decoder?

Q2: What is the training procedure of the high-resolution CSI use case?

5 – Sony Corporation

Thanks for the contribution. We have a question.

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AI/ML based encoder and decoder

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How are the AI/ML based encoder and decoder trained. For example, network provides some data set for training, or trained AI/ML model is downloaded to the UE?

6 – Samsung Electronics Polska

-Q1:Ericsson suggested the study item as two parts (In RWS-210382). Could you give more descriptions or examples about what the exact range of a broad and guiding study is and what the difference between two part is except for use case?

Q2: in slide 2, we have a question for objectives. What kind of interaction of AI/ML models between UE and network are you thinking?

Q3: 'What is "intent-based" management for use case?

Q4: question whether channel have impact on model/algorithm used for CSI compression.

7 – Qualcomm Incorporated

"a focused pilot study AI/ML-enhanced acquisition of high resolution csi". Does this mean a joint optimization of CSI-RS and CSF?

8 – MediaTek Inc.

Thanks for the contribution. Some question for clarification:

1) What are the prioritized use cases to be studied?

2) Does Ericsson think it is useful to establish the "test data set" (repository)?

9 – HUAWEI TECHNOLOGIES Co. Ltd.

Thank you very much for the contribution. Please find some questions for clarification as below:

Q1. Do you have any idea on the timeline for Part I and Part II study?

Q2. What is the criteria to pick the pilot example? Before sufficient study of the potential use cases, it seems difficult to directly pick one as the pilot example.

Q3. A use case picked as pilot example is only for further study on whether AI/ML is beneficial or not? That means only when sufficient benefits are identified for this use case, then AI/ML related mechanisms will be specified for this use case, right?

10 – NEC Corporation

NEC supports having SI on AI/ML for physical layer including mentioned topics. Specific use cases could be selected during the study.

11 – Nokia Corporation

Thank you for the contribution. Is your intention that Part I and Part II of the study item proposed be performed consecutively or in parallel?

2.1.1 Answers by the moderator

2.1.1.1 Lenovo (Beijing) Ltd

Thanks for the quality contribution. We share the similar views on the AI/ML for PHY enhancement and agree with your proposal to have a pilot study to identify the impacts on the standardizations once the methodologies are studied. We have a question that do you think the functional frameworks for RAN intelligence is enough for the PHY study? And is a physical layer-specific framework better for the evaluation as indicated in our proposal (RWS-210260)?

Thank you for your question and contribution.

Since this is new territory for RAN1, we would like to have an initial discussion to help form high-level common understandings (e.g., list options) on how we should approach AI/ML on the physical layer. This

high-level discussion could then be supported by comprehensive use-case studies to dive further into the topic.

To answer your question: In the use-case deep dive(s), the RAN3 functional framework should provide a good foundation to start discussions. However, as you suggest, physical layer needs might require additional thinking.

2.1.1.2 vivo Mobile Communication Co.,

Thanks for your effort on this. We share similar views that AI/ML for PHY enhancement is one of the most important directions for NR 5.5G enhancement.

Several detailed questions from our side.

Q1: The study is proposed to be with two phases. The first question is for how to conduct the phase I study on evaluation methodology and performance requirement. If there is no specific use case in mind, would the study on evaluation methodology and performance requirement be hard to achieve on common understanding? Or would a sub-phase be needed to align on expected scope of use cases during the methodology study?

[Reply]

Thank you for the question and detailed contribution.

We would like to have an initial discussion to help form high-level understandings (e.g., list options) on how we can approach AI/ML on PHY. For example,

- What potential evaluation and standardization issues do companies foresee?
- What issues might cause problems in RAN4 testing? For example, how to model AI/ML techniques with respect to PHY layer testing?

We think a “Part I to the SI” could be used for the following:

- Help form an initial common view on how we can approach AI/ML on PHY.
- Summarize/document key learnings to form a basis for future AI/ML on PHY work.

We think it is useful to initiate such discussions before starting a detailed use-case pilot study with evaluations.

We agree with you that detailed evaluations will be necessary. We think a “Part II to the SI” could provide detailed pilot study to

- illustrate potential gains/pitfalls and
- provide important learnings for future AI/ML on PHY use-cases (e.g., via “Part I”).

Finally, the work in “Part I of the SI” does not need to conclude before “Part II” starts. For example, learnings from the pilot study can support discussions in Part I – in line with your reasoning above.

Q2: For Part II study, are there any criteria to downselect some use cases? Do we need to select only one pilot

use case, or can we select multiple use cases potentially with similar expected framework for AI/ML application?

[Reply]

We think that AI/ML on PHY might reveal new and unforeseen challenges that can be difficult to solve. To help ensure AI/ML on PHY is done well given limited time units (TUs), we recommend having one detailed pilot study. However, additional use-cases can be discussed.

In the discussed use-cases, we recommended CSI acquisition and reporting for the following reasons:

- It has clear specification impact and the potential to improve network performance. For example,
- The complexity of CSI reporting has long been an issue for UE vendors, and AI/ML technologies have the potential to reduce this complexity.
- Better CSI is of interest to network vendors, because it enables us to better exploit massive MIMO arrays via more sophisticated transmission strategies.
- It will likely require non-trivial AI/ML models in the network and UE to interact with one another, and, therefore, will help “excite” learnings on AI/ML model standardization, provisioning, maintenance, and AI-accelerated hardware. It may also give insights to what an AI/ML-driven physical layer might look like, as we head into 6G.
- The available SI time units may not be that large, and it is better if RAN1 spend their focus and energy on a single pilot use case in this SI than to have many parallel discussions covering similar AI/ML aspects.

2.1.1.3 Intel

Thank you for the contribution. One question.

Does the proposed CSI use-case broadly include L1-RSRP/SINR/PMI/RI/CQI or focused on RI/PMI only?

[Reply] What to include in such CSI report will be part of the study objective. This can be discussed further.

2.1.1.4 CATT

Thanks for the contribution, and we have following questions for clarification:

Q1: For the high-resolution CSI use case, how does the network and UE synchronize the parameters of the AI/ML-based encoder/decoder?

Q2: What is the training procedure of the high-resolution CSI use case?

[Reply] Thanks for the questions, these are questions to be answered by the SI. The scope of this SI can be discussed further on these aspects.

2.1.1.5 Sony

Thanks for the contribution. We have a question.

AI/ML based encoder and decoder: How are the AI/ML based encoder and decoder trained. For example, network provides some data set for training, or trained AI/ML model is downloaded to the UE?

[Reply] Thanks for the questions, such questions are precisely those to be answered by the SI.

2.1.1.6 Samsung

Q1:Ericsson suggested the study item as two parts (In RWS-210382). Could you give more descriptions or examples about what the exact range of a broad and guiding study is and what the difference between two part is except for use case?

Q2: in slide 2, we have a question for objectives. What kind of interaction of AI/ML models between UE and network are you thinking?

Q3: 'What is "intent-based" management for use case?

Q4: question whether channel have impact on model/algorithm used for CSI compression.

[Reply]

Thanks for the questions.

A1: We think a "Part I to the SI" could be used for the following:

- Help form initial common understandings (e.g., list options) on how we can approach AI/ML on PHY.
- Summarize/document key learnings (e.g., from a detailed pilot study) to form a basis for future AI/ML on PHY work.

We think it is useful to initiate such discussions before starting a detailed use-case study with evaluations. However, the high-level discussions of Part I do not need to conclude before detailed a pilot study in Part II starts. We think learnings from the pilot study can help discussions in Part I.

