RAN-R18-WS-crossFunc-ZTE - Version 0.0.1
RAN

3GPP TSG RAN Meeting Rel-18 workshop **RWS-210650**

e-Meeting, June 28th –July 2nd, 2021

Source: **ZTE, Sanechips**

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

Agenda Item: **4.3**

Document for: **Discussion and Decision**

1 Introduction

This document summarizes the discussion on ZTE contributions [1-10] submitted to the agenda item 4.3.

[1] RWS-210478, Support of Artificial Intelligence Applications for 5G Advanced, ZTE, Sanechips

[2] RWS-210481, Enhancements on predictable mobility for beam management, ZTE, Sanechips

[3] RWS-210483, Enhancement for data collection for AI in NR and EN-DC, ZTE, Sanechips

[4] RWS-210479, Uplink Enhancements for 5G Advanced, ZTE, Sanechips

[5] RWS-210480, Support of Blockchain for 5G Advanced, ZTE, Sanechips

[6] RWS-210482, Further enhancement of RAN slicing, ZTE, Sanechips

[7] RWS-210484, Discussion on Network Coding for 5G Advanced, ZTE, Sanechips

[8] RWS-210485, Further enhancement for IDLE/INACTIVE, ZTE, Sanechps

[9] RWS-210486, Discussion on network power saving for 5G Advanced, ZTE, Sanechips

[10] RWS-210487, Cross-link interference coordination, ZTE, Sanechips

The following is the timeline of the discussion:

Round 1 Q&A:

- Questions: June 14 08:00 UTC – June 17 8:00 UTC;

- Answers: June 17 8:00 UTC – June 18 23:59 UTC

Round 2 Q&A:

- Questions: June 21 08:00 UTC – June 23 8:00 UTC;

- Answers: June 23 8:00 UTC – June 24 18:00 UTC

Before June 25 18:00 UTC, email discussion summary is to be uploaded.

2 General comments

Please provide any general comments on the contributions [1-10] in this section.

Feedback Form 1: General comments

3 Summary of Q&A and comments on contributions

3.1 RWS-210478 Support of Artificial Intelligence Applications for 5G Advanced

In RWS-210478, we share our views and initial study results for enhancing 5G NR based on AI/ML. We propose to have at least an SI in Rel-18 for this topic. The proposed SI objectives include the following.

- Identify use cases to enhance NR air interface based on AI, including but not limited to the following ones [FFS: RAN or RAN1/RAN2]

- CSI feedback/prediction

- Beam management/mobility prediction

- Reference signal overhead reduction

- Positioning

- Study evaluation methodology and evaluate AI based schemes for the identified use cases [RAN1, RAN2]

- Note: Evaluation methodology includes evaluation assumptions, data set construction, used AI model, assumptions of training procedure for AI, etc.

- Study potential specification enhancements for the identified use cases [RAN1, RAN2]

Based on our initial study, AI/ML based enhancement on the above use case can bring good gain over the current NR air interface. Our detailed views on evaluation results, evaluation methodology, potential specification impact and scheme categorization are also presented in RWS-210478.

3.1.1 Round 1

Feedback Form 2: Round 1 comments to RWS-210478

1 – Apple Computer Trading Co. Ltd

In general, we share the same view on the scope of this potential SI withe regard to the potential use case and procedure. We have one question regarding the study of evaluation methodology, in our view, this can be a RAN1 work only, what would be the potential RAN2 work about it?

2 – Lenovo (Beijing) Ltd

Thanks for the quality contribution. We also think it is necessary to investigate the possibility of AI/ML for physical layer enhancement. Because this kind of solutions (i.e., data-driven) is much different with the traditional ones (i.e., model-based), we need to pay much more attentions on the evaluation methodology from RAN aspect, including assumptions, data set construction and results evaluation. In your proposals, we have a question that do you think whether the 'used AI model' and 'assumptions of training procedure for AI' are needed for evaluation?

3 – vivo Mobile Communication Co.

Thanks for your effort on this. We share similar view that AI/ML application over air interface is one of the most important directions for NR evolution. This should be thoroughly studied in RAN.

A few questions on the details as following:

Q1: For the study on use case and evaluation methodology, are they conducted in parallel or sequentially? If conducted sequentially, which one need to be studied first?

Q2: We notice the following proposal on RAN3 item to focus on higher layer aspects and RAN1 item to focus on PHY layer aspects. Is it correct understanding that for those related to air interface but not directly related to PHY layer (e.g. mobility related) would also need to be studied in RAN3? Or are they not studied?

"Follow-up normative work should be setup in Rel-18 considering the popular AI use cases identified in RAN3 focusing higher layer impacts. Study on AI applications in physical layer can be considered to start the AI standardization work on PHY for 5G Advanced."

Q3: For the evaluation methodology, we notice the following is proposed to have independent large-scale parameters for training and inference. Is it correct understanding such independent way of data set construction would prevent exploiting learning on radio environment?

"For system-channel model, parameter randomization is still needed for training and inference including some large-scale parameters, like delay spread, angular spread,

4 – Xiaomi Communications

[Xiaomi]:

Thanks for the good contribution and very intestring simulation results. Xiaomi is also intrested in this topic.

As you mentioned in your contribution, the target use case of AI is quite wide. Some use case requires link-level simulation and some other use cases require system-level simulation. What is your consideration on how to handle the use cases requiring different simulation types? Considering the methodology and parameters in link-level simulation are much simpler than that in the system-level simulation, maybe we could firstly start the discussion on the link-level use case.

5 – CAICT

We also see the four use cases as important candidates for Rel-18 study. One question on Page 10, how do you generate the SNR for training and inference? Is same or different SNR used?

6 – Guangdong OPPO Mobile Telecom.

Thanks for interesting paper. We in general think AI/ML is very important topic to be discussed in Rel18. Here are few questions and comments:

Q1: can you elaborate how can AI/ML help to improve positioning accuracy?

Q2: In slide 10, is the same channel estimator used for both eTypeII and AI-based solution?

Q3: In slide 10: Are the parameter settings optimized for eTypeII?

Q4: In TR 37.817 there is also a use case called mobility optimization. We just wonder what will be the difference compared to what have been done in RAN3 data collection study?

Q5: how can companies calibrate simulation assumption considering the AI/ML algorithm will be taken as black box?

7 – China Mobile Com. Corporation

1□ P13 second bullet: The parameters used for training/inference may not be independent, for example, delay spread and angular spread are relevant. Why to make the parameters independent?

2□P14 second bullet: For each identified use case, various AI models/training procedure may be applied. We think whether and how to align the AI models should also be considered.

8 – LG Electronics France

Q1) Would you please clarify the preferred use cases in the "Follow-up normative work in Rel-18 in RAN3 mentioned in slide 3?

Q2) Do you think the study also need to study enhancements to radio interface for adoption of ML to ensure inter-operability and performance guarantee, e.g., study on how to provision ML model between UE and network, and how the prediction task affects existing procedures and etc, possibly RAN2-led issues)?

9 – Intel Technology India Pvt Ltd

What is ZTE's view (in terms of scope) on the details of NN structures, weights etc. as part of Rel-18 study and for later specifications?

10 – Futurewei Technologies

FUTUREWEI supports the PHY layer use cases introduced in this contribution, like CSI feedback/prediction, beam management/mobility prediction, and RS overhead reduction. We also believe common evaluation methodology is important and should be clearly specified for identified use cases. Regarding the "assumption for training procedure should be discussed" phrase, we suggest adding some clarification to better understand the purpose and reason why it is needed.

As AI/ML-based approach is data-driven and data-dependent, we propose to establish common datasets for selected use cases to facilitate performance evaluation and benchmark comparison as described in our contribution, RWS-210038. We also introduced a few other use cases like mmWave blockage prediction, MCS selection and multi-functional-block PHY layer optimization. Please check our paper at https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_AHs/2021_06_RAN_Rel18_WS/Docs/RWS-210038.zip and feel free to provide your feedback at: https://nwm-trial.etsi.org/#/documents/4751

11 – Motorola Mobility UK Ltd.

Thank you for the interesting contribution. My question is related to your proposal in the ***"CSI compression feedback based on AI"*** section, which reads *"AI algorithm can compress the channel coefficient vectors in both spatial and frequency domain to a new coefficient vector with smaller size, to optimize the system performance vs. overhead"*. In our understanding, networks under the current spec can configure a fewer number of CSI-RS ports (e.g., using CSI-RS beamforming) and larger CQI sub-band size, and use AI/ML-based schemes transparently to extrapolate the channel corresponding to more antenna ports and narrower sub-bands, respectively. In light of that, can you please clarify how you envision the specification impact of AI/ML-based spatial and frequency CSI feedback compression?

12 – CATT

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

Q1: On page 5, for predictable mobility, does UE have to move along a fixed trajectory? Is the training data collected along the fixed trajectory? What is the non-AI based prediction algorithm?

Q2: On page 10, how is the neural network trained in the simulation? Is it per-UE trained or per-cell trained? Is it online or offline? Is the overhead of exchanging AI model counted as feedback overhead in the simulation results?

Q3: On positioning use case, how is the neural network trained in the simulation? Is it per-UE trained or per-cell trained?

Q4: On evaluation methodology, please clarify how parameter randomization is done for large scale parameter for training and testing data. Even with the same channel model, companies may generate very different data set. How to make sure that the results are comparable between companies?

Q5: Specification enhancements for different use cases may be very different. Studying specification enhancements to all identified use cases (e.g., CSI, beam management, reference signal, positioning) in a single study item would involve a large group of experts and large amount of work. What's ZTEs view on how to progress the study?

13 – LG Electronics Inc.

Thanks for the contribution. In the last slide, it includes a possible approach that RAN-level study for AI use cases and WG-level study for evaluation methodology for AI, which makes some sense due to the diverse use cases of AI. In this case, is it intended for parallel work or sequential work in RAN and WG (e.g. starting WG study after finishing RAN study)?

14 – NEC Corporation

We share most of the companies' view that use cases, evaluation methodology and specification impact should be included in the SI. And we think the use cases should be given higher priority because it will decide how to work for the other 2 motivations. Whether it is RAN, RAN1, or RAN2 working scope can be further discussed.

15 – China Unicom

We have comments on RWS-210483

1. How to generate the Location/trajectory/load prediction required data?
2. What is the common interface enhancement procedure?

3.1.2 Round 1 reply

Feedback Form 3: ZTE's reply to Round 1 comments

1 – ZTE Corporation

To comment #1 from Apple

The study of evaluation methodology is mainly in RAN1. There can be some potential work in RAN2 depending on the use cases to be studied. For example, if higher layer aspects of mobility are studied, there can be some discussion on evaluation in RAN2.

2 – ZTE Corporation

To comment #2 from Lenovo

Our consideration on "assumptions of training procedure for AI" means we should discuss, or at least companies should report, whether online training or offline training is used in the evaluation. This has impact on the observed gain and specification change.

Re "used AI model", we think at least companies should report the used AI model when presenting the simulation results, so that other companies can try to verify/double-check the simulation observations.

3 – ZTE Corporation

To comment #3 from vivo

Q1:

We think they can be studied in parallel in WGs during Rel-18 time frame. For example, we expect during the scope discussion for Rel-18 (in the second half of 2021), we will achieve a small set of use cases to be studied. After entering Rel-18, we can perform study potential solutions on these use cases and evaluation methodology in parallel.

Q2:

We don't have such hint in this proposal, and which way is better can be further discussed. Take mobility as an example, we think it can be studied either in RAN1 SI or RAN3 WI.

Q3:

It does not mean all the large-scale parameters should be generated independently. Some parameters which is important to broaden the utilization of the trained AI model should be generated independently. How to generate the detailed parameters is up to the discussion of evaluation methodology in RAN1, by considering the balance between the learning of radio environment and broadening the utilization of the trained AI model.

4 – ZTE Corporation

To comment #4 from Xiaomi

We think if different use cases requires different evaluation methodologies, we should discuss and use different evaluation methodologies for them. The potential prioritization of use cases should depend on potential benefit and companies' interest level, rather than which evaluation methodology is used. We expect RAN can conclude a small set of use cases during the Rel-18 scope discussion in the second half of 2021.

5 – ZTE Corporation

To comment #5 from CAICT

Thanks for the good question. We generate the SNRs for training and inference independently within an SNR range, i.e., they can be different.

6 – ZTE Corporation

To comment #6 from OPPO

Q1:

AI can learn a hidden relationship between channel matrix (e.g., time-domain channel response) and the accurate UE location (which is known in training) during training procedure. This trained model/relationship can be used to improve the positioning accuracy during inference phase based on our study and simulation.

Q2:

We used the error model specified for SLS for a given SNR. This modeling is same for eType II and AI inference.

Q3:

We used the parameter setting (codebook parameter combination) given in Rel-16 specification.

Q4:

What we consider here is mainly relevant to intra-cell/TRP beam switching and L1/L2-centric inter-cell mobility. Based on that, the main efforts corresponding to this predictable mobility also focus on beam management aspects. A detailed example can be seen in the upper left figure in Page 8.

Q5:

For calibration, if there is such step, what we have in mind is companies can calibrate their simulation results based on a given (or a small set of) reference model. Companies can improve the model during their evolution of different schemes, but they should report the used model when presenting their results.

