

3GPP TSG RAN Rel-18 workshop RWS-210609

Electronic Meeting, June 28 - July 2, 2021

Agenda Item : 4.3

Source : CAICT

Title : Email discussion summary for RAN-R18-WS-Crossfunc-CAICT

Document for : Discussion

1 Introduction

The document is to collect questions/comments for the docs provided by CAICT in Agenda 4.3 including:
RWS-210235 Views on AI based Physical layer enhancements [1]

RWS-210236 Introduction of the 1st Wireless communication AI competition(WAIC) [2]

2 Discussions

2.1 General aspects

RWS-210235 and RWS-210236 are all AI/ML related. The integration of wireless communication and AI becomes an important trend for the evolution of 5G. SA and RAN3 have already made some AI related studies and specification works for high layer. AI based physical layer enhancements could also be studied in R18.

2.1.1 1st round of questions/comments and answers

Feedback Form 1: 1st round of general questions and comments

1 – Futurewei Technologies

Futurewei is very interested in the 1st WAIC and would like to hear more on the details of the competition. We share the idea that new use cases, such as CSI overhead reduction, should be studied. And as AI/ML approach is data-driven, we also suggest considering using common datasets for at least testing identified use cases, using a common evaluation methodology, as discussed in RWS-210038.

Q1: The details of the 1st WAIC.

A1: The details of 1st WAIC are available in <https://arxiv.org/abs/2106.06759>.

Q2: Views on common dataset and evaluation methodology.

A2: We appreciate the concept of common dataset and evaluation methodology and open to discuss the details.

2.1.2 2nd round of questions/comments and summary

Feedback Form 2: 2nd round of general questions and comments

There are no further answers for the 2nd round.

2.2 Views on AI based Physical layer enhancements (RWS-210235)

RWS-210235 presents some potential AI based physical layer enhancements, e.g. CSI feedback, channel estimation, beam management, channel prediction, positioning, etc. We also provide a general view on the key issues of AI based PHY later enhancements. The proposed time plan is given in the last section.

2.2.1 1st round of questions/comments and answers

Feedback Form 3: 1st round of questions and comments

1 – ZTE Corporation

We already have an SI in RAN3. If RAN may have an SI, what is the relationship between this SI and the RAN3 SI?

2 – Spreadtrum Communications

Thanks for the contribution. We have some questions for clarification:

Q1: We noticed that phase 2 in your summary mentions RAN1/RAN2 level study follows the output of RAN level study. Then do you think in Rel-18 AI in high layer, e.g., RAN2, also is one study item? In our understanding, in Rel-17 there are good progress at AI in high layer. It is possible to start normative work in Rel-18.

Q2: We noticed that phase 2 in your summary starts to discuss data set construction. One question is about how to construct the data set, per use case, or per all use case?

Q3: There are many use cases listed in your contribution. Given that possible limited TU budget, do you consider the priority of the use case? If yes, what's the priority?

3 – vivo Mobile Communication Co.

Thanks for your efforts on this. We share similar views that AI/ML is one of the most important directions for NR 5.5G evolution. The arrangement of several phases in RAN/WG is reasonable to build consensus on this complicated study.

One detailed question: do we need any categorization or downselection of use cases in the RAN level for WG study? If needed, which criteria should we use to find out the appropriate one for WG study?

4 – Intel Technology India Pvt Ltd

thanks - what is your view on the criteria that should be used for use-case and scenario selection ?

5 – Futurewei Technologies

FUTUREWEI supports the view on the PHY layer use cases described in this contribution like CSI feedback design/compression, channel estimation and prediction are candidates to be considered as part of Rel-18. We also believe dataset construction or common dataset establishment is important in evaluating AI/ML-based functionalities as described in our proposal, RWS-210038, https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_210038.zip.

Some of the concepts and principles/guidelines introduced as part of Rel-17 RAN3 SI should be reused as much as possible and Rel-18 can focus on any new additions on top of that. Feel free to provide feedback on our contribution at: <https://nwm-trial.etsi.org/#/documents/4751>

6 – CATT

Thanks for the contribution. A 6-9 month RAN level study before WG study/work is a reasonable way to go in our view.

Q1: Can you share your views on how to construct dataset for evaluation of AI model?

Q2: Regarding verification on Page 13, what's the difference from simulation? Is it the intention to develop some dedicated hardware/software to perform verification?

7 – Lenovo (Beijing) Ltd

Thanks for sharing, and we also agree to start the investigation on AI/ML for PHY enhancement in 3GPP. As you mentioned, it is much different with our traditional ways-of-working, so we need to carefully define how to study and what to be studied in different phases and expected outputs as the *methodology*.