For Part I, we might initially aim to find a common understanding of the following challenges/questions (perhaps refined as the pilot study proceeds):

- Are there obvious fundamental limitations on deploying and executing AI/ML models in UEs and networks that we collectively foresee?
- Our initial view is that AI/ML models should be proprietary. Do we agree on this view, and, therefore, should we approach use-cases with this mindset?
- There may be well motivated situations where some parts of AI/ML models need standardization, and this might not be possible in 3GPP technical documents. Can we agree on how to approach such challenges?
- AI/ML-based solutions might be less robust to variations in data than classical solutions. For example, AI/ML models trained only on synthetic 3GPP channel models might not generalize well to "real" channels.

How should we approach such challenges in 3GPP evaluations?

- Several companies have proposed common 3GPP datasets (e.g., channel measurement datasets). Are such datasets needed? What challenges do we foresee with such datasets?

- What issues might cause problems in RAN4 testing?

Addressing the above might help to, for example, find a common mindset and expectations on how to evaluate use cases for potential later standardization.

We think a “Part II to the SI” could provide a detailed pilot study to

- Illustrate potential gains/pitfalls and

- Provide learnings for future AI/ML on PHY use-cases (e.g., via “Part I”).

A2: Our initial view is that AI/ML models should be proprietary, and, therefore, model interactions primarily relate to characterizing inputs and outputs. This view presents certain challenges for training and validation that could be included in “Part I” discussions.

A3: Please see our answer on this question in the RAN AI/ML document.

A4: This will be part of the pilot study to find out.

2.1.1.7 Qualcomm

”a focused pilot study AI/ML-enhanced acquisition of high resolution CSI”. Does this mean a joint optimization of CSI-RS and CSF?

[Reply] What does CSF mean, can you clarify?

2.1.1.8 MediaTek

Thanks for the contribution. Some question for clarification:

1) What are the prioritized use cases to be studied?

2) Does Ericsson think it is useful to establish the ”test data set” (repository)?

[Reply]

A1: In the set of discussed use cases, we recommended focusing on CSI acquisition and reporting for the following reasons:

- It has clear specification impact and the potential to improve network performance. For example,

– The complexity of CSI reporting has long been an issue for UE vendors, and AI/ML technologies have the potential to reduce this complexity.

– Better CSI is of interest to network vendors, because it enables us to better exploit massive MIMO arrays via more sophisticated transmission strategies.

- It will likely require non-trivial AI/ML models in the network and UE to interact with one another, and, therefore, will help “excite” learnings on AI/ML model standardization, provisioning, maintenance, and AI-accelerated hardware. It may also give insights to what an AI/ML-driven physical layer might look like, as we head into 6G.

- The available SI time units may not be that large, and it is better if RAN1 spend their focus and energy on a single pilot use case in this SI than to have many parallel discussions covering similar AI/ML aspects

A2: Thanks for the question, we believe it needs to be answered by the SI

2.1.1.9 Huawei

Thank you very much for the contribution. Please find some questions for clarification as below:

Q1. Do you have any idea on the timeline for Part I and Part II study?

Q2. What is the criteria to pick the pilot example? Before sufficient study of the potential use cases, it seems difficult to directly pick one as the pilot example.

Q3. A use case picked as pilot example is only for further study on whether AI/ML is beneficial or not? That means only when sufficient benefits are identified for this use case, then AI/ML related mechanisms will be specified for this use case, right?

[Reply]

A1: Likely in parallel for the extent of the whole Rel.-18 time frame, but we are open to discuss this. Part I of the study item, does not necessarily need to conclude before Part II starts. For example, the pilot study in Part II can help discussions in Part I.

A2: We recommended CSI acquisition and reporting as the pilot study for the following reasons:

- It has clear specification impact and the potential to improve network performance. For example,

– The complexity of CSI reporting has long been an issue for UE vendors, and AI/ML technologies have the potential to reduce this complexity.

– Better CSI is of interest to network vendors, because it enables us to better exploit massive MIMO arrays via more sophisticated transmission strategies.

- It will likely require non-trivial AI/ML models in the network and UE to interact with one another, and, therefore, will help “excite” learnings on AI/ML model standardization, provisioning, maintenance, and AI-accelerated hardware. It may also give insights to what an AI/ML-driven physical layer might look like, as we head into 6G.

- The amount of time units for the SI is limited, it is better to focus on one pilot than to have many parallel discussions, likely covering same AI/ML aspects.

A3: Right, this is normal SI/WI procedure, we have to show benefits and feasibility of standardization to start the WI.

2.1.1.10 NEC

NEC supports having SI on AI/ML for physical layer including mentioned topics. Specific use cases could be selected during the study.

[Reply]

One concern is the available time units and we suggest the CSI as one single pilot study. Among the different discussed use cases, we recommended CSI acquisition and reporting for the following reasons:

- It has clear specification impact and the potential to improve network performance. For example,
 - The complexity of CSI reporting has long been an issue for UE vendors, and AI/ML technologies have the potential to reduce this complexity.
 - Better CSI is of interest to network vendors, because it enables us to better exploit massive MIMO arrays via more sophisticated transmission strategies.
- It will likely require non-trivial AI/ML models in the network and UE to interact with one another, and, therefore, will help “excite” learnings on AI/ML model standardization, provisioning, maintenance, and AI-accelerated hardware. It may also give insights to what an AI/ML-driven physical layer might look like, as we head into 6G.
- The amount of time units for the SI is limited, it is better to focus on one pilot than to have many parallel discussions, likely covering same AI/ML aspects

2.1.1.11 Nokia

Thank you for the contribution. Is your intention that Part I and Part II of the study item proposed be performed consecutively or in parallel?

[Reply] Likely in parallel for the extent of the whole Rel.-18 time frame, but we are open to discuss this. Part I of the study item, does not necessarily need to be completed before Part II commences. For example, the deep-dive study of Part II can provide important learnings to support discussions in Part I.

2.2 2nd round questions to the proposals on AI/ML for PHY enhancements

Please provide your 2nd round questions to RWS-210382 and RWS-210382 in the below feedback form:

**Feedback Form 2: 2nd round questions to the proposals on
AI/ML for PHY enhancements**

1 – China Unicom

Do you think a general framework should be define in the standardization for the report mode and data set in part I? Or AI/ML models and standardization impact should be studied case by case?

2 – HUAWEI TECHNOLOGIES Co. Ltd.

Thank you very much for your clarifications for the first round. For the reasons to select a use case for further study, we can further discuss what kind of factors should be considered. However, we think that there is clear specification impact seems not a critical factor, the most key thing is whether sufficient gain can be achieved by AI/ML, it is even better if it can bring sufficient gain with minimum specification impact.

2.2.1 Answers by the moderator

2.2.1.1 China Unicom

Do you think a general framework should be define in the standardization for the report mode and data set in part I? Or AI/ML models and standardization impact should be studied case by case?

[Reply] Case by case studies are needed but in Part 1 in our draft SID, we propose to discuss common and higher level issues.

2.2.1.2 HUAWEI TECHNOLOGIES Co. Ltd.

Thank you very much for your clarifications for the first round. For the reasons to select a use case for further study, we can further discuss what kind of factors should be considered. However, we think that there is clear specification impact seems not a critical factor, the most key thing is whether sufficient gain can be achieved by AI/ML, it is even better if it can bring sufficient gain with minimum specification impact.

[Reply] Yes sufficient gain should be a necessary condition, but it is not a sufficient condition unless there is a specification impact. 3GPP should study features that have a clear or possible standardization impact.

3 AI/ML for RAN enhancements

3.1 1st round questions to the proposals on AI/ML for RAN enhancements

Please provide your 1st round questions to RWS-210510 in the below feedback form:

**Feedback Form 3: 1st round questions to the proposals on
AI/ML for RAN enhancements**

1 – LG Electronics France

Q) We agree that restriction of applicable AI models hinder UE vendors' competitiveness. But on the other

hand, it is questioned if network fully trust arbitrary ML models used by UE. Do you think that AI model provisioning between UE and network can be beneficial? Do you assume that performance requirements (existing or something new) related to the concerned features are sufficient to ensure performance and inter-operability, or what other considerations are needed?