7 – ZTE Corporation

To comment #7 from CMCC

P13:

Please see our reply to vivo's Q3. The reason of independently generating some large-scale parameters is to make sure the model can be broadly utilized for inference. Some parameters relevant to the target scenario can be same for training and inference. The two parameters mentioned in this slide are just examples. The detailed generation is to be discussed in RAN1 considering the balance mentioned in our reply to vivo's Q3.

P14:

Yes, to some degree how to align the model can be discussed, e.g., for calibration purpose. But in principle the detailed AI model should be strived to be implementation issue and reported by each company in evaluation discussion.

8 – ZTE Corporation

To comment #8 from LGE France

Q1)

This means the potential follow-up WI of the Rel-17 AI SI in RAN3 on data collection, which we think should be independent and in parallel with the proposed air interface work. Please refer to section 3.3 (RWS-210483) in this NWM document.

Q2)

Yes, these issues can be discussed and studied for the use cases proven to have benefit. I think what you mean includes how to align the model used in UE and gNB, and other necessary change on the existing procedure in RAN2. These can be discussed under the third bullet of the proposed SID, i.e., potential specification enhancement.

9 – ZTE Corporation

To comment #9 from Intel

We think we should strive to make the details of NN (including weights) to be implementation. There can be some discussion during the study and evaluation, e.g., companies should report the AI model they use for evaluation. But from specification impact perspective, we should strive to avoid the model details to be specified. Then if AI is implemented in both UE and gNB sides, some spec enhancement to align the used AI model may be needed.

10 – ZTE Corporation

To comment #10 from Futurewei

On "assumption for training procedure should be discussed", it basically means whether offline training or online training is used. We think for any evaluation on proposed schemes during the SI, companies should report whether they assume or use online training or offline training. This is necessary to understand the gain and potential specification impact.

11 – ZTE Corporation

To comment #11 from MotM

First of all, the alternative approach you mentioned requires UE specific CSI-RS which will cost large CSI-RS overhead. Further, Rel-17 has excluded the enhancement on CSI-RS overhead reduction. This restricts the benefit that can be achieved in real world.

Secondly, we think to use joint training and inference for both UE and gNB sides can help to improve the compression itself over legacy DFT based compression. This is where the gain comes from. It can work together with things you mentioned, like subband/CSI-RS optimization.

In terms of specification impact, we think at least the input of the AI model should be discussed, e.g., which channel matrix to be compressed, the best dimension(s) to perform compression, the suitable parameter settings, etc. Further, there can be some enhancements on how to align the AI model used by UE and gNB, etc.

12 – ZTE Corporation

To comment #12 from CATT

Q1:

No, it does not have to be fixed trajectory. Trajectory prediction/selection can also be contained in the AI model. In our evaluation, we already consider trajectory selection among multiple railway tracks, directions and random users near these tracks. The non-AI algorithm is based on traditional mathematical approach, e.g., to use average based method to predict velocity.

Q2:

In our thinking and evaluation, training is performed offline. The trained AI model is common at least for all the UEs in a cell. In fact, it can be same for all the cells and UEs in a trained scenario. Since the training is offline, there is barely any overhead to exchange AI model.

Q3:

Similar as in Q2, the AI model is trained offline. The trained AI model is common for all the cells and UEs in a trained scenario.

Q4:

For example, some parameters like SNR or noise power can be generated independently for training, and testing with a random value subject to a distribution. Even if companies generate different data set, as long as the approach to generate the data set is aligned, results can be comparable. This is similar as what we are doing in SLS now. We don't restrict companies to use a same set of channel matrix entries, but we just align the approach to generate the channel matrices.

Q5:

We agree specification impact for different use cases can be different. At current stage we are open on how to progress the study. If companies think the workload to study all the specification impact is too high in one release, we can span this part in multiple releases. For example, we can select a subset of higher-priority use cases for specification enhancement study or work in Rel-18.

13 – ZTE Corporation

To comment #13 from LGE Inc

We think whether a RAN-level study is needed requires further assessment. It depends on the discussion during the scope-discussion phase before Rel-18 starts. If a small set of use cases can be identified, we probably do not need the RAN-level study.

If we may need the RAN-level study, we think some WG work, e.g., evaluation methodology discussion, can work in parallel with the potential RAN study. In any case, we don't need a long study phase in RAN as most of the aspects require very technical discussion.

14 – ZTE Corporation

To comment #14 from NEC

Thanks for the comment. We have similar view. On how to organize the potential SI, please see our reply to LGE's question in #13.

15 – ZTE Corporation

To comment #15 from China Unicom

These are questions to our RAN3 AI WI proposal RWS-210483. Please see in Section 3.3.2 for the reply.

16 – ZTE Corporation

Last but not least, we thank all the good questions and comments on this potential Rel-18 item. If you have any further or follow-up comments/questions, please feel free to raise them in Round 2.

3.1.3 Round 2

Feedback Form 4: Round 2 comments to RWS-210478

1 – China Unicom

Q1. Considering load balancing and mobility, load prediction maybe not only for cell-level load prediction. For some types of service, the service continuity and data rate are new requirements for mobility. Whether the UE-levev load prediction also need to consider in AI prediction?

2. Is there some scenarios that gNBs share the prediction information and transfer via the Xn/Ng?

2 – Samsung Electronics Polska

For mobility prediction, the AI model is running on UE devices? (page 6) If it is, then delay caused by communication between UE and gNB should be considered when evaluate performance, since such delay may cause performance degradation, especillay when beam dwelling time is small. Also, what information is exchanged between UE devices and gNB for mobility prediction?

For HST beam prediction, is only RRH index and time stamp are required as input of AI algorithm for inference?

3 – MediaTek Inc.

Thanks for the contribution, two general questions for clarification:

(1) Does ZTE have any priority of specific higher-layer use cases for AI/ML?

(2) Does ZTE have any target parameters for evaluation methodologies?

4 – Guangdong OPPO Mobile Telecom.

Thanks for your reply. We have some further questions as below:

1. In the proposals for evaluation methodology, only 3GPP channnel model is suggested for training/test data generation. The 3GPP channle model is well-modeled. In theory, it is easier for AI to get the information of its structure. Not sure how the performance is when the trained AI model is applied to practical channels. Do you have any plan to get some measurement in the field for the training/test data set?

2. Do you have any plan on the data sharing? Does each company generate its training/test data set based on the same channel model (likely to share the same value of the most/all parameter? or Do all compnanies use the same data set generated by some one?

3. For the AI-based positioning, what's the spec impact? Can it be done by implementation?

4. P11, the AI mechanims itself seems not to have spec impact. "More flexible DMRS indication" is proposed by some companies without metioning AI.

5 – NTT DOCOMO INC.

We are also interested in AI-aided beam management.

In page 6, you mentioned two AI deployment cases, on BS side and UE side. For AI on BS, what is the potential specification impact in your mind? Since how to select the beam is up to gNB, it seems that this AI-aided approach could be achieved even in the current specification.

Regarding UE deploying AI, is the AI algorithm shared between UE or is it UE-specific? When it is shared, how to transfer the AI algorithm between UEs can be another issue in our view.

3.1.4 Round 2 reply

Feedback Form 5: ZTE's reply to Round 2 comments

1 – ZTE Corporation

Firstly, we would like to thank all the companies for their careful reviews and good questions in both round 1 and round 2. We expect to work together with companies in 3GPP and organize discussion on the use cases which attract wide interest, to investigate the great potential of using AI/ML on NR air interface.

2 – ZTE Corporation

To comment #1 from China Unicom

Thanks a lot for the questions.

For your first question, we are sure that load prediction can't preclude the UE-level AI based-load prediction. Besides, for load balancing, in Rel-17 SI, we can first focus on studying the cell-level load prediction and its standard impacts, because load prediction is also benefit to the network energy saving and mobility decision.

Then, for your second question, the predicted information should be shared, which the NG-RAN node can make optimization decision or train its AI model further with predicted information from neighbour NG-RAN nodes.

3 – ZTE Corporation

To comment #2 from Samsung

Thanks for the questions.

First, we would like to clarify that P6-8 are all for a same issue, which is L1/L2 centric mobility based on beam prediction.

For the first question on AI host, the AI model is actually running on NW side in our thinking. The upper-left figure in P6 means BS collects information reported by UEs and generate the actions (e.g., beam switch) UEs need to take in the next period of time. These actions can be indicated by BS through dynamic signaling so that the latency can be minimized. We in general agree that this prediction can be performed by UE as well. But as you pointed out, there can be extra latency caused by UE reporting such prediction to gNB. These aspects can be studied further. According to our current evaluation, the impact of extra latency may be very few (maybe, only relevant to starting point of this predictable approach) due to the fact that, if the gNB can be aware of the time point corresponding to a given measurement exactly, the extra latency for the subsequent beam indication can be well compensated by AI-based approach.

For the second question on the exchanged information, our solution is provided in the upper-right figure of P8. This figure is implemented in BS side, where the input includes ToA, beam ID and RRH ID, derived

from UE's reporting of its measurements in multiple time instances. So in our view, the exchanged information should be UE reporting which can at least provide the above three pieces of information. We are also open to discuss other types of information.

For the third question on the input of AI model, we have already clarified this in the answer to the second question. The input includes ToA, beam ID and RRH ID of multiple instances.

4 – ZTE Corporation

To comment #3 from MediaTek

Thanks for the questions.

(1) We expect this study is mainly for use cases identified by physical play aspects. But some of them may have impact on higher layer, e.g., mobility enhancements.

For more use cases in higher layer esp. the ones involving RAN3, please refer to our contribution RWS-210483, which is summarized in section 3.3. Our understanding is network energy saving, load balancing and mobility optimization should be studied first. These are high-priority use cases in Rel-17 SI. And then some potential higher-layer use case can be considered, e.g. QoE optimization, Slicing, etc.

(2) I assume "target parameters" should mean KPIs? If so, we think different use cases or evaluation methodologies may require different KPIs. We generally consider KPIs typically used before. For example, for use cases requiring SLS, we can use throughput, while for use cases requiring LLS, we can use BLER or MSE.

5 – ZTE Corporation

To comment #4 from OPPO

Thanks for the further questions.

1. We think the mandatory requirement in evaluation should be based on 3GPP channel model. We use this model for a long time because it can reflect the real-world channel well. When developing features in 3GPP, we never require the outcome should have to be based on real field-test results. To get field-test results is not an easy job. That is why we develop such channel model in 3GPP. Of course, companies are welcome to optionally provide results based on test and measurements in real world.

2. I think we can just follow what we always do in 3GPP. For each evaluation, we align the aspects like channel model, target scenario, how to generate large-scale parameters, etc.. We need not require all companies to use a same channel matrix. Even if companies generate different data set, as long as the approach to generate the data set is aligned, results can be comparable. This is similar as what we are doing in SLS now. We don't restrict companies to use a same set of channel matrix entries, but we just align the approach to generate the channel matrices.

3. We think the spec impact for AI based positioning can be very small. It can just optimize the UE report on the PRS measurements, e.g., UE reports more number of measured paths where each path may include arrive timing, power and phase probably, etc..

4. For P11, we think in general AI based approach can help us to reduce the DMRS overhead. This is the motivation to study this aspect. Whether eventually it may have similar spec impact as another aspect motivated by something different can be further discussed after we complete the study.

6 – ZTE Corporation

To comment #5 from NTT DOCOMO

Thanks for the question. Our answer to Samsung's questions in comment #2 can partially address these question as well. Please see more clarification below.

The AI model is actually running on NW side in our thinking. The upper-left figure in P6 means BS collects information reported by UEs and generate the actions (e.g., beam switch) UEs need to take in the next period of time. In this case, our solution is provided in the upper-right figure of P8, where the input includes ToA, beam ID and RRH ID, derived from UE's reporting of its measurements in multiple time instances. So in our view, the exchanged information should be UE reporting which can at least provide the above three pieces of information. This requires some enhancement on the current spec. We are also open to discuss other types of information.

We are also open to consider implementing this AI model in UE side. In this case, we don't think there is a need to require UEs exchange the AI related parameters. Each UE can operate on its own.

3.2 RWS-210481 Enhancements on predictable mobility for beam management

In RWS-210481, we elaborate a potential application of predictable mobility (AI-based) for beam management in FR2 UE high mobility scenarios, such as high speed train and high way, in order to make sure that narrow beams can be used for better coverage and performance and save the RS overhead for beam tracking. This can be seen as detailed elaboration of beam management/mobility prediction use case in RWS-210478. We recommend to consider predictable mobility for beam management with the following objectives as a Rel-18 enhancement aspect, e.g., in AI based air interface SI.

- Study and evaluate the feasibility and potential system level gain on predictable mobility for beam management based on the identified scenario(s).

- Evaluate and, if needed, specify beam-management-related enhancements for predictable mobility, involving beam measurement, beam report, beam indication and fall-back approach from predictable mobility to legacy one.

3.2.1 Round 1

Feedback Form 6: Round 1 comments to RWS-210481

1 – Intel Technology India Pvt Ltd

(1) According to RAN4 study, the number of required beams to operate high-speed train deployment in FR2 is not significant. Can you clarify about large RS overhead?

(2) For example of FR2 high-speed train scenarios, RAN4 is considering a substantial reduction of the number gNB Tx beams as well UE Rx beams. How is the analysis relevant to the FR2 HST scenarios considered in RAN4 in Rel-17? How will reduction of number of RX beams impact the results?