On your proposals in Page 15, we have following questions:

Q1: What do you mean 'Whole pictures for AI based PHY layer enhancements'? Does it mean a *framework* for PHY as indicated in our contribution RWS-210260?

Q2: What's your opinion to involve the overhead of training and possible tuning, when being compared with the baseline?

Q3: Don't you think the supports from RAN4 are needed in Phase 2, if any baseline is needed for comparison?

8 – HUAWEI TECHNOLOGIES Co. Ltd.

Thank you very much for the contribution. We have one question for clarification as below:

Q1. For phase I RAN level study, what kind of guidelines needed for specification works? It would be appreciated if you can provide some example here.

Q1: What's the relationship between RAN and RAN3 SI/WI?(ZTE and Spreadtrum Q1)

A1: Our thinking is that the SI in RAN3 for high layer is the starting point for RAN level study. The normative works for high layer in R18 could be operated in parallel.

Q2: How to construct the data set, per use case, or per all use case?(Spreadtrum Q2, CATT Q1, Futurewei)

A2: We think per use case dataset construction is the basis of performance verification. Most of the physical

layer enhancements based on AI require channel information as the basic dataset for training, e.g., CSI feedback, DMRs estimation, positioning, channel prediction. From this point of view, it is a good way to build dataset based on the existing 3GPP channel model to support research and verification.

We also observe that different use cases in the same channel environment may share the same dataset, such as channel prediction and channel estimation. It's a good idea to use common datasets for at least testing identified use cases. The construction method and supporting use cases need to be discussed further.

Q3: What is the priority of the use case and selection criteria? (Spreadtrum Q3, Intel, vivo)

A3: We found that lots of AI based physical layer enhancements were proposed from different companies. AI based CSI feedback enhancement has been widely studied in academic and has also been selected as the subject of 1st WAIC. At least for RAN1 level study, AI based CSI feedback enhancement should be included.

For use cases selection, priorities are not easy to give. There are some traditional criteria for reference, such as performance gain, specification effects. From the point of view of AI, we can also consider the model complexity, training difficulty, model generalization ability and so on. AI based algorithm is more complex than the traditional communication algorithm and is strongly related to the dataset. Before system verification, the above criterias are difficult to be applied for use case selection. We believe the process of use case selection is very important and should be studied in RAN level. The categorization method given in RWS-210170[3] is a good example.

Q4: Regarding verification on Page 13, what's the difference from simulation? Is it the intention to develop some dedicated hardware/software to perform verification?(CATT Q2)

A4: The development of verification tools is an important part in the process of productization. We hope that the simulation method in the study phase could also be used to the development of verification tools.

Q5: What do you mean 'Whole pictures for AI based PHY layer enhancements? Does it mean a framework for PHY as indicated in our contribution RWS-210260?(Lenovo Q1)

A5: To our understanding, there are several aspects should be included for the whole pictures for AI based PHY layer enhancements. Obviously, a framework as mentions in contribution RWS-210260 is an important part. Some consensuses on the specification phases and potential use cases should also be included.

Q6: What's your opinion to involve the overhead of training and possible tuning, when being compared with the baseline?(Lenovo Q2)

A6: If online training is used, it is necessary to consider the overhead of training and possible tuning.

Q7: Don't you think the supports from RAN4 are needed in Phase 2, if any baseline is needed for comparison?(Lenovo Q3)

A7: The supports from RAN4 are use case specific. The initial study may be more RAN1/RAN2 specific and if any RAN4 related work is identified, then RAN4 should be involved.

Q8: For phase I RAN level study, what kind of guidelines needed for specification works? It would be appreciated if you can provide some examples here.(HUAWEI)

A8: The guidelines could include the consensuses on use case, dataset, AI model and framework related. For example: the criterion of use case categorization and selection, principle of dataset construction, reference AI model, specification frameworks in RAN.

2.2.2 2nd round of questions/comments and answers

Feedback Form 4: 2nd round of questions and comments

There are no further questions and answers for the 2nd round.

2.2.3 Summary

AI based physical layer enhancements are proposed in this contribution. Questions and comments are related to use case selection, dataset construction, AI model training and work plan. The answers for each questions/comments are provided.

In general, it is the first time that AI based physical layer enhancements are discussed in RAN. Before the detail study of simulation methodology and performance verifications, some consensus on use cases selection, dataset construction, AI models, computation resources distribution and specification frameworks are beneficial not only for the study and specification works in RAN but also for the industry to understand the process of wireless and AI integration in 5G evolution.