2 – Nokia

Regarding "UE-generated Augmented Information":

Q1: Does it mean the UE also uses AI/ML models? If not, how is the information generated?

Q2: Does "UE-generated Augmented Information" have to be standardized/how can the network and UE have the same understanding of this information (in conflict with having models implementation specific)?

3 – Samsung Electronics Polska

What is "intent-based" management for use case?

4 – MediaTek Inc.

Thanks for the contribution. A question for clarification:

1) What kind of standardization enhancements do you expect for these use cases? E.g. dataset collection, or AI model learning and distribution, etc.

5 – NEC Corporation

NEC supports having WI in RAN3 as continuation of the current RAN3 SI. It is also proposed to have a new SI in RAN3 as continuation of the current RAN3 SI covering wider scope and use cases.

3.1.1 Answers by the moderator

3.1.1.1 LG

Q): We agree that restriction of applicable AI models hinder UE vendors' competitiveness. But on the other hand, it is questioned if network fully trust arbitrary ML models used by UE. Do you think that AI model provisioning between UE and network can be beneficial? Do you assume that performance requirements (existing or something new) related to the concerned features are sufficient to ensure performance and inter-operability, or what other considerations are needed?

Ericsson Answer:

We are still forming our opinion here, but the following is our best current thinking. We are ok to a model where the network can push towards a UE a model that the UE can execute. This model will need some level of specification with respect to the inputs the model requires and the outputs the model produces. The advantage of this model is that the network can trust the model and there is knowledge at the network about the uncertainty of the outputs produced by the model.

If the model is totally UE implementation specific, there will be the need to specify requirements on the output of the model, e.g. the outputs will need to be well defined and testable.

Note that the principle of keeping the ML models implementation specific does not incur in the same drawbacks when the model is deployed at RAN level, so long as the output provided by the model can be

explained by means of extra information describing, for example, the accuracy of the model output.

3.1.1.2 Nokia

Regarding "UE-generated Augmented Information":

Q1: Does it mean the UE also uses AI/ML models? If not, how is the information generated?

Ericsson Answer:

Either the UE can run predictions based on its own capabilities (AI/ML or simply extrapolations) or the UE can provide extra information not known to the network today and that can enrich the ML inputs used for training and inference

Q2: Does "UE-generated Augmented Information" have to be standardized/how can the network and UE have the same understanding of this information (in conflict with having models implementation specific)?

Ericsson Answer:

As commented before, we are ok to a model where the network can push towards a UE a model that the UE can execute. This model will need some level of specification with respect to the inputs the model requires and the outputs the model produces. The advantage of this model is that the network can trust the model and there is knowledge at the network about the uncertainty of the outputs produced by the model.

If the model is totally UE implementation specific, there will be the need to specify requirements on the output of the model, e.g. the outputs will need to be well defined and testable.

3.1.1.3 Samsung

Q) What is "intent-based" management for use case?

Ericsson Answer:

Intent based management is a management framework where the RAN receives "intents" as input from the OAM, instead of receiving exact configurations aimed at solving a possible issue. An "Intent" could for example be to "reduce mobility failures between Cell A and Cell B to a value not higher than x%". Once the RAN receives such intent, the RAN can determine the best configuration to reduce mobility failures. Namely, the RAN is given a target to achieve. How to achieve the target (or Intent) is up to RAN implementation

3.1.1.4 MTK

Q) What kind of standardization enhancements do you expect for these use cases? E.g. dataset collection, or AI model learning and distribution, etc.

Ericsson Answer:

AI Models are out of standardization scope, namely they are implementation specific. With that, model

distribution can be supported only if the model is considered implementation specific.

The main task of standardization is that of identifying for each use case the set of inputs needed by the range of models that could support the use case, as well as the set of outputs the range of models can produce. Standardization could specify a mechanism by which a Model Training or Model Inference function subscribes to receiving a list of inputs (selected by the function itself) from different parts of the network. Likewise, standardization could specify mechanisms for which any node or function in the network could subscribe to reception of one or more outputs produced by an ML model.

3.1.1.5 NEC

NEC supports having WI in RAN3 as continuation of the current RAN3 SI. It is also proposed to have a new SI in RAN3 as continuation of the current RAN3 SI covering wider scope and use cases.

Ericsson Reply:

Perhaps we should first try to conclude the WI phase stemming from the current AI/L study before starting a new SI in RAN3

3.2 2nd round questions to the proposals on AI/ML for RAN enhancements

Please provide your 2nd round questions to RWS-210510 in the below feedback form:

Feedback Form 4: 2nd round questions to the proposals on AI/ML for RAN enhancements

1 – CATT

Thank you for your contribution.

One question on your answers in the first round. It was ever mentioned in your answer that the network can push towards a UE a model that the UE can execute. If the model is trained in NG-RAN node, what do you have in your mind on how to transfer the AI model from NG-RAN node to UE? My concern is that it seems difficult to transfer it via RRC message since the data volume would be very big.

2 – Fujitsu Limited

Thank you for the contribution and answers.

We have one question. Could you more elaborate on the rationale of the selection among traffic steering, load balancing, energy efficiency? This is because that QoE optimization and mobility management is also effective from the UE perspective.

3 – Intel Corporation (UK) Ltd

Q1: Regarding to “Standardization could specify a mechanism by which a Model Training or Model Inference function subscribes to receiving a list of inputs (selected by the function itself) from different parts of the network.” Does this mean if “Training” function at RAN node requires certain data from UE side, this node need to perform subscription procedure from network to UE? Or UE reports data to network, then training node only need to request data from the network nodes which collects reported data?

4 – Samsung Electronics Polska

Q1: Ericsson suggested the study item as two parts (In RWS-210382). Could you give more descriptions or examples about what the exact range of a broad and guiding study is and what the difference between two parts is except for use case?

Q2: in slide 2, we have a question for objectives. What kind of interaction of AI/ML models between UE and network are you thinking?

Q3: question whether channel has impact on model/algorithm used for CSI compression.

5 – MediaTek Inc.

Just following the answers,

1) AI traffic includes data collection & model transfer, the former may be done with existing procedure, how about the latter?

3.2.1 Answers by the moderator

3.2.1.1 CATT

Thank you for your contribution.

One question on your answers in the first round. It was ever mentioned in your answer that the network can push towards a UE a model that the UE can execute. If the model is trained in NG-RAN node, what do you have in your mind on how to transfer the AI model from NG-RAN node to UE? My concern is that it seems difficult to transfer it via RRC message since the data volume would be very big.

[Reply] We should study the constraints of signalling an ML model to the UE. There could be a number of options such as transferring models that are limited in size, or enabling new signalling procedures, or signalling only parts of the model. The obvious advantage of a solution where the RAN can signal a model to the UE and the UE can execute such model is that the RAN can unequivocally interpret the outputs of the UE-run model and therefore deliver maximum results, while continuing to maintain ML models implementation specific.

3.2.1.2 Fujitsu Limited

Thank you for the contribution and answers.

We have one question. Could you more elaborate on the rationale of the selection among traffic steering, load balancing, energy efficiency? This is because that QoE optimization and mobility management is also effective from the UE perspective.

[Reply] We think that the three use cases on traffic steering, load balancing, and energy efficiency have the largest potential for AI/ML-based improvements.

3.2.1.3 Intel Corporation (UK) Ltd

Q1: Regarding to “Standardization could specify a mechanism by which a Model Training or Model Inference function subscribes to receiving a list of inputs (selected by the function itself) from different parts of the network.” Does this mean if “Training” function at RAN node requires certain data from UE side, this node need to perform subscription procedure from network to UE? Or UE reports data to network, then training node only need to request data from the network nodes which collects reported data?