(3) According to RAN4, the impact of beam indication is not significant. What is the motivation to further reduce time to 0ms?

(4) Can you clarify how the complexity can be justified in UE implementing ML algorithms? What is the tradeoff evaluated between the gain and the cost? Besides, is there any potential network specifications

regarding this proposal?

2 – CAICT

We also see the benefits of predictable mobility for beam management as a sub topic of AI-PHY in R18. One question on page 5, since there are some false detections for line/curve/exit and thus the incorrect map may be used, does it have serious impact on system performance?

3 – Apple Computer Trading Co. Ltd

We have some questions on the use case, is it correct understanding that this can only be applied for HST or HST like scenario? For other scenarios like dense urban, is the prediction based BM still possible? In addition, the UE rotation and panel switching may have some impact on the beam dwelling time. It seems hard for gNB to predict the UE rotation. Is this prediction considered to be implemented in gNB side or UE side or both?

4 – vivo Mobile Communication Co.

Thanks for your efforts on this.

One question from our side: where do you think the beam prediction module should reside? At the UE side or at the network side? Are there any pros and cons for each possibility?

5 – NTT DOCOMO INC.

We are interested in the predictable mobility/beam-management as useful in future. We assume another discussion is needed who will predict the future situation. For example, if UE predicts, the following all of 1) - 4) enhancements would be needed. On the other hand, if gNB predicts, the following 3) and 4) enhancements would be needed. Is this correct understanding?

- 1) beam measurement
- 2) beam reporting
- 3) beam indication
- 4) fallback approach

6 – China Mobile Com. Corporation

Thanks for the contribution. Regarding the enhancement of beam reporting, the propagation time for the physical channel from gNB and UE or a time offset from receiving a DL signal to transmitting another UL signal seems can be decided by gNB. Why should UE report these information?

7 – China Unicom

Thanks for this contribution. We have some comments for clarification.

What is the impact on specs, e.g. add some mobility prediction parameters or define a new predictable mobility architecture?

3.2.2 Round 1 reply

Feedback Form 7: ZTE's reply to Round 1 comments

1 – ZTE Corporation

First, we would like to thank all the companies for their good and constructive questions. This process indeed helps us to gauge interest across companies and identify typical scenarios, benefits, costs and spec impacts for AI driven predictable mobility/beam management as a potential aspect of Rel-18 AI-PHY enhancement.

2 – ZTE Corporation

To comment #1 from Intel

Q1: In our views, in FR2, for UE mobility, analog beam switching/updating is determined according to beam dwelling time. For instance, for HST with 300 km/h, the minimum value of beam dwelling time is 11.7 ms where we assume that DFT beam with oversampling ratio of 1 is used by gNB [M, N, P, Mg, Ng] = [4, 8, 2, 2, 2].

As usual, for beam tracking, the gNB shall perform the corresponding beam measurement for neighboring beams with a period that is less than 11.7 ms. For instance, under 10ms beam tracking period, the gNB and UE should track 3 candidate gNB Tx beams (current, left and right) and 3 candidate UE Rx beams (current, left and right), respectively, which means that at least 9 CSI-RS resources should be transmitted for channel measurement in each beam tracking procedure.

Meanwhile, it should be noticed that CSI-RS for beam tracking is UE specific, and the RS overhead increases with the number of UEs. In such case, RS occupancy for overall time/frequency resources is up to 40.18% and 80.36% for the number of UEs = 50 and 100, respectively.

Q2: We also realize the RAN4 efforts on the reduction of number of gNB Tx beams based on a simple/wide Tx beam (e.g., for Scenario-A). Although link budget corresponding to RAN4 approach can be satisfied, the cost is very huge. In our views, the system performance is degraded severely compared with the ideal case that is based on beam selection from multiple narrow candidate beams and has been widely used for FR2 development.

For the sake of presentation, we consider low gNB antenna configuration case with limited but wide Tx beams, i.e., #1 low gNB antenna configuration [M, N, P, Mg, Ng] = [2, 2, 2, 2, 2]; #2 low gNB antenna configuration [M, N, P, Mg, Ng] = [2, 4, 2, 2, 2]. In technical, we think that RAN4's solution and the low gNB antenna configuration (considered in our contribution) are almost equivalent, i.e., using few beams for avoiding expensive beam tracking. In Figure 7 in this contribution, we provide the corresponding simulation results. It can be observed that, although RS overhead is reduced significantly, there is severe throughput degradation for cell-edge UE, i.e., poor coverage.

Alternatively, through well handling narrow beam with significantly high beam forming gains, the predictive approach can bring feasible system performance and obtain significant gain of both cell-edge and mean UPT, compared with legacy approach regardless of low or legacy gNB antenna configuration.

Q3: On contrary, we think that due to long latency of beam measurement, report and indication, RAN4 has to make simple design with a single or few Tx beam(s), for instance, and then beam indication is not significant. As a cost, beam-forming gain for some areas, e.g., close to the neighboring RRH before HO, will be reduced significantly. If based on multiple narrow beams (e.g., 32 beams), the reduction of beam indication latency becomes essential in our views.

Q4: As our first preference (also simulation assumption for this tdoc), the ML algorithm is implemented in gNB side rather than UE side. But, with the assistance of this approach, from UE perspective, it just needs

to provide some more measurement/physical channel related information, e.g.,a propagation time for the physical channel from gNB and UE, a time offset from receiving a DL signal to transmitting another UL signal, or a time-stamp to be report for indicating time point(s) of beam switching, etc.

Regarding the gain of predictable approach, as we replied to above questions, narrow beams with high beam-forming gain can be used for better coverage and performance in high speed scenarios and meanwhile we can save the RS overhead for beam tracking. Regarding the cost, some further UE reporting and gNB implementation for ML algorithm is needed. Also, additional spec impact (related to beam measurement/reporting/indication) is needed. Some more details can be found in Section2.3 in our contribution.

3 – ZTE Corporation

To comment #2 from CAICT

The error cases corresponding to false detection between line and curve only occurs in the red area as shown in Figure 3 where the UE is closed to the crossing of P-point within 30 m distance. In technical, the relative distance between line and curve is too close (no more than 0.082 m) and beyond the accuracy of ToA estimation. Once the UE is outside the red area, the successful detection ratios can increase to 100% accordingly. Then, in Figure 6, it can be observed that the predictable BM approach can be close to optimal performance in terms of 5%-edge, 95%-ile and mean UPT. It can further prove that there is few impacts on system performance due to the false detection.

4 – ZTE Corporation

To comment #3 from Apple

Regarding usage, HST or HST like scenario is appropriate scenario where the RS overheads corresponding to beam tracking due to high mobility is huge, and beam transition pattern is also similar. Then, if paying attention to dense urban, we think that the predictable approach may also be useful for improving HO efficiency. Specifically, based on our field trial, the effective coverage of a cell is very irregular and different from sub-6G cell, and as a result, the ping-pong effect for HO becomes more serious. Based on predictable approach, we also observe that the ping-pong can be well handled (some simulation results can be observed in our companion contribution RP-210620).

Regarding UE rotation, it is a good topic. To be honest, we assume that there is no UE rotation as in simulation assumption, and the prediction approach is implemented in gNB side. In our initial views, some prediction from UE side about rotation seems to be necessary. If you have any in-depth views about UE side beam prediction, please share with us, and look forward to your further comments.

5 – ZTE Corporation

To comment #4 from vivo

As we replied to Apple above, as in our initial views, the beam prediction module is implemented in network side (in general, the scenario/channels corresponding to a given gNB are stable/changed very slowly, e.g., rural, railway, or several buildings in dense urban), and our analysis in this contribution is also based on this assumption. But, if considering UE rotation as Apple mentioned, it seems that the UE side beam prediction for adjusting UE Rx beams due to rotation seems to be also very useful. Do you have any specific thoughts on this UE side module? If any, please share with us, and look forward to your further comments

6 – ZTE Corporation

To comment #5 from NTT DOCOMO

This is a very good comment, and the question about who will predict the future situation is also raised by Apple and vivo. Regarding UE prediction, we share the same views with you. Regarding gNB prediction, we think that beam measurement/reporting may also need to be considered besides for beam indication and fall approach.

In our views, if the gNB can well perform beam prediction approach, some channel related parameters are very essential to depict the relationship between the predicted beam and gNB beam related location. For instance, UE reporting with propagation time for the physical channel from gNB and UE or a time offset from receiving a DL signal to transmitting another UL signal can be considered as a key parameter for depicting/mapping to beam transition pattern and enabling predictable beam management. Besides, the event-driven report procedure about beam switching (e.g., a time-stamp to be report for indicating time point(s) of beam switching) can be considered, and in such case, the reporting overhead of UE reporting can be saved significantly.

Besides, for beam measurement, we may need to consider the flexible parameter configuration (e.g., being activated by MAC-CE or associated with a time stamp that depicts the effective time of corresponding parameters) and corresponding activation/triggering approach should be enhanced for beam measurement framework.

If something wrong or you have some good suggestion, please feel free to raise them. Look forward to your further comments.

7 – ZTE Corporation

To comment #6 from CMCC

Regarding propagation time or a time offset between DL and UL signaling, we think that the gNB can NOT be aware of these parameter with sufficient accuracy. Like UE positioning, if we would like to construct the data set of depicting the beam transition pattern and beam related location, we need to have high-accurate measurement parameter, e.g., absolute error corresponding to propagation time should be around 1 ns. Consequently, UE reporting is essential for gNB to calculate the high-accurate time information.

If something wrong or you have some good suggestion, please feel free to raise them. Look forward to your further comments

8 – ZTE Corporation

To comment #7 from China Unicom

In our views, we need to consider to add some mobility prediction related parameters, e.g., to be reported in L1, at least. Regarding a new predictable mobility architecture, we are very open to have some corresponding discussion. In our initial thoughts, the former may have small spec impacts compared with the latter. If you have specific views or suggestion, please feel free to raise them. Look forward to your further comments.

3.2.3 Round 2

Feedback Form 8: Round 2 comments to RWS-210481

1 – Apple Computer Trading Co. Ltd

Thank you for the kind clarification.

Regarding UE based prediction, we think a potential starting point could be a car instead of a phone, since the possibility of rotation and blocking for a car can be much lower. Moreover, the power consumption for a phone is a more severe problem. At current stage, we are not sure about the UE complexity.

For NW based prediction, we think one important point is the UE privacy. e.g. the solution would not require UE to report its location. We think the potential further study would take such privacy related aspect into account, correct?

In addition, we have another question about the test methodology. How to test whether the prediction implemented in NW or UE side is good enough or not? It is hard to say a NW beam is the best, since the best NW beam somehow depends on the UE Rx beam.

2 – Guangdong OPPO Mobile Telecom.

Generally speaking, AI-based beam/mobility prediction may be benefical. For the contribution, we shave some further discussion as below:

1. We are not sure high speed train (e.g., 300Km/h, 500km/h) is a typical scenario for FR2. At least, from our understanding, FR2 will not be deployed widely for high-speed scenarios.

2. For Fig.2, is it a better configuration of periodic CSI-RS for beam meansuremnt? At least, the overhead of perodic CSI-RS shared by all UEs will not increase linearly with the number of UEs when there are lots of numbers.

3. it it possbile to do mobility/beam prediction at gNB side based on UE's normal reporting(e.g., beam reporting)?

3 – NTT DOCOMO INC.

Thanks for the contribution and good evaluation results. We share the same view that AI-based beam management should be an important use case to be studied. Just have two questions regarding to the SLS evaluation,

- For the AI-based predictable method, what is the assumption on RS configuration/overhead of periodically beam measurement (every 200ms)? Does ZTE assume UE measure all possible Tx-Rx beam pairs and report the beam ID corresponding to the best Tx beam?

- The inputs for AI model include Tx beam ID but with no information about what is its corresponding RX beam. And the final prediction result is the Tx-Rx beam pairs that can be used in the following 1 second. Is the understanding correct?

Thanks!

3.2.4 Round 2 reply

Feedback Form 9: ZTE's reply to Round 2 comments

1 – ZTE Corporation

To comment #1 from Apple

Thank you so much for your further reply.

Firstly, it seems good that a car (also, a train/airplane cabin) can be assumed as a starting point for this discussion. Regarding UE complexity, we can further evaluate this case for UE rotation and blockage, and in our initial thoughts the predictable approach for UE DL Rx beam should be implemented in UE/phone side. Due to the fact that logic for UE rotation and blockage is not complicate, we initially think that the complexity of corresponding AI algorithm seem to be acceptable.

Regarding private issues, we indeed share the same views with you. As in beam/CSI measurement, UE just need to provide some channel-related parameter, and gNB do NOT need UE to report its physical location information.

Regarding test methodology, we shall have optimal Tx-Rx beam pair based on the real-time exhaustive searching along with UE mobility, and the prediction algorithm is to determine the best pair. Successful beam detection ratio as in Table 2 of our contribution can be assumed as a KPI. Regarding UE Rx beam, we think that the same methodology can be used.

2 – ZTE Corporation

To comment #2 from OPPO

Thank you so much for your comments and support for this topic.

Answer to Q1: This is a typical scenario in our views. The corresponding test case for this has been discussed in Rel-16 NR*HST*FR2 in RAN4, and we believe that it may be deployed soon. But, as we replied to Intel last round, unfortunately, in order to save RS/beam tracking overhead, the current RAN4 work is based on a fixed beam per RRH/TRP (boresight point to neighboring RRH/TRP) to be used for transmission (no doubt, in such case, some performance degradation like coverage hole and mean UPT loss has been observed in RAN4).