2.3 Introduction of the 1st Wireless communication AI competition(WAIC) (RWS-210236)

RWS-210236 provides a detail description of the 1st wireless communication AI competition (WAIC). Full-CSI feedback is chosen as the competition subject and 3GPP Uma with modified parameters is used as the dataset. The enhanced schemes appeared during the competition are also listed. The competition results show that AI/ML based solutions have good potentials in solving wireless communication problem.

2.3.1 1st round of questions/comments and answers

Feedback Form 5: 1st round of questions and comments

1 – Spreadtrum Communications

Thanks for the contribution. Thanks for the great effort of the WAIC to promote AI development in wireless communication.

In this paper, data set for CSI compression and recovery is generated based on 3GPP channel model. We are a little curious how it to match the real environment, for the real communication environment is dynamic and complex.

Last, we are Looking forward to the next magical WAIC, and if possible, tightly combined with reality scenario is better and preferred.

2 – Intel Technology India Pvt Ltd

thanks - this is great information. Is there more information available on the details of NN based solutions and comparison with existing Type II codebooks?

3 – Sony Corporation

Thanks for the contribution. We have a question.

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Full CSI feedback with AI encoder/decoder can compress bits from 24576bits to 286bits with NMSE<0.1. Does this evaluation consider the wireless channel model? Are there any bit error between UE and BS?

4 – Apple Hungary Kft.

Would like to understand is the proposed RAN level study focus on the PHY centric use case? If so, why not in RAN1 directly? If not, how is it related to the ongoing RAN3 led SI?

Q1: What's the considerations on the relationship between 3GPP model and real environment in the 1st WAIC?(Spreadtrum)

A1: 3GPP channel model is constructed based on the abstraction of real environment. We choose 3GPP Uma model as the dataset to explore the AI model capability in complex wireless environment. For real world deployment, for different scenarios, AI model should be retrained and tuning.

Q2: Is there more information available on the details of NN based solutions and comparison with existing Type II codebooks?(Intel)

A2:The details descriptions of 1st WAIC could be found in <https://arxiv.org/abs/2106.06759>. Type II codebooks is eigenvector-based CSI feedback and we will provide the directly comparisons between existing Type II codebooks and AI-based CSI feedback in the 2nd WAIC which will be online in next week.

Q3: Full CSI feedback with AI encoder/decoder can compress bits from 24576bits to 286bits with NMSE 0.1. Does this evaluation consider the wireless channel model? Are there any bit error between UE and BS?(Sony)

A3: We assume ideal feedback channel between UE and BS and the feedback bit error rate is set to zero.

Q4: Would like to understand is the proposed RAN level study focus on the PHY centric use case? If so, why not in RAN1 directly? If not, how is it related to the ongoing RAN3 led SI?

A4: We think this question is more related to RWS-210235. We suggest a RAN level study to capture the overall views for 5G and AI integration in RAN, including not only AI for RAN but also RAN for AI as proposed in RWS-210052[4]. We believe a high-level SI in RAN is helpful for the industry to have a more comprehensive understanding of how to carry out the integration of wireless communication and AI in 5G evolution. At the same time, the study in RAN could also provide an overall planning for the use cases that could be supported in 5G-Advanced to avoid the fragmentation of standards.

A RAN level study could capture all use cases not only PHY centric but also high layer in RAN and provide the guidelines for RAN1 SI/WI. PHY centric use cases are more complicated than high layer cases. Use cases selection, dataset construction, AI models, computation resources distribution and specification frameworks related consensus could also be captured in RAN level study to guide the works in RAN1.

2.3.2 2nd round of questions/comments and answers

Feedback Form 6: 2nd round of questions and comments

There are no further questions and answers for the 2nd round.

2.3.3 Summary

Competition is a good way to involve forces from different areas to solve typical wireless problems with AI/ML tools. The 1st WAIC has chosen Full CSI feedback as competition task and the details are available in <https://arxiv.org/abs/2106.06759>. The 2nd WAIC is online now with two tracks: AI-based Channel State Information Feedback and AI-based Channel Estimation. The 2nd WAIC will last till the end of August and the website is <https://www.datafountain.cn/special/IMT-2020-2?lang=en-US>.

3 Reference

- [1] RWS-210235 Views on AI based Physical layer enhancements CAICT
- [2] RWS-210236 Introduction of the 1st Wireless communication AI competition(WAIC) CAICT, OPPO
- [3] RWS-210170 Study on AIML based air interface enhancement in Rel-18 vivo
- [4] RWS-210052 Motivation of study of RAN enhancement for AIML OPPO