[Reply] The subscription procedure would rather be RAN internal, e.g. from the training function to the RAN entity configuring and receiving the corresponding UE measurements. The UE would be configured to deliver UE measurements as of today.

3.2.1.4 Samsung Electronics Polska

’-Q1:Ericsson suggested the study item as two parts (In RWS-210382). Could you give more descriptions or examples about what the exact range of a broad and guiding study is and what the difference between two part is except for use case?

[Reply]

In Part 1, we would like to have an initial discussion to help form high-level understandings (e.g., list options) on how we can approach AI/ML on PHY. For example,

- What potential evaluation and standardization issues do companies foresee?
- What issues might cause problems in RAN4 testing? For example, how to model AI/ML techniques with respect to PHY layer testing?

Hence, we think a “Part I to the SI” could be used for the following:

- Help form an initial common view on how we can approach AI/ML on PHY.
- Summarize/document key learnings to form a basis for future AI/ML on PHY work.

We think it is useful to initiate such discussions before starting a detailed use-case pilot study with evaluations.

Then, we think a “Part II to the SI” could provide detailed/deeper pilot study to

- illustrate potential gains/pitfalls and
- provide important learnings for future AI/ML on PHY use-cases (e.g., via “Part I”).

Finally, the work in “Part I of the SI” does not need to conclude before “Part II” starts. For example, learnings from the pilot study can support discussions in Part I

Q2: in slide 2, we have a question for objectives. What kind of interaction of AI/ML models between UE and network are you thinking?

[Reply]

Our initial view is that AI/ML models should be proprietary, and, therefore, model interactions primarily relate to characterizing inputs and outputs. This view presents certain challenges for training and validation that could be included in “Part I” discussions.

Q3: question whether channel have impact on model/algorithm used for CSI compression.

[Reply]

This needs to be studied in the SI.

3.2.1.5 MediaTek Inc.

Just following the answers,

1) AI traffic includes data collection & model transfer, the former may be done with existing procedure, how about the latter?

[Reply] This needs to be studied in the SI.

4 Full Duplex

4.1 1st round questions to the proposals on Full Duplex

Please provide your 1st round questions to RWS-210295 in the below feedback form:

Feedback Form 5: 1st round questions to the proposals on Full Duplex

1 – MediaTek Inc.

Q1: What is the impact of gNB FD support onto NR legacy terminals from R15/16/17 due to UE-UE CLI? How can these terminals be protected from UE-UE CLI? Legacy UEs cannot implement any CLI mitigation techniques or CLI-related measurements.

Q2: What is the impact on legacy gNB because of gNB-gNB CLI?

Q3: Is there any expected RF specification tightening for future R18 Half Duplex UEs (ACLR, ACS, in-band blocking, etc) to operate with a SFFD or SBFD-capable gNB?

Q4: Is there a significant power consumption impact onto FD-capable gNBs?

Q5: Is there any significant difference between FR1 and FR2 to minimise UE-UE CLI and gNB-gNB CLI.

Q6: A huge amount of effort will be needed in RAN4, which is already overloaded. Do you believe the RAN4 effort be prioritised on FR2 over FR1?

2 – Futurewei Technologies

FUTUREWEI considers that gNB full duplex is an interesting topic that deserves RAN1 attention and a very careful study that would require RAN4 involvement. We agree with your assesment the system simulation evaluations for well defined realistic scenarios are necessary. We would like to know Ericsson view on some intermediate step, such as flexible duplex (and necessary interference handling schemes), to be considered in Rel 18. Please take a look at our contribution RWS-210036 (https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR1/2018/Workshop/201809/CTD/CTD_210036.zip) and feel free to comment at: <https://nwm-trial.etsi.org/#/documents/4580>

3 – Samsung Electronics Polska

- We agree that subband operation in TDD carrier (called XDD or subband) is more feasible than pure FD. We have one question about Ericsson’s initial anaysis in the tdoc, how D-SIC budget is caculated and what is assumption for non-linearity cancellation? Also so non-linearity cancellation, are you assuming time-domain cancellation or frequency-domain?

- According to text in Tdoc, full duplex operation are highly scenario dependent. Which specific scenarios can be studied for full duplex or subband operation in TDD carrier?

- We have question for that Ericsson’s view for CLI mitigation method on subband operation in TDD carrier. Do you think current CLI mitigation method is enough for handling the advanced duplex? If any needs for enhancement of CLI mitigation method, what kind of scenario or technique need to be studied?

-Section 2.3.1 Do you think the full-duplex study should first start in RAN4 to identify applicable limitations and RF assumptions before RAN1 proceeds to system-level evaluations of gains/losses, or do you think this can be handled in parallel? Section 2.4 For the ”TX split array” option which you evaluated, do you anticipate any limitation in terms of in-band filtering ability when swtiching between Tx/Rx and Rx only? Do you see the evaluated ”full split array” or the ”Tx split array” option as more realistic?

4 – Fraunhofer HHI

Thank you very much for the FD contribution which highlights important challenges in particular at the gNB side. We’d like to learn more about your view on the following aspects:

Q1: Assuming stationary deployments of gNB, inter-gNB CLI should mainly be based on dynamic beam-forming of gNBs around or moving reflectors close to the ground, otherwise static. Pathological CLI cases could be observed by AI and avoided by coordination among the gNBs. Do you expects a need to extend coherent self-interference mechanisms from on-site SIC to across-site SIC?

Q2: Do you expect specific new aspects/signals needed to be incorporated when extending the existing UE-2-UE CLI framework to cover gNB-2-gNB CLI as well? If so which are these aspects?

4.1.1 Answers by the moderator

4.1.1.1 MediaTek Inc.

Q1: What is the impact of gNB FD support onto NR legacy terminals from R15/16/17 due to UE-UE CLI? How can these terminals be protected from UE-UE CLI? Legacy UEs cannot implement any CLI mitigation techniques or CLI-related measurements.

[Reply] Impact to legacy UEs due to UE-UE CLI should be considered as part of the evaluations of the benefits of full or flexible duplex in general. Such impact can potentially be mitigated by avoiding scheduling of UEs together that can interfere with each other. But, this would need scheduling coordination between cells and also can create scheduling restrictions that can increase latency potentially impacting the latency reduction benefits from using full or flexible duplex. For inter-operator case, this can be somewhat unreasonable to

assume such scheduling coordination.

Q2: What is the impact on legacy gNB because of gNB-gNB CLI?

[Reply] Impact to legacy gNBs due to gNB-gNB CLI can be a more difficult problem to handle than UE-UE CLI since gNBs are not mobile. Furthermore, any scheduling-based approaches will have more severe impacts due to scheduling restrictions since each gNB may handle many UEs in a cell. For gNBs within the same operator, such impacts could potentially be mitigated by updating gNBs at the same time. However, inter-operator gNB-gNB CLI is a more challenging problem and to what extent approaches such as creating a sub-band for UL transmissions within a DL carrier can mitigate inter-operator gNB-gNB CLI need to be properly evaluated.

Q3: Is there any expected RF specification tightening for future R18 Half Duplex UEs (ACLR, ACS, in-band blocking, etc) to operate with a SFFD or SBFDD-capable gNB?

[Reply] For full duplex on a carrier where DL and UL are in separate sub-bands, existing RF specifications for Half Duplex UEs may need to be tightened. Whether tightening is needed and, if so, by how much needs to be part of the evaluations.

Q4: Is there a significant power consumption impact onto FD-capable gNBs?

[Reply] There will likely be an increase in gNB power consumption, but the extent of the increase needs further study.

Q5: Is there any significant difference between FR1 and FR2 to minimise UE-UE CLI and gNB-gNB CLI.

[Reply] FR2 will likely see lower UE-UE and gNB-gNB CLI due to the greater directivity of transmissions and the pathloss characteristics in FR2.

Q6: A huge amount of effort will be needed in RAN4, which is already overloaded. Do you believe the RAN4 effort be prioritised on FR2 over FR1?