Answer to Q2: Beam tracking is UE specific, and only the neighboring beams are probed) as usual. For instance, the gNB and UE should track 3 candidate gNB Tx beams (current, left and right) and 3 candidate UE Rx beams (current, left and right). If sharing across all UEs as you mentioned, it means that we need to increase the density of RS with a given period, e.g., 10ms according to minimal beam swelling time. If 64 gNB and 8 UE beams are considered in a typical case, 64*8= 512 OFDM symbols has to be transmitted within 10ms. It means that 512/(10*8*14) @120KHz 45.7% in terms of RS overhead. Clearly, the RS overhead is totally unacceptable for NW.

Answer to Q3: Yes, your understanding is correct. In this contribution, the recommended mobility/beam prediction is at gNB side. For enabling this AI approach, some more channel parameters may need to be further reported, as described in Section 2.3 in our contribution.

3 – ZTE Corporation

To comment #3 from NTT DOCOMO

Thank you so much for good comments.

We do believe that prediction based BM can be considered for other scenarios rather than HST or HST-like scenario only. For dense urban, we think that the predictable approach may also be useful for improving HO efficiency. Specifically, based on our field trial, the effective coverage of a cell is very irregular and different from sub-6G cell, and as a result, the ping-pong effect for HO becomes more serious. Based on predictable approach, we also observe that the ping-pong can be well handled (some related simulation results can be observed in Figure 4(c) in RP-210620).

Then, if considering UE rotation and panel switching, in our initial thoughts, this prediction can be considered in UE side. But, if also based on gNB side, the UE Rx beam configuration information and corresponding measurement results may be reported to gNB for enabling AI approach.

3.3 RWS-210483 Enhancement for data collection for AI in NR and EN-DC

In RWS-210483, we provide our views on enhancement for data collection for AI in NR and EN-DC.

The Rel-17 study item of "Study on Enhancement for data collection for AI in NR and EN-DC" has been conducted in RAN3, and in the latest RAN3 meeting, three prioritized use cases, which are energy saving, load balancing and traffic steering/mobility optimization, have been agreed to identify corresponding standard impact. During the discussion, AI/ML technique provides a powerful tool to help operators to improve the network management and optimization, and some common understanding on input/output of these use cases are coming out.

Therefore, solutions for load balancing, mobility optimization and energy saving should be normative in Rel-18.

To specify solutions, measurements, signalling, and procedures for AI-based load balancing in Rel-18, including:

- Load prediction required data and the corresponding assistance information that will be used for load balancing.

- Support to convey load prediction required data and the corresponding assistance information for load balancing.

- Support to align the corresponding AI functions between different network nodes.

- Support to distribute/update the ML model between NG-RAN nodes.

- Support to exchange predicted load between NG-RAN nodes.

To specify solutions, measurements, signalling, and procedures for AI-based mobility optimization in Rel-18, including:

- Location/trajectory prediction required data and the corresponding assistance information that will be used

for mobility optimization.

- Support to convey location/trajectory prediction required data and the corresponding assistance information for mobility optimization.

- Support to align the corresponding AI functions between different network nodes.

- Support to distribute/update the ML model between NG-RAN nodes.

- Support to exchange predicted UE location/trajectory between NG-RAN nodes.

To specify solutions, measurements, signalling, and procedures for AI-based energy saving in Rel-18, including:

- Location/trajectory/load prediction required data and the corresponding assistance information that will be used for energy saving.

- Support to convey location/trajectory/load prediction required data and the corresponding assistance information for energy saving optimization.

- Support to align the corresponding AI functions between different network nodes.

- Support to exchange predicted UE location/trajectory between NG-RAN nodes.

As can be seen above, the standard impacts for each use case may have some common AI/ML function procedures. Moreover, since AI/ML functionality can be deployed into different RAN nodes (e.g. NG-RAN node, CU, DU), common interface enhancement for AI/ML should be specified over NG/Xn/F1 interface.

Therefore, common interface enhancement procedures over split architecture and non-split architecture should be normative in Rel-18 WI.

Furthermore, large scale of data transmission and data security guarantee need to be further studied in Rel-17, the corresponding enhancements should be supported in R18 WI.

3.3.1 Round 1

Please provide your company's views in the table below, in particular, on the following three questions.

Q1: Companies are invited to provide comments on proposals to elaborate the objectives for prioritized use cases.

Q2: Companies are invited to provide comments on the proposal that common interface enhancement procedure supporting AI/ML functionality in split architecture and non-split architecture should be normative in Rel-18 WI.

Q3: Companies are invited to provide comments on enhancement for the security of data transmissions in Rel-18.

Feedback Form 10: Round 1 comments to RWS-210483

1 – LG Uplus

Q1: To us, MRO and Beam management is highly prioritized. Above all, in order to enable them, M1 (RSRP,RSRQ,SINR) and M2 are essential and should be mandatory feature for implementation.

Q2: In principle, we can agree with the concept of unified data container through the all entities in split architecture.

Q3: Not deep insight so far.

2 – Futurewei Technologies

Q1: Rel-17 data collection SI should proceed further to conclude proper Rel-18 objectives for those identified use cases.

Q2: We can see common data collection procedure for different use cases. As Rel-17 SI bases on existing architecture and interfaces, what a common interface proposed here would be?

Q3: what would new security requirements be for data collection for those identified use cases?

3 – CATT

Thank you for the contribtuion.We share the view that normative work should be conducted in Rel-18 for the priotized cases in Rel-17.However,we could not quite understand the security requirement for data collection,could you please clarify more?

4 – Lenovo Information Technology

Q1: we can follow the outcomes of R17 study.

Q2/Q3: we share the same views. In order to support distributed AI, AI workflow/AI data/AI computation information may be shared among different nodes. A common procedure/interface are beneficial the data security is an essential issue. For this part, we are wondering it is work item or study item in Rel18. We tend to think we can start to study how to support distributed AI in Rel-18.

5 – China Mobile International Ltd

Basically, the three questions could follow the discussion and conlcusions of Rel-17 enhancement of data collection SI. In current RAN3 discusison, companies seem prefer to discuss the standard impacts on a per-use case basis. We could decide later whether a common procdure should be defined. Also we agree some other cases can be further studied in REl-18.

6 – China Unicom

Thanks for this contribution. We have some comments for clarification.

1. How to generate the Location/trajectory/load prediction required data?
2. What is the common interface enhancement procedure?

7 – NEC Corporation

NEC supports having WI in RAN3 as continuation of the current RAN3 SI. We think it would be beneficial to also have a new SI as continuation of the current RAN3 SI covering wider scope and use cases.

3.3.2 Round 1 reply

Feedback Form 11: ZTE's reply to Round 1 comments

1 – ZTE Corporation

To comment #1&2 from Futurwei and comment#2 from China Unicom: what a common interface

Thanks a lot for your comments and questions.

Well. Rel-18 WI objectives should follow the outcome of the Rel-17 SI, and prioritized use case will continue to discuss in Rel-17.Then, we are going to clarify what you concern.

First, what's the common interface enhancement procedure

As we know, the standard impacts for prioritized use cases will be studied in next RAN3 meeting. But some AI/ML function procedure between NG-RAN nodes to support these use cases should be introduced, e.g. AI/ML function management procedure for AI/ML function start/stop, AI/ML measurement procedure for AI/ML measurement request/report, AI model management procedure for AI/ML model distributing/update.

-AI Function Management: This function enables the AI function(s) start/stop between the NG-RAN nodes, if the AI function(s) supported by both nodes.

-AI Model Management: This function enables one NG-RAN node to retrieve the ML model from the peer NG-RAN node. With this function, the updated ML model can be synchronized/exchanged between NG-RAN nodes.

-AI Measurement Management: This function allows AI measurement report (data required for model training/inference)between NG-RAN nodes.

2 – ZTE Corporation

To comment #3 from Futurewei's and comment from CATT : Security aspect

If current RAN architecture can support data collection for AI, configuration commands of the AI/ML model and data including measurements and training data need to be transferred between the base station and the AI Entity. These configuration commands and data play an important role in solving network configuration and operation problems in an intelligent manner. Therefore, the network needs to consider the security of transmission between the base station and the AI Entity.

And then, if the AI Entity may be provided by the third party, it is often in a different NDS network from the NG-RAN node, and the problem of secure connection must be resolved. A feasible way is to statically configure the parameters required by the secure link between the AI Entity and the NG-RAN node through the network management.Therefore, manual configuration is very inflexible. Setup security connection via Signaling is a potential way.

3 – ZTE Corporation

To comment #1 from China Unicom : How Location/trajectory/load prediction required data

Thanks a lot for your comments and questions.

For your first question, "Location/trajectory/load prediction required data", is the data needed for location/-trajectory/load prediction, which may be UE historical location(latitude, longitude, altitude), UE motion direction/velocity, historical traffic load of cells, historical PRB utilization rate, etc.

4 – ZTE Corporation

To comment from LG Uplus:

Thanks very much for your comments.Prioritized use case will be discussed first in Rel-17 SI. Security for AI data transmission is a critical issue that we cannot be ignored in Rel-18.

5 – ZTE Corporation

To comment from Lenovo Information Technology:

Thanks very much for your comments and consideration. For common procedure/security, we think, it can be studied in Rel-18 WI but this depends on the outcome of Rel-17 SI. Security for AI data transmission is a critical issue that we cannot ignored. Whatever, from our side, common interface procedure can be leveraged to support federated/distributed AI in RAN network (e.g. data sharing/model sharing).

6 – ZTE Corporation

To comment from China Mobile International Ltd:

Thanks very much for your comments. Well, we should focus on standard impacts for prioritized use case first.

7 – ZTE Corporation

To comment from NEC:

Thanks a lot for your comments and support WI in Rel-18. Regarding Rel-18 SI for AI, it's essential to study new interfaces to integrate AI/ML function with RAN architecture well. But before a new SI ,we may need know objectives e.g what's new functional entities and what's new AI functionality.

3.3.3 Round 2

Feedback Form 12: Round 2 comments to RWS-210483

1 – Intel Corporation (UK) Ltd

Q1: Regarding to "the network needs to consider the security of transmission between the base station and the AI Entity", Does it mean AI entity is outside of the base station? What does AI entity mean here? Does "AI entity" refer to "Model training", "model inference" which are defined in RAN3 SI functional framework?

2 – China Unicom

1. For "load prediction", it is maily for the cell load prediction, not for the UE load prediction?
2. So the prediction required data for cells need to be transferred in the Xn/Ng? And what about the UE based data prediction?

3.3.4 Round 2 reply

Feedback Form 13: ZTE's reply to Round 2 comments

1 – ZTE Corporation

To comment from Intel

Thanks a lot for your comments and questions.

AI entity can be located in CU/DU, OAM or 5GC, even and provided by the third party. AI entity is mainly responsible for model training and/or model inference. If data transmission for AI is required between

NG-RAN node and AI entity(AI entity can be also located in NG-RAN node),secure connection must be considered and resolved.

2 – ZTE Corporation

To comment from China Unicom

Thanks a lot for your comments and questions.

We are sure that load prediction can't preclude the UE-level AI-based load prediction. Besides, for load balancing, in Rel-17 RAN3 SI, we can first focus on studying the cell-level load prediction and its standard impacts. Because load prediction is also benefit to the network energy saving and mobility decision. Then, predicted information should be shared in the network, which the NG-RAN node can make optimization decision or train its AI/ML model further with predicted information from neighbour NG-RAN nodes.

3.4 RWS-210479 Uplink Enhancements for 5G Advanced

In RWS-210479, it is observed that more UL-heavy applications have emerged, e.g., machine vision with required data rate in order of Gbps/10Gbps and air interface latency of 2 10ms. To satisfy such requirements, 5G uplink should be further enhanced, especially for higher UL capacity. Therefore, the following enhancements are proposed for Rel-18 evaluation.

- Enhancements on UL CA

- More UL carriers than DL carriers

- Flexible association of DL and UL carriers

- Support of UL CA in idle/inactive state

- Enhancement on power control

- UL spatial multiplexing/layer mapping

- More MIMO antennas/layers e.g. 8 layers

- Layer to codeword mapping (support 2 MCS or modulation orders for 2- 4 layers)

- Frequency selective precoding

- Uplink beam management

- Enhance the case where beam correspondence cannot be utilized e.g. more UL carriers than DL carrier

- UL simultaneous multi-panel transmission

- Higher order modulation for fixed wireless access

- Interference coordination

- User virtualization and cooperation

More details on the motivation, specification impacts, preliminary evaluation results are presented in RWS-210479.

3.4.1 Round 1

Feedback Form 14: Round 1 comments to RWS-210479

1 – China Telecommunications

For the following aspect, we share the similar view that they should be supported for UL enhancement:

· Enable flexible spectrum allocation

- More UL carriers than DL carriers

- Flexible association of DL and UL carriers

· Support 8 transmission layers for UL

· Support 1024 QAM for UL

· Enable UE cooperation

For simultaneous multi-pannel UL transmission, does the performance gain comes from more transmit antennas or something else?

2 – SoftBank Corp.

Thanks for your proposals. Question on ”More UL carriers than DL carriers” in page 4: in our understanding, the current limitation of UL CA is RF capability and the upper bound of transmission power, in our understanding. Therefore, these issues need to be addressed to utilize aggressive UL CA. Do you have any idea for this matter ? Thanks.

3 – Apple GmbH

For the case

”Enhance the case where beam correspondence cannot be utilized e.g. more UL carriers than DL carrier”

Do you imagine we will relax the RAN4 requirement for beam correspondence for the UE? or UE is still mandated to support the requirement from RAN4 but opportunistically, the BC may not hold?

4 – SHARP Corporation

In slide 5,
What is the benefit for cell1 + cell2 CA over CA with uplink only SCell?
What do you expect is the special carrier requirement in band3 for cell2?

5 – China Mobile Com. Corporation

Thanks for the contribution.

For the flexible DL and UL carrier association, what is the time granularity for the carrier switching ?

For the layer to codeword mapping, is that feasible to use a different mapping method for uplink? And how about the implementation complexity ?

Further clarification on the user virtualization. If the user in a single virtualization group can share the same or similar channel state information and how much difference between those users. For the communication within the group, does it base on the sidelink ?

6 – vivo Communication Technology

1) With more UL carriers than DL carriers, does it mean UL carriers are simultaneously transmitted? It will increase UE hardware complexity and how about UL coverage?

2) What is the motivation/use case of flexible DL UL carrier association? Are they intra band or inter band?

3) "One cell (either Pcell or Scell) can be selected by UE for PRACH/Msg3 transmission." Does it mean UE selects either Pcell or Scell by itself given PRACH is configured on both cells? Is it possible PRACH on Pcell and Msg3 on Scell?

7 – Qualcomm communications-France

Q1: Regarding "Enhance the case where beam correspondence cannot be utilized", do you also have the scenario that DL and UL TRPs are different in mind, or it is primarily for the case that there are more UL CCs than DL CCs?

Q2: Regarding "interference coordination", can you elaborate a bit more regarding the scenario / enhancements in mind?

8 – CATT

Thanks for your contribution. We have the following comments/questions.

1) For flexible DL and UL carrier association, are the PUSCHs on different carriers scheduled by a single DCI for separate DCIs on the same DL carrier?

2) for UL CA in idle/inactive state, on which cell does the UE expect to receive Msg2/4? Is it the same cell as that on which UE selected for PRACH/Msg3 transmission?

3) We support UL MIMO enhancements on P7 in general.

4) What interference coordination enhancements do you have in mind?

9 – Qualcomm Incorporated

For the proposal of "Flexible association of DL and UL carriers", what are the differences between this proposal and today's CA framework? What is the advantage (if any) of this proposed scheme over today's CA framework? On slide 5 of RWS-210479, with cell1+cell2 CA where physically the DL of cell 1 and 2 are from f3, how to partition f3 between cell 1 and cell2?

10 – Samsung Electronics Co.

Q1. Slide 5: can you elaborate more on one DL carrier shared by multiple cells? Does the shared DL carrier creates a cell that overlaps with the multiple cells?

Q2. Slide 6: 1. UL CA in idle/inactive state looks similar to SUL operation. What is the difference from SUL?

Q3. Slide 6: How the UE selects the cell?

11 – Spreadtrum Communications

We share a similar view that UL enhancements should be considered in Rel-18, due to new use cases and requirements.

Regarding User virtualization and cooperation, we think it is a good point for UL improvements. Would you please clarify that in one virtual UE, do all UEs are with equal status, or there is one super UE as a leader. Another question is the communications among UEs using PC5 or other methods.

12 – Qualcomm Incorporated

Q1: Could you elaborate a little more on UL CA operation in idle/inactive mode? Is the intent to create RACH occasions across multiple carriers to avoid RACH collisions? An example would be helpful.

Q2: Regarding multiple MCS when we have 2-4 layers in uplink, does each MCS map to a different TB?

13 – Qualcomm Technologies Int

Questions regarding UE aggregation feature:

1. Is the link between aggregated UEs proprietary or is it based on standardized 5G NR feature?

2. Is the proposed framework for UE aggregation limited to multiple UEs of a the same user or UE aggregation can occur across UEs that belong to different users as well?

14 – China Unicom

Thanks for the contribution, we share the same view that uplink enhancements is benefit to improve UL capacity. The following questions are listed for clarification:

Q1. Both frequency domain and space domain are considered in the contribution, what is the enhancement for uplink resource allocation in time domain?

Q2. What is the potential solution for Flexible Association of DL and UL Carriers?

15 – Xiaomi Communications

We think it is necessary to UL capacity especially in hot spot. What is the priority of the potential solutions?

16 – Xiaomi Communications

We think it is necessary to improve UL capacity especially in hot spot. What is the priority of the potential solutions?

3.4.2 Round 1 reply

Feedback Form 15: ZTE's reply to Round 1 comments

1 – ZTE Corporation

To comment #1 from China Telecommunications

Yes, your understanding is correct. The performance gain comes from more transmit antennas, i.e., more UL layers to be transmitted.

2 – ZTE Corporation

To comment #2 from SoftBank Corp.

Currently, the normal commercial mobile phones can support 2 Tx, and some high capability UEs could support 3 Tx or even 4 Tx (e.g., CPE). For these UEs with up to 4 Tx, more UL carriers than DL carriers could accommodate better in the scenarios with UL heavy applications. This doesn't need to increase the UE RF capability considering the number of UL carriers for transmission is no larger than the number of Tx supported. In addition, more Tx could be supported for future UEs, e.g., a motion controller without much limitation on the form factor in factory scenario. Then, more benefits could be anticipated.

Regarding transmission power, we agree that UL CA for high capacity is mainly used for the scenarios that UE power is not limited. So, we also think potential power control enhancement as proposed in our contribution could be considered. For instance, it may no need to maintain current SAR compliance for some factory scenarios, or using UE aggregation to boost UL transmission power by multi-path transmissions from UEs in the same group.

3 – ZTE Corporation

To comment #3 from Apple GmbH

It is a good question. In our initial views, we need to consider the case that beam correspondence can NOT be supported in a given scenario (like we can not support channel reciprocity in FDD), rather than relaxing the RAN4 requirement. Then we share the same views that the UE is still mandated to support the requirement from RAN4 but opportunistically, the BC may not hold.

4 – ZTE Corporation

To comment #4 from SHARP Corporation

Q1: From available physical carriers perspective, it is the same. The intention here is try to reuse current NR CA framework, where each serving cell is associated with one DL carrier and one UL carrier. This causes less specification impacts. But we are also open to discuss CA with uplink only SCell.

Q2: For some of the TDD bands, it may have special requirements such as only UL allowed or DL power should be minimized, e.g. due to regulation or spectrum sharing.

5 – ZTE Corporation

To comment #5 from China Mobile Com. Corporation

Q1: The flexible association of DL and UL carrier could be RRC configured. We can also use MAC CE activation/de-activation to enable fast carrier switching among different DL/UL associations. We are also open to consider more dynamic way for carrier switching.

Q2: In general, we slightly prefer to use the same mapping method for uplink as downlink. Since the more than one codeword has been supported in LTE, we think that the implementation complexity introduced by more than one codeword is acceptable.

Q3: It's a good question. Based on current specifications, the channel state information for different UEs is independent and could be different even they are located closely in an area. But, we think this could be one study aspect with more evaluations needed for support of user virtualization.

Q4: It could be based on sidelink or other connections, e.g., wifi or wire connection.

6 – ZTE Corporation

To comment #6 from vivo Communication Technology

Q1: If the number of Tx is no smaller than the number of carriers, all UL carriers can be simultaneously transmitted for higher capacity. Currently, the normal commercial mobile phones can support 2 Tx, and some high capability UEs could support 3 Tx or even 4 Tx (e.g., CPE). For these UEs with up to 4 Tx, it doesn't need to increase the UE hardware complexity to enjoy more UL carriers than DL carriers for the scenarios with UL heavy applications. If the number of Tx is smaller than the number of carriers, it needs Tx switching among these carriers. As how many Tx should be supported by a UE could be studied together in Rel-18.

More UL carriers than DL carriers is mainly for UL capacity. When larger UL coverage is desirable, Tx switching among different carriers can be considered or the flexible DL/UL association could be configured with cell#3 in the example in slide#5.

Q2: There are three use cases, 1) To achieve more UL carriers than DL carriers 2) To handle special requirements (e.g. only UL allowed or DL power should be minimized) in a band (e.g. due to regulation or spectrum sharing). 3) To satisfy different requirements in downlink and uplink more flexibly. We are open to consider both intra band or interband.

Q3: Yes, it means UE can select either Pcell or Scell by itself given PRACH is configured on both cells. Our intention is to let PRACH and Msg3 on the same serving cell, while we are open to discuss the case that they are in different serving cells.

7 – ZTE Corporation

To comment #7 from Qualcomm communications-France

Q1: In our initial views, it is primarily for the case that there are more UL CCs than DL CCs, e.g., from different bands. But, after reviewing the other companies' contribution, we also think that the case that DL and UL TRPs are different, like UL-TRP-dense scenario, can be further considered herein.

Q2: Our intention is for interference coordination for TDD scenarios, where gNB-gNB interference or UE-UE interference exits in case of unaligned TDD configurations (e.g., one legacy DL-heavy TDD configuration and one UL-heavy TDD configuration). In Rel-16 CLI, gNB-gNB interference is left to network implementation. Then, one aspect to enhance is about the mechanism to enable the gNB-gNB interference measurement, e.g., based on RS and enable inter-gNB coordination mechanism via backhaul. We are also open to discuss other UL interference coordination.

8 – ZTE Corporation

To comment #8 from CATT

Q1: The PUSCHs on different carriers scheduled by separate DCIs could be the baseline, and we think a single DCI scheduling multiple PUSCHs could be also considered.

Q2: It could be a baseline to let Msg2/4 and PRACH/Msg3 in the same cell. Meanwhile, for better downlink coverage, we think Msg2/4 and PRACH/Msg3 transmission in different cells could also be considered.

Q3: Thanks for the support.

Q4: gNB-gNB interference or UE-UE interference exits in case of unaligned TDD configurations (e.g., one legacy DL-heavy TDD configuration and one UL-heavy TDD configuration). In Rel-16 CLI, gNB-gNB interference is left to network implementation. Then, one aspect to enhance is about the mechanism to enable the gNB-gNB interference measurement, e.g., based on RS and enable inter-gNB coordination mechanism via backhaul. We are also open to discuss other UL interference coordination.

9 – ZTE Corporation

To comment #9 from Qualcomm Incorporated

Q1: Compared to current CA framework, the main differences include 1) the DL and UL physical carrier of the same cell are not limited to the same band, 2) one DL physical carrier can be shared by multiple cells.

Q2: By allowing flexible association of DL and UL carrier, it can 1) support more UL physical carriers than DL physical carriers for higher throughput in uplink 2) handle special requirements (e.g. only UL allowed or DL power should be minimized) in a band (e.g. due to regulation or spectrum sharing), by allowing the DL and UL carrier in different bands. 3) satisfy different requirements in downlink and uplink more flexibly e.g. higher throughput req. in DL & larger coverage req. in UL.

Q3: For frequency resource partition of f3 between cell 1 and cell2, it can be up to implementation. The physical DL resources for cell 1 and 2 could be the same or different. We are also open to discuss any potential restrictions/enhancements.

10 – ZTE Corporation

To comment #10 from Samsung Electronics Co.

Q1: Based on current NR CA framework, the network can configure downlink and uplink carrier frequency separately for each serving cell. 'one DL carrier shared by multiple cells' means that network can configure the same DL carrier for multiple cells by with current CA signaling with additionally allowing DL and UL carrier from different bands. We are also open to discuss other DL/UL association.

The multiple cells sharing the same DL carrier may have the same or partial overlapping frequency resources. We are also open to discuss further potential restrictions/enhancements.

Q2: Similar to connected mode, the main difference is the multiple UL carriers belong to the same cell. As we see more flexibility of CA over SUL in connected mode, e.g., support of more than 2 UL carriers, we think such flexibility can also extend to idle/inactive mode.

Q3: It could be based on UE implementation or depending on one or more RSRP thresholds for the selection.

11 – ZTE Corporation

To comment #11 from Spreadtrum Communications

Q1: We think the two cases mentioned are both possible. For instance, the mobile phone from a UE could be a leader compared to other wearable devices. In another example in factory scenario, all motion controllers from a same robot/product line could be with equal status.

Q2: It could be based on sidelink or other connections, e.g., wifi or wire connection.

12 – ZTE Corporation

To comment #12 from Qualcomm Incorporated

Q1: Reducing PRACH collisions could be one use case. Another motivation is to select one cell with better channel condition for better UL coverage.

Q2: Correct. MCS should be TB/codeword-specific.

13 – ZTE Corporation

To comment #13 from Qualcomm Technologies Int

Q1: It could be either proprietary (e.g., wifi/wire/Bluetooth connection) or sidelink specified by NR.

Q2: Our initial consideration is that multiple UEs belong a same user. We are also open to discuss if there is any difference compared to UEs that belong to different users.

14 – ZTE Corporation

To comment #14 from China Unicom

Q1: Yes, our main focus is on CA, UL MIMO and user virtualization etc. We are open to discuss any potential UL enhancements in the time domain.