[Reply] RAN4 work on this topic is extremely important to ensure that the study uses realistic assumptions. While FR2 may have an advantage in terms of lower CLI and is potentially better suited for consideration of full or flexible duplex operation, whether FR2 should be prioritized needs further discussion.

In addition, sub-band full duplex is based on antenna design including spatial duplexer and the interference mitigation from DL sub-bands is more of a linearization aspect. Both areas are very much relating to RAN4 expertise and thus the extreme importance of involving RAN4 from the beginning if there is a study even though RAN4 is quite overloaded.

4.1.1.2 Futurewei Technologies

FUTUREWEI considers that gNB full duplex is an interesting topic that deserves RAN1 attention and a very careful study that would require RAN4 involvement. We agree with your assesment the system simulation evaluations for well defined realistic scenarios are necessary. We would like to know Ericsson view on some intermediate step, such as flexible duplex (and necessary interference handling schemes), to be considered in Rel 18.

[Reply] Intermediate steps such as flexible duplex or sub-band full duplex are simpler than complete full duplex where all time and frequency resources are overlapping between DL and UL from the gNB. However,

cross-link interference is still a significant issue which can significantly affect gains from using flexible/full duplex. Methods to mitigate such interference may often result in lower gains than expected due to practical considerations. Schemes such as coordination of scheduling and beamforming can also result in scheduling restrictions that can affect latency. These interference cancellation schemes also add significant complexity. Hence, if there is a study in Rel-18, the performance from any of these duplexing schemes needs evaluation with careful consideration of practical constraints to assess the benefits in realistic scenarios.

4.1.1.3 Samsung Electronics Polska

- We agree that subband operation in TDD carrier (called XDD or subband) is more feasible than pure FD. We have one question about Ericsson's initial analysis in the tdoc, how D-SIC budget is calculated and what is assumption for non-linearity cancellation? Also so non-linearity cancellation, are you assuming time-domain cancellation or frequency-domain?

[Reply] Our analysis considers the additional suppression needed between DL sub-bands toward UL sub-bands in frequency domain implying that it is more of a linearization of power amplifier compared to pure FD where cancellation of wanted signal is needed.

- According to text in Tdoc, full duplex operation are highly scenario dependent. Which specific scenarios can be studied for full duplex or subband operation in TDD carrier?

[Reply] If a study is carried out in Rel-18, it is important to determine gains for all scenarios that may be of interest, e.g., a macro network, a heterogeneous network with both macro and micro cells and a small cell network.

- We have question for that Ericsson's view for CLI mitigation method on subband operation in TDD carrier. Do you think current CLI mitigation method is enough for handling the advanced duplex? If any needs for enhancement of CLI mitigation method, what kind of scenario or technique need to be studied?

[Reply] During Rel-14 and Rel-16, CLI mitigation was studied and a subset of the studied techniques was specified. If there is a study in Rel-18, it is important that work that was already performed in prior releases is not unnecessarily repeated. Considering the practical challenges of effectively cancelling CLI, schemes that avoid CLI in the first place may be more realistic.

-Section 2.3.1 Do you think the full-duplex study should first start in RAN4 to identify applicable limitations and RF assumptions before RAN1 proceeds to system-level evaluations of gains/losses, or do you think this can be handled in parallel? Section 2.4 For the "TX split array" option which you evaluated, do you anticipate any limitation in terms of in-band filtering ability when switching between Tx/Rx and Rx only? Do you see the evaluated "full split array" or the "Tx split array" option as more realistic?

[Reply] It may be better for RAN4 to start earlier than RAN1, and this can be discussed. However, if there is a study, it is important that RAN4 at least starts concurrently with RAN1.

The in-band channel filtering needs to be further studied as fast reconfiguration between sub-bands in UL/DL case might be needed as well as fast reconfiguration to UL only timeslots.

4.1.1.4 Fraunhofer HHI

Thank you very much for the FD contribution which highlights important challenges in particular at the gNB side. We'd like to learn more about your view on the following aspects:

Q1: Assuming stationary deployments of gNB, inter-gNB CLI should mainly be based on dynamic beamforming of gNBs around or moving reflectors close to the ground, otherwise static. Pathological CLI cases could be observed by AI and avoided by coordination among the gNBs. Do you expect a need to extend coherent self-interference mechanisms from on-site SIC to across-site SIC?

[Reply] Cancelling CLI in addition to self-interference at the gNB will further add complexity to the gNB. Therefore, CLI avoidance mechanisms are preferable in general from a complexity perspective. However, mechanisms based on coordination can also result in scheduling restrictions that can adversely affect performance. If there is a study, these aspects need to be considered and gains with realistic constraints need to be assessed.

Q2: Do you expect specific new aspects/signals needed to be incorporated when extending the existing UE-2-UE CLI framework to cover gNB-2-gNB CLI as well? If so which are these aspects?

[Reply] Generally, gNB-gNB interference can be handled proprietarily when the gNBs are provided by the same vendor which is not feasible for UE-UE CLI. Some signaling over the backhaul has also been specified in Rel-16 to exchange information between gNBs. In general, gNB-gNB interference would need to be discussed separately from UE-UE interference if there is a study.

4.2 2nd round questions to the proposals on Full Duplex

Please provide your 2nd round questions to RWS-210295 in the below feedback form:

Feedback Form 6: 2nd round questions to the proposals on Full Duplex

1 – Spark NZ Ltd

FD appears attractive but accompanying with it is a lot of pain.

Consider this how will FD be implemented in a band with say three operators and the other two do not want to deploy FD.

Even if all operators agree to deploy FD, then it is relatively easy to mitigate self interference at the base station but a challenging task at the UE. there will also be UE to UE interference . At the base station one could use subtractive interference calculation but not at the UE where one would need to know the interferes from other UEs. regardless the computation overhead at the UE will be huge.

In many Asia Pacific countries we have co existence of 850 Mhz and 900 Mhz band where Tx band of one overlaps with Rx band of the other. This kind of situation is similar to FD. Co existence is only possible by TX and RX shaping filters and additional coupling loss via isolation.

for these reasons and more this study has many difficulties in practical implementation.

2 – Samsung Electronics Polska

Thank you for your very detailed replies. In Section 2.3.1 you evaluated the "TX split array" option and the "full split array" options as examples. Do you think that these different panel design approaches to

achieve spatial isolation should both be mandatorily evaluated in the R18 SI? For sure we'd also expect that different companies would want to include different antenna / ... panel design options into the RAN1 SLS and RAN4 RF & Coexistence study. Given that these fundamentally result in very different evaluations scenarios (potential gains may reduce depending and /or constraints be introduced), how important is it from your perspective to include a sufficiently meaningful variety of antenna / ... panel design options into the evaluated configurations?

4.2.1 Answers by the moderator

4.2.1.1 Spark NZ Ltd

FD appears attractive but accompanying with it is a lot of pain.

Consider this how will FD be implemented in a band with say three operators and the other two do not want to deploy FD.

Even if all operators agree to deploy FD, then it is relatively easy to mitigate self interference at the base station but a challenging task at the UE. there will also be UE to UE interference . At the base station one could use subtractive interference calculation but not at the UE where one would need to know the interferes from other UEs. regardless the computation overhead at the UE will be huge.

In many Asia Pacific countries we have co existence of 850 Mhz and 900 Mhz band where Tx band of one overlaps with Rx band of the other. This kind of situation is similar to FD. Co existence is only possible by TX and RX shaping filters and additional coupling loss via isolation.

for these reasons and more this study has many difficulties in practical implementation.

[Reply] We agree that cross-operator, cross-link interference from UE-UE can arise with Full Duplex arrangements and could risk causing degradations to neighbor operator networks if not managed. In our view, it is just as important to consider cross operator CLI within a study item as it is to consider co-channel (same operator) CLI.

For sub-band full duplex, since the UEs in the Full Duplex network transmit in the middle of the carrier, there is a much larger guard from the BWP used by the UE to the next carrier and so the interference can to some extent be mitigated. However, even if the guard is greater and the interference much easier to mitigate, it is not clear whether current RAN4 UE requirements are sufficient to avoid cross operator interference and this needs to be studied.

4.2.1.2 Samsung Electronics Polska

Thank you for your very detailed replies. In Section 2.3.1 you evaluated the "TX split array" option and the "full split array" options as examples. Do you think that these different panel design approaches to achieve spatial isolation should both be mandatorily evaluated in the R18 SI? For sure we'd also expect that different companies would want to include different antenna / ... panel design options into the RAN1 SLS and RAN4 RF & Coexistence study. Given that these fundamentally result in very different evaluations scenarios (potential gains may reduce depending and /or constraints be introduced), how important is it from your

perspective to include a sufficiently meaningful variety of antenna / ... panel design options into the evaluated configurations?

[Reply] In our view, a part of the study should include agreeing on one or (hopefully) a small number of realistic and meaningful reference architectures for evaluation. Companies should propose and motivate example architectures. We show these two architectures as examples but at this stage do not have a strong view that they have to be selected as architectures during the Study compared to other architectures. We welcome feedback and discussion in a Study as to what architecture is most relevant and realistic to evaluate.

5 TSG SA items impacting TSG RAN

5.1 1st round questions to the proposals on TSG SA items impacting TSG RAN

Please provide your 1st round questions to RWS-210490 in the below feedback form:

Feedback Form 7: 1st round questions to the proposals on TSG SA items impacting TSG RAN

5.1.1 Answers by the moderator

There were no questions.

5.2 2nd round questions to the proposals on TSG SA items impacting TSG RAN

Please provide your 2nd round questions to RWS-210490 in the below feedback form:

Feedback Form 8: 2nd round questions to the proposals on TSG SA items impacting TSG RAN

5.2.1 Answers by the moderator

There were no questions.

6 Positioning enhancements

6.1 1st round questions to the proposals on positioning enhancements

Please provide your 1st round questions to RWS-210315 in the below feedback form:

Feedback Form 9: 1st round questions to the proposals on positioning enhancements

1 – CATT

Questions:

In Section 2.3, “In coverage, partial coverage and out of coverage positioning support” is discussed with the following observation:

Observation 5 The current NR RAT-dependent and RAT-independent positioning solutions are able to cover the deployment scenarios for public safety and V2X.

However, in the proposed release 18 SI objectives, the following objective is included:

”Study and identify positioning support for all deployment scenarios in coverage, partial coverage and out of coverage scenarios in order to address positioning for public safety and V2X use-cases.”

Q1: If “The current NR RAT-dependent and RAT-independent positioning solutions are able to cover the deployment scenarios for public safety and V2X”, could you please specify the motivation of objective ”Study and identify positioning support for all deployment scenarios in coverage, partial coverage and out of coverage scenarios in order to address positioning for public safety and V2X use-cases”?

2 – Sony Europe B.V.

We generally support positioning for RedCap UE, and also the evolution of Positioning which include the integrity aspect for RAT dependent. These are indicated in our contribution RWS-210301.

1) On RAT-dependent integrity and reliability, would you consider that as RAN1-led item?

2) On RedCap positioning, would you consider that as a dedicated SI or a study within WI (e.g. enhanced RedCap)?

3 – InterDigital Communications

Do you expect impacts on physical layer specification for RedCap UE positioning? For example, is a new positioning method required for RedCap UEs (who are given limited resources for positioning)?

4 – Beijing Xiaomi Mobile Software

-

Q1: Do you think is there a need to define new accuracy requirement for RedCap positioning or just reuse the requirement defined for eMBB?

-

Q2: Do you think is there a need to have a short study phase to clarify the requirement for RedCap and perform the evaluation to see if there is gap to reach that requirement?

-

Q3: Do you think unlicensed band should be considered? If so, what frequency range is considered (e.g. 60GHz)?

-

Q4: For observation 5, we think Rel-17 positioning solutions can be used to perform absolute positioning for public safety and V2X, but for the relative positioning, if Rel-17 positioning solutions are used, it will be more complexity and lead high positioning latency compared to sidelink positioning. Moreover, even with the coverage enhancement solutions described in the contribution, we think the problem is still existed in the scenario of out of coverage case. So we think the sidelink positioning is necessary for Rel-18 positioning enhancements.

5 – Qualcomm Incorporated

With regards to Redcap positioning, it seems the focus of the paper is on RAN4 requirements for such devices, while there is a note on "RAN1 involvement to identify specific requirements & use-cases". What about RAN1-centric enhancements to get better performance for such devices?

6 – Spreadtrum Communications

Thanks for the well-written contribution, we have some questions.

For RedCap positioning □ what is the positioning KPIs ? Whether Rel-16/Rel-17 positioning can meet the requirements?

7 – ZTE Corporation

(1) 'Study and identify positioning support for all deployment scenarios in coverage, partial coverage and out of coverage scenarios in order to address positioning for public safety and V2X use-cases. [RAN1]' There will be outcome on this from the ongoing RAN SI (TR38.845), thus is it correct understanding that the consensus from the RAN SI for deployment scenarios can be used to guide the relevant normative work in RAN1 in terms of support?

(2) Could you please share some more detailed working method to deliver the integrity aspects of (SL) positioning?

8 – Samsung Electronics Polska

1. Could the redcap positioning only focus on the DL based method, to save power? E.g., remove the Multi-RTT.

2. Based on Observation 5, do you think that sidelink positioning in Rel18 is not necessary?

9 – MediaTek Inc.

Regarding out-of-coverage, is your intention that, whenever I may need to position somebody, I need to first deploy and activate e.g. 3 Base Stations in an area around the target for location, and either make sure that those users do not leave that area or that the area is dynamically adaptable? or do you see it as complementary to some sidelink positioning functionality?

10 – Guangdong OPPO Mobile Telecom.

Question:

From Observation 5, NR RAT-dependent/RAT-independent solutions can cover deployment scenarios for PS and V2X, is it for both absolute and relative positioning?

11 – LG Electronics Inc.

Q1: What positioning methods can be considered in area where there is neither a fully autonomous network nor an extended network access through IAB?

Q2: For RAT-dependent positioning integrity, could you explain expected normative work at RAN1 after that RAN1 works on identifying and analyzing the impact of error sources for different RAT-dependent positioning methods.

6.1.1 Answers by the moderator

6.1.1.1 CATT

In Section 2.3, “In coverage, partial coverage and out of coverage positioning support” is discussed with the following observation:

Observation 5 The current NR RAT-dependent and RAT-independent positioning solutions are able to cover the deployment scenarios for public safety and V2X.

However, in the proposed release 18 SI objectives, the following objective is included:

”Study and identify positioning support for all deployment scenarios in coverage, partial coverage and out of coverage scenarios in order to address positioning for public safety and V2X use-cases.”

Q1: If “The current NR RAT-dependent and RAT-independent positioning solutions are able to cover the deployment scenarios for public safety and V2X”, could you please specify the motivation of objective ”Study and identify positioning support for all deployment scenarios in coverage, partial coverage and out of coverage scenarios in order to address positioning for public safety and V2X use-cases”?

Answer: Thanks for your question. In our analysis, the current positioning solutions and deployment available are sufficient to cover PS and V2X use cases. For in coverage and partial coverage, there are obviously network based solutions based on network deployment and IAB for coverage extension. For out of coverage, GNSS solutions are available for outdoor. However, there is a RAN study currently assessing the issue, and should RAN1 decide to take in work to enable V2X and PS use cases, we are open to further study the issue in RAN1, based on the observation made on the RAN study.