Q2: Based on current NR CA framework, the network can configure downlink and uplink carrier frequency separately for each serving cell. So, our thinking is to reuse the same signaling framework while allowing the following configuration 1) the DL and UL physical carrier frequency for one cell is not limited to the same band, 2) one DL physical carrier can be shared by multiple cells.

15 – ZTE Corporation

To comment #15 and #16 from Xiaomi Communications

We think all our proposed enhancements could provide benefits for improving UL capacity, though some of them could be directly in normative work and the others could be first carried out in a study phase (e.g., UE virtulization and cooperation).

3.4.3 Round 2

Feedback Form 16: Round 2 comments to RWS-210479

1 – China Telecom Corporation Ltd.

Regarding the objective of **-Enhancements on UL CA**, we share the same view and also show our interest for the scenario of 700/800/900MHz in our document of RWS-210147.

A question for further clarification on the sub-objective of Enhancement on power control

Could you elaborate in a little detail on how to enhance the UE power control?

2 – Samsung Research America

Slide 8: For beam management enhancements with more UL carrriers than DL, is the assumption that the UL carriers are co-located (i.e. transmitted to the same TRP), or transmitted to different TRPs?

Slide 9: For user virtualization, can this be used for beam management, one user in the group determines beam information (measurement/reporting) that is used for the benefit of other users in the group?'

3 – Qualcomm Incorporated

One further question is: whether the proposal is to enable initial/random access on a UL carrier based on SSB/SIB/paging reception on a DL carrier that is not paired/linked with the UL carrier in the band definition. For any possible linkage, REFSENS, MSD and other requirements still need to be derived and specified per pairing. Once it is done, how is the pairing really different from simply defining it as an FDD band? Also, in such pairings, the possible DL BW and UL BW combinations and frequency offsets would still need to be defined, which again would make it not much different from simply defining it as an FDD band.

4 – China Mobile Com. Corporation

Slide 7

In right-hand side figure in slide 7, the performance gain of 2 CWs seems not too high over single CW. And performance gain is marginal below 20dB SINR and only increase when the SINR is above 20dB. Is there any consideration of the using scenario of 2 CW ? e.g. In the backhaul link of IAB ?

Slide 6

Please provide more illustration on how could enabling the UL CA in idle/inactive state could bring benefit for the uplink. Thanks.

5 – HuaWei Technologies Co.

1. For UE virtualization, do you conside data split/duplication and transmit over multi-UE in additon to path switch as that could bring improved throughput and realibility?

1. On page 9, it mentions users share MIMO/PA/carrier processing capability. Does it assume L1 architecture for the collaboration or L2 architecture like L2 relay?

2. Would the virtual UE appear to the network as a single UE or separate UEs?

6 – Qualcomm Technologies Int

Thank you for your responses in round 1. Here are some follow up questions regarding UE aggregation feature for round 2.

1. Does the network schedule aggregated UEs independently, or aggregated UE is treated as more capable, but a single UE?
2. Is UE aggregation configured by the network, or a decision to aggregate is up to the UEs?

7 – China Unicom

Thanks for your contributions and clarification. For further clarification:

1) the DL and UL physical carrier frequency for one cell is not limited to the same band, does this mean the DL and UL carrier can be separately configured?

2) one DL physical carrier can be shared by multiple cells. Would you please elaborate more on the scenario and feasibility for this scheme?

8 – Sony Europe B.V.

On User Virtualisation, it is described that multiple devices form a virtual user to collaboratively transmit and receive from the network. This takes advantage of the scenario where a user has multiple devices. How do these devices know that they belong to a single user and therefore know how to form a virtual user?

3.4.4 Round 2 reply

Feedback Form 17: ZTE's reply to Round 2 comments

1 – ZTE Corporation

To comment #1 from China Telecommunications

In our view, UL CA for high capacity is mainly used in the scenarios that UE power is not limited. So, we think potential power control enhancement could be considered. For instance, whether to maintain current SAR compliance for some factory scenarios, or using UE aggregation to boost UL transmission power by multi-path transmissions from UEs in the same group.

2 – ZTE Corporation

To comment #2 from Samsung Research America

Q1: More UL carrriers than DL carriers is based on current CA framework, i.e., the UL carriers are associated with different serving cells. Therefore, the UL carriers could be either co-located (carrier aggregation) or non-co-located (multiple connectivity).

Q2: For user virtualization, spatial domain enhancements can be explored by sharing MIMO capabilities among UEs in the same group. Beam management could be one direction and we are open to study whether beam information of one UE in the group could be used for other UEs in the same group.

3 – ZTE Corporation

To comment #3 from Qualcomm Incorporated

Our intention is to try to reuse current requirements as much as possible for the potential new pairing if the corresponding requirements for DL band and UL band in the pair have been defined in RAN4.

4 – ZTE Corporation

To comment #4 from China Mobile Com. Corporation

Q1: The figure based on 2T4R is just one of our simulation results. Actually, for 2T8R, larger performance gain can be observed in the case of 20dB SINR. Please find more results in our RAN1 tdoc R1-2014596. The simulation results are aligned with the real test in which one CW issue usually happens for UEs with high SINR/MCS since data demodulation is more sensitive and needs more proper scheduled MCS.

In our view, supporting 2 CWs will be optional UE feature, it's up to gNB scheduling. There is no problem to use 2 CWs for UEs in low SINR range since there is no performance loss after all.

For the use case of IAB, we are positive to support this feature. We think it can be discussed after 2CWs are specified for regular use cases.

Q2: Supporting UL CA in idle/inactive state could bring the following benefits. 1) Reducing PRACH congestion by offloading PRACH transmissions on multiple cells. With less PRACH congestion, it could also reduce the access delay and save UE power.

2) Better UL coverage by selecting one cell with better channel condition.

5 – ZTE Corporation

To comment #5 from HuaWei Technologies Co.

Q1: Yes.

Q2: We think both L1 and L2 based coordination could be possible, which may also depend on the scenarios. For instance, if the multiple UEs are connected by wire, these UEs could be regarded as one super UE and jointly scheduled in L1 layer. In some scenarios, split/aggregation at L2, e.g., PDCP, could be also considered. Anyway, it could be regarded the overall MIMO layers/# of Tx/resources are increased considering the data is eventually transmitted by multiple UEs.

Q3: Both modes (single UE or separate UEs) could be possible which may also depend on the scenarios. How to switch (e.g., semi-statically or dynamically) between the two modes could be further studied.

6 – ZTE Corporation

To comment #6 from Qualcomm Technologies Int

Q1: Both cases (independently schedule or jointly schedule) could be possible which may also depend on the scenarios. For instance, if the multiple UEs are connected by wire, these UEs could be regarded as one super UE and jointly scheduled at L1 layer. In some scenarios, split/aggregation at L2, e.g., PDCP, could be also considered. These UEs could be scheduled independently or some L1 scheduling enhancements could be considered depending on whether network can identify the grouping of the UEs at L1 layer.

Q2: Similar to our response to Q1, we think both could be possible. How to switch between the two modes (single UE or separate UEs) could be further studied.

7 – ZTE Corporation

To comment #7 from China Unicom

Q1: Yes, DL and UL carrier can be separately configured, and this also aligns with current specification.

Q2: This is mainly for UL-heavy scenario, where it requires less DL frequency resources while much more UL frequency resources. In such scenarios, the network can configure the same DL physical carrier while different UL physical carriers for different serving cells, since the DL and UL carrier can be separately configured.

8 – ZTE Corporation

To comment #8 from Sony Europe B.V.

The UEs could be aggregated to one virtual UE or can be worked independently. In our view, the network can switch (e.g., semi-statically or dynamically) between the two modes, and details could be further studied.

3.5 RWS-210480 Support of Blockchain for 5G Advanced in R18

In RWS-210480, we elaborate the benefit and necessity of applying blockchain technology in 5G advanced network, especially in the network sharing scenario. Therefore, we recommend to trigger RAN3-led initial study on blockchain supported 5G advanced network in R18, which includes the following potential objectives.

- The potential objectives are to define the solutions to support blockchain for 5G advanced. The following prioritized use cases can be considered as examples:

- Network sharing

- ...

- The following objectives should be followed when developing the blockchain solutions based on current 5G network architecture:

- Both real time and non-real time measurements and measurement reporting to the blockchain platform needs to be analyzed. Basic measurement objects from 5G network should be identified and defined which are transferred onwards to the blockchain platform.

- Measurement may be triggered by various rules, for example based on radio condition dependent thresholds.

- Measurement configurations, report, procedure design and interface impacts should be identified and specified for the prioritized blockchain use cases.

- Security requirements on data transferred to the blockchain platform needs to be studied.

3.5.1 Round 1

Feedback Form 18: Round 1 comments to RWS-210480

1 – Lenovo Information Technology

We support to study how to apply blockchain technology in network sharing. We think blockchain technology could be beneficial on more efficient radio resource allocation, charging among multiple operators.

We are wondering whether other groups should be involved such as OAM or CN.

2 – Qualcomm Incorporated

Blockchain allows good scalability when large number of parties are involved. For the proposed use-case, what is the estimate of number of parties involved (i.e. number of entities who are interested in recording transactions etc)?

3 – Spreadtrum Communications

The issue of supporting RAN sharing may be good use case for the combination of Bolckchain and mobile communication. just asking for some clarificatios: 1. it seems like no impact on UE, right? 2. how to understand ”hosting operator” ?

4 – China Mobile International Ltd

An interesting topic, we would like to clarify the potential RAN impacts of block chain, where is the block chain platform resides in?

5 – China Unicom

Thank you for the proposal. Blockchain is an interesting topic in RAN sharing network.

There are some comments for clarification.

Q1: Whose Blockchain nodes should be deployed except hosting operator and participating operator?

Q2: How many nodes should be deployed to fulfill the min requirements?

Q3: How to define the interface between Blockchain platform and 5G RAN logical node?

3.5.2 Round 1 reply

Feedback Form 19: ZTE's reply to Round 1 comments

1 – ZTE Corporation

To comment from Lenovo Information Technology:

Thanks for supporting. We share the same view on the benefit of blockchain for interactive among multiple operators including charging. Our understanding is that in Rel-18, the study should focus on RAN side and it is also possible to coordinate with other groups such as SA2 and SA5.

2 – ZTE Corporation

To comment from Qualcomm Incorporated:

Thanks for your question and consideration. For the proposed network sharing use case, the typical num-

ber of parties involved in China is one hosting operator and one participating operator. The blockchain technology helps to establish trust while maintaining privacy in multi-party networks.

3 – ZTE Corporation

To comment from Spreadtrum Communications:

Thanks for the question. Yes, so far, for network sharing use case, it has no impact on UE, but it does not preclude the other possible scenarios identified which will have impact on UE.

Network sharing can be realized in several ways, such as sharing of site infrastructure and MOCN. Sharing of site infrastructure is the most common form of network sharing, where multiple operators share site locations, equipment rooms, and towers, etc., and each operator operates and maintains its network independently. MOCN mode means that RAN can be connected to multiple operator core networks, and can be built by multiple operators in cooperation, or one of the operators can build the RAN alone, while other operators rent the operator's RAN network.

Hosting operators are responsible for providing the sharing RAN system to other participating operators, usually hosting operators are the operators who build and manage the network, such as providing service to the customers of participating operators, uploading required key data to the blockchain platform through their sharing base stations.

4 – ZTE Corporation

To comment from China Mobile International Ltd:

Thanks for your question.

Our understanding is that the blockchain platform is an independent server, similar to TCE/MCE.

5 – ZTE Corporation

To comment from China Unicom*:*

Thanks for your questions.

Q1: The blockchain node can also be partially or wholly from a third party. Operator(s) obtains services in lease modes at the early stage of use. This can reduce initial capital investment. However, how to use blockchain from a third party is an implementation issue and will not be limited in the standard.

Q2: The typical number of deployed nodes involved in China is one hosting operator and one participating operator. However, the exact minimum node number may need to be further discussed, because it depends on the resource requirements, such as the number of sites, the size of the contents on the chain, the cycle of the chain, and the storage time.

Q3: Our understanding is that a new interface will be introduced to support the connection between the blockchain platform and the 5G RAN logical node, but similar to QoE server, we will not standardize such interface.

3.5.3 Round 2

Feedback Form 20: Round 2 comments to RWS-210480

3.5.4 Round 2 reply

Feedback Form 21: ZTE's reply to Round 2 comments

3.6 RWS-210482 Further enhancement on RAN slicing in Rel-18

In RWS-210482, we suggest work on further enhancement for RAN slicing in Rel-18, where the potential enhancement aspects include:

- RAN impacts from Rel-18 Network Slicing work in other WGs (e.g. SA1 and SA2)

- Slice based cell reselection for MO

- Slice specific RSRP/RSRQ thresholds for cell selection and reselection

- Continuation of the slice remapping for service continuity

- UE leverage different slice resources in MN and SN simultaneously in MR-DC

3.6.1 Round 1

Feedback Form 22: Round 1 comments to RWS-210482

1 – China Mobile Com. Corporation

Thanks for the proposals. Generally, we support further enhancement for RAN slicing on SA1 requirements as well as some left over issues in RAN2/3 for Rel-17. And CMCC also submitted a R18 motivation paper for slicing in RWS-210349.

One question for the objective "Slice specific RSRP/RSRQ thresholds for cell selection and reselection", if the thresholds are refered to Qrxlevmin and SintrasearchP, what's the intention for introducing seperate thresholds for slices? Is that mean different slices may have different coverage?

2 – KDDI Corporation

Thanks for the proposals.

One question is about "Different offsets or RSRP/RSRQ thresholds for inter and intra-frequency slice based cell reselection".

Are you trying to change/enhance cell-ranking criterion Rs/Rn? Or cell selection criterion S? Or both Rs/Rn and S?

3 – Intel Technology India Pvt Ltd

(1) It is unclear which of the SA1 requirements is not yet fulfilled by Rel-17 enhancement. Do you think the requirements should be first analyzed before creating a SI to analyze it?

(2) In Rel-17, performing cell reselection at the point of MO triggered does not provide fast access. Moreover, this will not happen if allowed slices are uniform in a TA. Can you clarify what has been changed to include such scenario?

4 – CATT

Thanks for the contribution. In general,we support to have a Rel-18 WID on further slicing enhanement.One question on Slice specific RSRP/RSRQ thresholds for cell selection and reselection from our side is as below:

If there are two slices with different RSRP thresholds in one cell, how will the UE performs Cell reselection?

5 – LG Electronics UK

Thanks for the proposal. We agree that RAN slicing enhancements should be discussed in Rel-18 to address further network slice enhancements discussed in SA1/SA2. If any of Rel-17 ongoing discussion is not finalized, we can continue discussion in Rel-18. We think slice specific parameters such as different RSRP/RSRQ thresholds can be discussed in Rel-17.

We have a question for clarification regarding left over issue: network slicing on MR-DC. Do you expect to enhance the slice uniform availability principle in Rel-18, or assume uniform availability in Rel-17 considering enhancements between network elements?

3.6.2 Round 1 reply

Feedback Form 23: ZTE's reply to Round 1 comments

1 – ZTE Corporation

To comment #1 from CMCC

Thanks for the question.

The slice specific RSRP/RSRQ thresholds refer to the Qrxlevmin and Qqualmin as service in some slices may require higher radio quality.

We are also interested in slice specific Qoffset which will impact the Rn of neighbor cells supporting certain slices in cell ranking.

2 – ZTE Corporation

To comment #2 from KDDI

Thanks for the question.

The slice specific RSRP/RSRQ thresholds refer to the Qrxlevmin and Qqualmin in S-criterion.

We are also interested in slice specific Qoffset which will impact the Rn of neighbour cells supporting certain slices in cell ranking.

3 – ZTE Corporation

To comment #3 from Intel

Thanks for the question.

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For (1), per our analysis, we understand that at least the following SA1 requirements are not yet fulfilled by Rel-17 enhancement and would have RAN impact:

[CPR-001] For a UE authorized to access multiple network slices of one operator which cannot be simultaneously used by the UE (e.g. due to radio frequency restrictions), the 5G system shall be able to support the UE to access the most suitable network slice in minimum time (e.g. based on the location of the UE, ongoing applications, UE capability, frequency configured for the network slice).

[CPR-002] For a UE authorized to access to multiple network slices of one operator which cannot be simultaneously used by the UE (e.g. due to radio frequency restrictions), the 5G system shall minimize service interruption time when the UE changes the access from one network slice to another network slice. (e.g. based on changes of active applications).

[CPR-006] The 5G system shall be able to minimize power consumption of a UE (e.g. reduce unnecessary cell measurements), in an area where no authorized network slice is available.

[CPR-007] When a UE moves out of the service area of a network slice for an active application, the 5G system shall be able to minimize impact on the active applications (e.g., providing early notification).

We observe that some other companies also share their understanding on the potential RAN impact of the SA1 requirements and focus on different aspects. Creating a SI to analyze the requirements, with all the companies' input taken into consideration, would be helpful to have a full picture of the RAN impact.

- For (2), as mentioned by you, we understand that MO access to allowed slice not supported by the camped cell will not happen under homogeneous deployment. This is mainly for the traffic not in allowed NSSAI or traffic in allowed NSSAI under non-homogeneous deployment. Regarding the solution part, we understand the MO triggered cell reselection can be one candidate solution while another solution, as mentioned in our paper on IDLE/INACTIVE mode enhancement (RWS-210485) that UE receive RACH resource of other cells from the camped cell and initiate access to another cell directly, would also be useful for this case and we prefer to have it as a common mechanism in idle and inactive mode which can also help reduce load triggered HO and redirection.

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4 – ZTE Corporation

To comment #4 from CATT

Thanks for the question.

If there is only one intended slice at UE side, UE will apply the corresponding RSRP threshold in cell selection and reselection.

If there is more than one intended slice at UE side, UE will select a slice first and apply the corresponding RSRP threshold.

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5 – ZTE Corporation

To comment #5 from LGE

Thanks for the question.

We understand the homogeneous support of slice within TA is only for Rel-17 and we are open to follow this rule or to have non-homogeneous support of slice within TA in Rel-18.

For MR-DC related enhancement, we would like to focus on how to support a UE leverage different slice resource in MN and SN simultaneously, which would be applicable in both homogeneous and non-homogeneous support of slice within TA:

- homogeneous support of slice within TA: MN and SN belong to different TA and support different slices.

-

non-homogeneous support of slice within TA: MN and SN belong to same or different TA and support different slices.

3.6.3 Round 2

Feedback Form 24: Round 2 comments to RWS-210482

1 – FGI

Thanks for the nice contribution on Rel-18 RAN slicing. We also think RAN slicing should be further enhanced in Rel-18, not only based on Rel-18 SA1/SA2 input but also considering the Rel-17 leftover, as you mentioned.

We also support further enhancements on supporting RAN slicing in MR-DC. First, we would like to clarify the AMF behavior as you mentioned in the first paragraph of slide page 10. During the network deployment, suppose the AMF already knows the provision of network slices, so it is confusing to read "The AMF learns the S-NSSAIs supported per TA by the NG-RAN when the NG-RAN nodes establish or update the connection with the AMF." Could you elaborate more on the relationship between the AMF and NG-RAN regarding S-NSSAIs?

Regarding your comment#5 to LGE, homogeneous and non-homogeneous support of slice within TA are proposed. For homogeneous support of slice within TA, do you also consider that (1) MN and SN belong to different TA and support the same slices and (2) MN and SN belong to the same TA and support different slices? For non-homogeneous support of slice within TA, do you also consider that MN and SN belong to same or different TA and support the same slices?

2 – China Telecomunication Corp.

Thanks for the proposals.

We are also interested in further enhancement on RAN slicing. Some R17 leftovers shall be further discussed in R18. One question is of all the proposed objectives, what is the preference/priority of R18 RAN slicing?

3.6.4 Round 2 reply

Feedback Form 25: ZTE's reply to Round 2 comments

1 – ZTE Corporation

To comment #1 from FGI

Thanks for your follow-up questions.

-Q1: Understand your concern. It is true that AMF already know network slice itself can supported, but it does not mean each of RAN node connected to an AMF support all slice as AMF supported. One possible deployment scenario could be as following case: 5GC connected with three NG-RAN nodes (RAN node 1, 2, 3). While 5GC supports S-NSSAI 1&2&3, a possible deployment could be RAN node 1 support S-NSSAI 1&2, RAN node 2 supports S-NSSAI 2&3 and RAN node 3 supports S-NSSAI 1&3.

AMF aware the slice(s) supported by each RAN node via NGAP procedure, e.g. NG SETUP, RAN CONFIGURATION UPDATE. The detail can be found in TS 38.413.

-Q2: If MN and SN supported the same slices, we understand the slices supported on SN can be utilized by UE following the existing procedures.

2 – ZTE Corporation

To comment #2 from China Telecom

Thanks for the follow up question.

We understand the continuation of the slice remapping for service continuity as well as the RAN2 leftover issues (i.e. slice based reselection for MO and slice specific thresholds for cell selection and reselection) can be started first since we have finished the SI phase in Rel-17.

For the RAN impacts from Rel-18 Network Slicing work in other WGs (e.g. SA1 and SA2), we need some analysis to identify the RAN impacts first and the solutions can be discussed afterwards.

3.7 RWS-210484 Network Coding for 5G Advanced

In RWS-210484, we provide simulation results to verify that network/packet coding can be used to further increase the reliability or data transmission efficiency for multiple connections. Therefore, we recommend to consider NC (network coding)-based PDCP duplication with the following objectives for Release 18.

- Identify scenarios and use cases, as well as the corresponding evaluation methodology and simulation assumptions for performance evaluation.

- Study mechanism of network coding based PDCP duplication to exploit link diversity [RAN2].

- The packets segment/concatenation with equal size.

- The ordering of packets.

- Flexible redundancy ratio for different reliability requirements.

- Flexible split for different paths.

- Study erasure code schemes for network coding [RAN1]

- Study the potential erasure codes e.g. Reed-Solomon codes, Raptor codes, LDGM codes for network coding based duplication over multiple links, and strive to derive a solution of the optimal erasure codes.

More details on the motivation and simulation results can be found in RWS-210484.

3.7.1 Round 1

Feedback Form 26: Round 1 comments to RWS-210484

1 – Lenovo Mobile Com. Technology

Since network coding needs more time to coding and decoding in the transmission and reception sides,

how about the overall latency performance between networking coding and duplication?

Does it means the network coding is perform in the PDCP sublayer, or it can introduce a new sublayer for network coding?

2 – Qualcomm CDMA Technologies

Q1: Is the target scenario to enhance the packet duplication in DC? IIOT case?
Q2: Page 2, why the Parity packets can be transmitted in the second path only? Confuse that is it the duplication?
Q3: The figure in Page 2 is a general DC, not packet duplication, but proposal in page 7 says network coding based PDCP duplication.

3 – NTT DOCOMO INC.

- Do you consider only scenarios with multiple links (e.g., DC/IAB/mTRP) for this study?
- Assuming that XR and IIoT are considered as target use cases, the latency would also important as well as transmission efficiency and reliability. Then, what is the considered range for N and M? Is it correct understanding that larger values of N and M would cause latency issue (including computational complexity issue)?
- Since the proposed coding is packet level coding, is it possible to study this only in RAN2? Do you think packet coding (NW coding) has RAN1 spec impact if supported?

3.7.2 Round 1 reply

Feedback Form 27: ZTE's reply to Round 1 comments

1 – ZTE Corporation

To comment #1 from Lenovo

According to the current industrial application of network coding, e.g., Raptor codes in the application layer for DVB or MBMS system, we believe that the overall latency of network coding and duplication is small to support the transmission of big file or video stream. Moreover, the latency difference between network coding and duplication highly depends on the detailed coding scheme and its parameters, e.g., the size of generator matrix, the generator polynomial degree of RS codes. Therefore, it is possible to find a solution with acceptable latency and attractive performance gain.

It is preferred that network coding can be introduced in PDCP sublayer or RLC layer. Whether a new sublayer for network coding is introduced can be further discussed.

2 – ZTE Corporation

To comment #2 from Qualcomm

The reply to Q1 is 'Yes'.

Reply to Q2: In Page 2, we provide an example that the source packets are transmitted in the **first** path,

while the parity packets are transmitted in the **second** path. It can also work in the opposite way, i.e., source packets are transmitted in the **second** path, while the parity packets are transmitted in the **first** path.

For the proposed NC based duplication, we only need M (parity packets) = N (source packets), wherein the parity packets are obtained by one-by-one mapping from the source packets. For example, applying RS code to derive the parity packets, instead of simple duplication. But we are also open to the solutions with more redundancy information , i.e., M is larger than N.

Reply to Q3: Please see our reply to Q2.

3 – ZTE Corporation

To comment #3 from NTT DOCOMO

Reply to Q1: Except for the scenarios with multiple links, we think that the scenarios with high data rate requirement (e.g. XR, IIoT), high reliability (e.g. URLLC), and unstable channel (e.g. users in the inter-cell field and users in the edge of cell) can be also considered as the target scenarios.

Reply to Q2: For the original duplication feature, the N packets (obtained by duplication) are transmitted in each path. For the proposed NC-based duplication, we would like to clarify that M is equal to N. The parity packets are derived by one-by-one mapping from the source packets, e.g., RS code is used to obtain the parity packets in our simulation. But the total number of transmitted packets does not increase.

Although larger values of N and M may cause latency issue, a grouping-based method which is similar with CBG concept in NR can be used to resolve the problem .

Reply to Q3: We don't think that packet coding (NW coding) has RAN1 spec impact.

3.7.3 Round 2

Feedback Form 28: Round 2 comments to RWS-210484

3.7.4 Round 2 reply

Feedback Form 29: ZTE's reply to Round 2 comments

3.8 RWS-210485 Further enhancement for IDLE/INACTIVE in Rel-18

In RWS-210485, we suggest work on enhancements for idle and inactive mode procedures in Rel-18. The potential enhancements span multiple use cases and multiple verticals as noted below:

- Load balance and UE distribution (useful for wideband carrier deployments, NTN and supporting specific verticals)

- Enhanced cell reselection with redistribution factor

- Inter-cell fast initial access (i.e. fast initial access from camped cell to other cells).

- Differentiated Paging and MT access (useful for supporting specific verticals where MT traffic prioritization is essential – e.g. NSPS)

- Specific paging resources for slice/service type/UE type

- Indicate the slice/service type in paging

- Enhancement for Small data transmission (useful supporting specific verticals and for general eMBB applications)

- Small data transmission through RACH or pre-allocated resources from RRC_IDLE state

- Extend small data transmission schemes to support also the MT traffic.