6.1.1.2 Sony

We generally support positioning for RedCap UE, and also the evolution of Positioning which include the integrity aspect for RAT dependent. These are indicated in our contribution RWS-210301.

1) On RAT-dependent integrity and reliability, would you consider that as RAN1-led item?

Answer: Thanks for your question. No, we consider that RAT-dependent integrity is still a RAN2-led item, however, as it was already discussed in Rel-17 SI there are needs for RAN1 study on the error sources, etc.

2) On RedCap positioning, would you consider that as a dedicated SI or a study within WI (e.g. enhanced RedCap)?

Answer: Thanks for your question. We think that RAN4 requirement for the existing NR positioning methods with a reduced number of Rx branches at the UE side can be discussed in RedCap WI while other potential enhancements are discussed in a dedicated SI.

6.1.1.3 InterDigital

Do you expect impacts on physical layer specification for RedCap UE positioning? For example, is a new positioning method required for RedCap UEs (who are given limited resources for positioning)?

Answer: Thanks for your question. There could be some minor physical layer impacts allowing RedCap UEs to achieve higher performance when utilizing Rel. 16 positioning methods. New positioning methods should not be considered.

6.1.1.4 Xiaomi

Q1: Do you think is there a need to define new accuracy requirement for RedCap positioning or just reuse the requirement defined for eMBB?

Answer: Thanks for your question. RedCap UE is a mid-tier UE with lower complexity and/or lower power consumption' and lower performance than for MBB UEs have to be accepted. Still, we want to study the possibility to enhance the performance of Rel. 16 and Rel. 17 positioning methods for RedCap UEs. This should be based on a study of what is achievable by tweaking the current methods rather than starting from use case requirements.

Q2: Do you think is there a need to have a short study phase to clarify the requirement for RedCap and perform the evaluation to see if there is gap to reach that requirement?

Answer: Thanks for your question. We think a study phase is needed to evaluate RedCap positioning performance based on Rel. 16 and Rel. 17 positioning and to study potential tweaks of the Rel. 16 and Rel. 17 methods that could enhance positioning performance for RedCap UEs. We don't think it's necessary to define RedCap requirements.

Q3: Do you think unlicensed band should be considered? If so, what frequency range is considered (e.g. 60GHz)?

Answer: Thanks for your question. We think that in Rel-18 positioning we can focus on the discussion of enhancements for RedCap use cases, public safety and V2X use cases as well as further enhancements for general commercial use cases, and positioning in unlicensed band can be considered in future releases due to workload.

Q4: For observation 5, we think Rel-17 positioning solutions can be used to perform absolute positioning for public safety and V2X, but for the relative positioning, if Rel-17 positioning solutions are used, it will be more complexity and lead high positioning latency compared to sidelink positioning. Moreover, even with the coverage enhancement solutions described in the contribution, we think the problem is still existed in the scenario of out of coverage case. So we think the sidelink positioning is necessary for Rel-18 positioning enhancements.

Answer: We respect your opinion but don't see any question here to response.

6.1.1.5 Qualcomm

With regards to Redcap positioning, it seems the focus of the paper is on RAN4 requirements for such devices, while there is a note on "RAN1 involvement to identify specific requirements & use-cases". What about RAN1-centric enhancements to get better performance for such devices?

Answer: Thanks for your question. We think we have to accept worse performance for RedCap UEs than for MBB. We don't want to spend time setting up new requirements. Still we want to study if there are any minor tweaks of the existing Rel. 16 and Rel. 17 methods that would improve RedCap positioning performance. There could be some minor RAN1 impact. RedCap use cases and scenarios are needed to evaluate RedCap performance based on Rel. 16 and Rel. 17 positioning methods.

6.1.1.6 Spreadtrum

Thanks for the well-written contribution, we have some questions.

For RedCap positioning □ what is the positioning KPIs ? Whether Rel-16/Rel-17 positioning can meet the requirements?

Answer: Thanks for your question. We think that the positioning KPIs for RedCap positioning are related to use cases and include positioning accuracy, latency, availability, scalability, UE complexity and/or UE power consumption. Rel-16 and Rel-17 positioning support use cases for general commercial positioning and IIoT positioning while have not discussed RedCap positioning, so we expect that the use cases and corresponding positioning requirements for RedCap positioning can be discussed in Rel-18.

6.1.1.7 ZTE

(1) 'Study and identify positioning support for all deployment scenarios in coverage, partial coverage and out of coverage scenarios in order to address positioning for public safety and V2X use-cases. [RAN1]' There will be outcome on this from the ongoing RAN SI (TR38.845), thus is it correct understanding that the consensus from the RAN SI for deployment scenarios can be used to guide the relevant normative work in RAN1 in terms of support?

Answer: Thanks for your question. Yes, this is a correct understanding and how we think it is reasonable to work on this topic.

(2) Could you please share some more detailed working method to deliver the integrity aspects of (SL) positioning?

Answer: Thanks for your question. For integrity support, whether RAT-dependent (which is not yet standardized) or RAT-independent, there is still a need for assistance information sharing from the LMF and proper study of error sources in which the UE is experiencing, hence to us the discussion of integrity aspect of SL positioning is still a very vague discussion and requires much earlier fundamental studies.

6.1.1.8 Samsung

1. Could the redcap positioning only focus on the DL based method, to save power? E.g., remove the Multi-RTT.

Answer: Thanks for your question. We don't think removing Multi-RTT functionality would give any significant reduction in RedCap device cost. Whether to utilize Multi-RTT for RedCap UEs or not could be based on deployment, taking power consumption into consideration.

2. Based on Observation 5, do you think that sidelink positioning in Rel18 is not necessary?

Answer: Thanks for your question. There will be an outcome on the ongoing RAN SI (TR38.845), thus we believe the consensus from the RAN SI for deployment scenarios can be used to guide the relevant normative work in RAN1 in terms of support.

6.1.1.9 MediaTek

(1) Regarding out-of-coverage, is your intention that, whenever I may need to position somebody, I need to first deploy and activate e.g. 3 Base Stations in an area around the target for location, and either make sure that those users do not leave that area or that the area is dynamically adaptable? or do you see it as complementary to some sidelink positioning functionality?

Answer: Thanks for your question. No, we do not necessarily see it as complementary to some sidelink positioning functionality, but we believe that there will be a consensus from the RAN SI to guide us to the relevant normative work on the topic of sidelink positioning.

(2) From Observation 5, NR RAT-dependent/RAT-independent solutions can cover deployment scenarios for PS and V2X, is it for both absolute and relative positioning?

Answer: Thanks for your question. We agree that Observation 5 is mainly for absolute positioning. However, we should not forget that there are already RAT-independent positioning methods such as GNSS, WiFi, BT, sensors available in which some of them can be used to cover relative positioning as well. Note also that a reliable way of estimating a relative position between two devices is via estimated absolute positions of the two devices.

Q1: What positioning methods can be considered in area where there is neither a fully autonomous network nor an extended network access through IAB?

Answer: Thanks for your question. This is definitely a very challenging condition while we should not forget that there are already RAT-independent positioning methods such as GNSS, WiFi, BT, sensors available to cover such scenarios, however we assume such scenarios would be discussed in the current RAN SI study and we agree that RAN1 should decide to take in work to enable V2X and PS use cases, we are open to further study the issue in RAN1, based on the observation made on the RAN study. Out of coverage and out of RAT-independent positioning coverage is a very special case that can be handled in different ways for PS and V2X. For PS, temporary infrastructure can be considered, and for V2X extending the cellular network is the natural step especially given integrity aspects becoming more central.

Q2: For RAT-dependent positioning integrity, could you explain expected normative work at RAN1 after that RAN1 works on identifying and analyzing the impact of error sources for different RAT-dependent positioning methods.

Answer: Thanks for your question. We consider that RAT-dependent integrity is still a RAN2-led item, however, as it was already discussed in Rel-17 SI there are needs for RAN1 study on the error sources.

However, as it was considered in the RAT-independent integrity study and normative work in Rel 16 - this is mainly to identify and define the feared events, define the associated measurements and design the RAN2 signaling.

6.2 2nd round questions to the proposals on positioning enhancements

Please provide your 2nd round questions to RWS-210315 in the below feedback form:

Feedback Form 10: 2nd round questions to the proposals on positioning enhancements

1 – Huawei Tech.(UK) Co.. Ltd

Q1: Do you think it is possible to deploy an entire local core network to support LCS service, including AMF, LMF, GMLC, UDM?

Q2: Regarding extending integrity to RAT dependent, we understand the concerned use cases normally would also require onboard sensors, which determines the overall reliability, but may not be visible to standards. How could the protection level of such a high confidence as 99.9999% ($IR < 0.0001$) based on NR RAT-dependent method be useful?

Q3: Regarding REDCAP positioning enhancement with new RAN4 requirement considering reduced number of Rx branches, do you expect the change of side conditions? Shouldn't the existing side condition be based on any available single Rx branch?

2 – Beijing Xiaomi Mobile Software

Thank you for the response.

Your answers to Xiaomi's questions can be seen below:

- This should be based on a study of what is achievable by tweaking the current methods rather than starting from use case requirements.
- We don't think it's necessary to define RedCap requirements.

Your answers to Spreadtrum's questions can be seen below:

- Rel-16 and Rel-17 positioning support use cases for general commercial positioning and IIoT positioning while have not discussed RedCap positioning, so we expect that the use cases and corresponding positioning requirements for RedCap positioning can be discussed in Rel-18.

Our further question: Based on your above responses, we are a little confused on your opinion on redcap positioning use cases and requirements. What we should do for the use cases and requirements for redcap positioning in your mind?

3 – CATT

Q1: About the impact of RedCap positioning to the specification, we could understand Ericsson's responses "There could be some minor physical layer impacts allowing RedCap UEs to achieve higher performance

when utilizing Rel. 16 positioning methods” and “We think a study phase is needed to evaluate RedCap positioning performance based on Rel. 16 and Rel. 17 positioning and to study potential tweaks of the Rel. 16 and Rel. 17 methods that could enhance positioning performance for RedCap UEs.” But, it is unclear to us why Ericsson also says “We don’t think it’s necessary to define RedCap requirements.” In our view, there will be, at least, some impact on the RAN2/RAN4 specifications even there is no enhancement in PHY layer. Could Ericsson further explain why Ericsson does not think “it’s necessary to define RedCap requirements”?

6.2.1 Answers by the moderator

6.2.1.1 Huawei Tech.(UK) Co.. Ltd

Q1: Do you think it is possible to deploy an entire local core network to support LCS service, including AMF, LMF, GMLC, UDM?

[Answer] Thanks for your question. We believe that in case of local deployments, it is possible to consider the entire local core network support by introducing some local “boxes and moving out some interfaces. Especially with today’s virtualization capabilities, it’s certainly feasible to add CN functionality to e.g. a blade hosting a gNB-CU, for example. All this is possible today with no specification impact.

Q2: Regarding extending integrity to RAT dependent, we understand the concerned use cases normally would also require onboard sensors, which determines the overall reliability, but may not be visible to standards. How could the protection level of such a high confidence as 99.9999% (IR<0.0001) based on NR RAT-dependent method be useful?

[Answer] Thanks for the very good and interesting question. We agree on the impact of onboard sensors and having them outside the scope of the standards. On the other hand we also think perhaps the NR RAT-dependent integrity support may have lower confidence levels compared to RAT-independent integrity. However, providing support for enabling the NR RAT-dependent integrity is still beneficial and perhaps RAN1 can not only check the error sources but also the achievable protection levels based on RAT-dependent positioning methods.

Q3: Regarding REDCAP positioning enhancement with new RAN4 requirement considering reduced number of Rx branches, do you expect the change of side conditions? Shouldn’t the existing side condition be based on any available single Rx branch?

[Answer] Thanks for your question. Yes, we expect that the existing side conditions can be reused but that the requirement values will be affected.

6.2.1.2 Beijing Xiaomi Mobile Software

Thank you for the response.

Your answers to Xiaomi’s questions can be seen below:

- This should be based on a study of what is achievable by tweaking the current methods rather than starting from use case requirements.

- We don't think it's necessary to define RedCap requirements.

Your answers to Spreadtrum's questions can be seen below:

- Rel-16 and Rel-17 positioning support use cases for general commercial positioning and IIoT positioning while have not discussed RedCap positioning, so we expect that the use cases and corresponding positioning requirements for RedCap positioning can be discussed in Rel-18.

Our further question: Based on your above responses, we are a little confused on your opinion on redcap positioning use cases and requirements. What we should do for the use cases and requirements for redcap positioning in your mind?

[Answer] Thanks for your question. We don't think defining RedCap positioning target requirements in terms of a positioning accuracy is fruitful. There exist use cases that require very high positioning accuracy but RedCap devices are supposed to be low cost and to target such accuracies is therefore not reasonable. For cost reasons it's also not realistic to develop completely new positioning methods for RedCap positioning. Rather, existing signals and procedures should be reused, possibly with minor tweaks to enhance performance for RedCap UEs. A balance needs to be made between cost/complexity and positioning performance. Such a balance is hard to capture in requirement numbers and thus we think it's better that RAN1 makes that balance when discussing concrete enhancement proposals. In that discussion RedCap use cases and corresponding positioning requirements have a role. We think a potential SI scope should be to identify enhancements of existing positioning methods for RedCap UEs without significant impact on RedCap device cost. A potential technique could be frequency hopping RX of Rel. 16 DL PRS.

While we want to avoid defining target requirements for RedCap UEs, RAN4 requirements for RedCap devices are obviously needed and we also want to see an evaluation of RedCap positioning performance based on Rel. 16 and Rel. 17 positioning features.

6.2.1.3 CATT

Q1: About the impact of RedCap positioning to the specification, we could understand Ericsson's responses "There could be some minor physical layer impacts allowing RedCap UEs to achieve higher performance when utilizing Rel. 16 positioning methods" and "We think a study phase is needed to evaluate RedCap positioning performance based on Rel. 16 and Rel. 17 positioning and to study potential tweaks of the Rel. 16 and Rel. 17 methods that could enhance positioning performance for RedCap UEs." But, it is unclear to us why Ericsson also says "We don't think it's necessary to define RedCap requirements." In our view, there will be, at least, some impact on the RAN2/RAN4 specifications even there is no enhancement in PHY layer. Could Ericsson further explain why Ericsson does not think "it's necessary to define RedCap requirements"?

[Answer] Thanks for your question. We don't think defining RedCap positioning target requirements in terms of a positioning accuracy is fruitful. There exist use cases that require very high positioning accuracy but RedCap devices are supposed to be low cost and to target such accuracies is therefore not reasonable. For cost reasons it's also not realistic to develop completely new positioning methods for RedCap positioning. Rather, existing signals and procedures should be reused, possibly with minor tweaks to enhance performance for RedCap UEs. A balance needs to be made between cost/complexity and positioning performance. Such a balance is hard to capture in requirement numbers and thus we think it's better that RAN1 makes that balance when discussing concrete enhancement proposals. In that discussion RedCap use cases and corresponding

positioning requirements have a role. We think a potential SI scope should be to identify enhancements of existing positioning methods for RedCap UEs without significant impact on RedCap device cost. A potential technique could be frequency hopping RX of Rel. 16 DL PRS.

While we want to avoid defining target requirements for RedCap UEs, RAN4 requirements for RedCap devices are obviously needed and we also want to see an evaluation of RedCap positioning performance based on existing signals and procedures.