- SDT with compact signalling on NW side (e.g. to save the context fetch by using default configurations at UE)

3.8.1 Round 1

Feedback Form 30: Round 1 comments to RWS-210485

1 – LG Electronics Inc. First, we think this paper includes three different topics, which may not be included in a single item. What do you think about splitting them into three different items? Secondly, we are interested in SDT for MT traffic. We also propose to support DL SDT in our paper RWS-210231. However, in your paper, it is not clear how the network triggers DL SDT for a UE. We assume paging needs to be enhanced for this purpose, but do you have any other idea on this? Please elaborate more on the mechanism to trigger DL SDT.
2 – Beijing Xiaomi Mobile Software The redistribution for loaded cells supporting large numbers of IDLE/INACTIVE UEs is somewhat interesting. Generally is there a possibility that an SDT device will find itself constantly having to reselect a new cell every time it sends data if all cells in the vicinity are heavily loaded and the RedistributionFuntion is active regardless of whether the transmission was successful? (successful transmission may indicate to the UE that there was sufficient cell bandwidth?) Also is the scenario more related to large numbers of only SDT users within the cell where normal load distribution is not possible for a smaller number of large bandwidth users?
3 – Apple (UK) Limited Agree with LG seems this covers several different aspects which may be split into different SI/WI. One specific question regarding SDT in idle and MT traffic, is the intention to support both MO and MT traffic in idle and MT traffic for inactive?
4 – CATT For SDT in idle mode, we are interested in how to ensure the security of the data. coud you elaborate more about this?

5 – China Telecommunications

Thanks for these interesting topics. We have some questions about topic 1 and topic 2:

For topic 1, could you elaborate more about the mechanism of fast initial access. How to decide which cell or BWP to choose during fast initial access. Is there additional requirement on neighbor cell measurement?

For topic 2, we are wondering the impact on paging capacity when introduce new slice/service types into paging message. Are these service types configurable by operator?

6 – Samsung Electronics Co.

Q1. Slide 15: What is the use case for SDT through RACH?

7 – vivo Mobile Communication Co.

Thanks for your contribution. We are also interesting the idle carrier management enhancement. We can consider it from both coverage and load distribution aspects in R18.

For Small date, can you clarify more usage aspects about you R18 enhancement comparing with our R17 work?

8 – China Mobile International Ltd

For Load balance and UE distribution, we are interested in it.

Q1: Is ”Enhanced cell reselection with redistribution factor” the similar objective as CMCC proposed in frequency-combination based elastic cell?

Q2: Inter-cell fast initial access (i.e. fast initial access from camped cell to other cells), does it mean the UE aquires the access information of neighboring cell from serving cell, this will enable the fast access to the neighboring cell which support the service/slicing the UE wants to conduct? This is one of objectives proposed during the RAN slicing SID drafting phase, but it is removed from the SID eventually. In the current Rel-17 RAN slicing WID, only cell reselection to neighboring cell, camp on this cell and then initiate access by reading the system information is supported.

For paging:

Q1: We are interested in this topic, is it has been dicussed in other WI, e.g., multi-SIM?

For SDT□

Q1□What’s your view on how to handle SDT topic, in a dedicated WI for SDT enhancement or combined with others?

9 – Nokia Corporation

We are generally positive to enhancing both SDT and INACTIVE mode operation.

Q1: Is the intent with the LB proposal to just copy-paste the similar LTE mechanism to NR?

Q2: Are the NTN-motivated mechanisms only intended for NTN or would they be applicable to generic NR scenarios as well?

Q3: [SDT from IDLE]: What would the target use cases benefitting from SDT from IDLE given the support of SDT from INACTIVE and CIoT CP/UP on 5GC?

10 – China Unicom

Thanks for this contribution. We support for the further enhancement for IDLE/INACTIVE in R18. Some comments need for clarification.

Q1: What is the definition of redistribution factor? and what is the mechanism if redistribution factor is used for the cell reselection?

3.8.2 Round 1 reply

Feedback Form 31: ZTE's reply to Round 1 comments

1 – ZTE Corporation

To comment#1 from LG

Thanks for the comments!

Indeed we have grouped multiple topics that benefit IDLE/INACTIVE mode under the same presentation. How to separate these into different work streams is definitely up for further discussion as rightly pointed out. We first wanted to get some feedback on the objectives and then we could try to understand how to group these into some logical containers (e.g. Work items etc) as a result of this discussion.

Yes, paging enhancement for supporting MT-SDT is certainly once way to achieve this. We just wanted to have the objective out there so as to not constrain any solution. For instance, it can also be configured per UE for instance etc. The main point is to enable the UE to initiate SDT upon being paged.

2 – ZTE Corporation

To comment#2 from Xiaomi

Thanks for the questions.

For the first question, the idea is to ensure that the UE resumes the SDT procedure in the "correct cell". By this we mean in the cell that is suitable and is not loaded etc. this then ensures that the data can be handled without issues and there is no need to have something like a fallback to connected and subsequent HO etc. One problem if there is a large population of SDT UEs camping in the same cell is that these UEs may generate traffic in the same cell and hence overload this cell (whilst the other cells which are suitable may be underutilized at the same point). It can be left to NW implementation to decide when to enable redistribution to avoid ping-pong selection. If all cells are overloaded, then the redistribution Function may not be enabled by NW as it is mainly used to distribute UEs when there is imbalanced load among cells and will not help when all the cells are overloaded

For the second question, we understand the redistribution factor based mechanism can be a common mechanism applicable to both SDT users and non-SDT users, to distribute UE among cells or frequencies without differentiate whether it is a SDT user or not. It is also possible for NW to enable redistribution only for specific users like SDT users, e.g. by having SDT specific redistribution targets and factors or having common redistribution targets and factors but only enable redistribution for SDT users via NW indication.

3 – ZTE Corporation

To comment#3 from Apple

Thanks for the question.

Indeed, as pointed out above, we grouped objectives that benefit IDLE/INACTIVE mode in this presentation and we are open to discuss the details of the objectives first and based on this decide on how to regroup them into different logical containers/WIs etc.

Since MO traffic in inactive has already been supported in Rel-17 for INACTIVE, we intend to support MO/MT traffic in both idle and inactive in Rel-18.

4 – ZTE Corporation

To comment#4 from CATT

Thanks for the question.

Indeed, data should be secured and we think the NAS security context could be used for this purpose in IDLE mode.

5 – ZTE Corporation

To comment#5 from ChinaTelecom

Thanks for the questions.

-For topic 1: For the case when more than one neighbor cells' access resources are provided from the camped cell, RSRP/RSRQ threshold can be configured for UE to select one from them. Since UE anyway needs to perform measurements on neighbor cells for reselection, there would be no additional requirements. Some other information, e.g. the supported slice(s) in neighbor cells and the redistribution factor for each cell can also be taken into consideration when UE select the target cell for fast access. We understand multiple initial BWPs can be supported in one cell for different verticals or slices and UE will select the corresponding initial BWP for a certain vertical/slice. We may also have redistribution factor for each initial BWP and UE will select one for fast access based on the redistribution factor.

-For topic 2, the required signaling overhead depends on the detailed design and there are still spare bits in short message or paging DCI, the paging capacity would not be impacted if we indicate such info via short message or paging DCI. If the spare bits in Short Message are not sufficient to indicate the slice or service type, separate P-RNTI or separate paging resources (e.g. search space or CORESET) can be defined for slices or service types. We understand the service type can be defined and configured by operator.

6 – ZTE Corporation

To comment#6 from Samsung

Thanks for the question.

So, similar to the Rel-17 work, where RA-SDT and CG-SDT are defined for INACTIVE state, we basically propose to extend the same to IDLE state. So, the main use case of RA-SDT for IDLE will then be where the UE generates small infrequent data whilst in IDLE state and potentially with unknown TA (and hence no CG resources).

7 – ZTE Corporation

To comment#7 from vivo

Thanks for the interest on the general enhancements. It would be good to flesh-out the details so that we can decide on the grouping of these objectives per above.

In Rel-17, only the INACTIVE state is supported and only the MO use case will be specified. Further we think there may be some left over issues with in Rel-17 that may also be of high interest. In general, we can group these together as the possible enhancements.

Specifically, for IDLE mode the advantage of enabling SDT is that the network can then avoid keeping the UE context for a large population of UEs. This for instance may be particularly useful when the NR technology matures with larger 5G UE penetration and also is useful for specific technologies (e.g. NTN, where there may be a very large number of UEs in a given cell by design).

Then, we think the support of MT traffic for SDT is a natural extension to the existing feature set and comes with rather minimal changes to the specification work and hence should certainly be pursued. This enables DL specific use cases (e.g. MT based positioning and verticals that need priority access for SDT based on DL triggers/paging).

8 – ZTE Corporation

To comment#8 from CMCC

Thanks for your support and comments.

-For Q1, I think our motivation is aligned, i.e. to realize more efficient load balancing before and from initial access. Enhance cell reselection with redistribution factor would be helpful for load balance before initial access while inter-cell fast access helps offloading from initial access.

-For Q2, the UE acquires the access information of neighbor cell from the serving cell and initiate access to neighbor cell directly to avoid the load triggered HO or redirection, which is also one of the main target of the idle/inactive mode distribution. The supporting slice of neighbor cells can also be taken into consideration when deciding the target for fast access if there are more than one candidate target cells but we understand this would be a common mechanism for fast access.

-For paging:

We understand only the MT-voice will be indicated as paging cause in the Rel-17 multi-SIM WI without differentiating other service types, slices or UE types. And specific paging resources for slice/service type/UE type have not been covered yet.

-For SDT:

In general, as noted above, we have grouped multiple topics that benefit IDLE/INACTIVE mode under the same presentation (and this includes SDT as rightly pointed out in the question below). How to separate these into different work streams is definitely up for further discussion as rightly pointed out. We first wanted to get some feedback on the objectives and then we could try to understand how to group these into some logical containers (e.g. Work items etc.) as a result of this discussion. Depending on scope, we do think that a separate WI for SDT enhancements in Rel-18 may be one possible option.

9 – ZTE Corporation

To comment#9 from Nokia

Thank you for your support and for the comments.

-Q1: Two solutions can be studied for the load balancing in idle and inactive state:

Solution 1: Enhanced cell reselection with redistribution factor (similar as LTE), with which the UE can be distributed to different cells by cell reselection. Each candidate redistribution target (cell/frequency) configured with redistribution factor and UE chooses redistribution target based on UE ID. Some NR specific features, e.g. SSB/slice/NPN/SDT can also be considered when we design the redistribution factor based mechanism in NR.

Solution 2: Inter-cell fast initial access (i.e. fast initial access from camped cells to other cells). The UE will acquire the initial access configuration for other cells through the SIB of camped cell, and can switch to the target cell and initiate the access procedure immediately to avoid the load triggered HO or redirection of UE.

-Q2: We understand the redistribution mechanism can be applicable to general NR scenarios as well as NTN. Also we understand the redistribution configuration and/or the inter-cell access configuration would be broadcast per cell and it would be up to NW to broadcast the configuration and enable the operation with much flexibility.

-Q3: With regards SDT for IDLE, the main target use case is when there is a large penetration of 5G UEs in the market. This becomes more and more relevant as technology matures. Keeping the UE context for all the UEs in INACTIVE state including the network interfaces and connections, will be problematic and hence IDLE mode solutions are useful. Further, as also noted above, some NR features such as NTN, will by design require supporting a large population of UEs and keeping all these in INACTIVE state will be impractical and avoiding signaling storm from these UEs for small data packets when these initiate connection procedure form IDLE mode would be beneficial especially for these use cases.

10 – ZTE Corporation

To comment#10 from ChinaUnicom

Thanks for your support and comments.

-Enhanced cell reselection with redistribution factor (similar as LTE), with which the UE can be distributed to different cells by cell reselection. Each candidate redistribution target (cell/frequency) configured with redistribution factor and UE chooses redistribution target based on UE ID. Some NR specific features, e.g. SSB/slice/NPN/SDT should also be considered when we design the redistribution factor based mechanism in NR.

-We give some explanation about the redistribution factor based solution in LTE (the redistribution target selection details can be found in 36304-e60 5.2.4.10.1).

The distribution factor is like the weight factor of each redistribution target. UE choose the redistribution target based on UE ID and consider this redistribution target to be the highest priority. As shown in our slide 4, the distribution factor for three redistribution targets are: Cell#1 with distribution factor 2, Cell#2 with distribution factor 2, Cell#3 with distribution factor 1.

Then:

2/(2+2+1)=40% of the UEs will be distributed to cell#1;

2/(2+2+1)=40% of the UEs will be distributed to cell#2; 1/(2+2+1)=40% of the UEs will be distributed to cell#3.

UE will choose cell#1/2/3 based on its UE ID.

For example:

UE with ID 1-80 will go to cell#1;

UE with ID 81-160 will go to cell#2;

UE with ID 161-200 will go to cell#3.

3.8.3 Round 2

Feedback Form 32: Round 2 comments to RWS-210485

1 – China Telecommunications

Thanks for your information. We acknowledged the direction of the WI and agree with the optimization on all these topics.

For topic2, we also think the service type or slice should be configurable to operator. Can you elaborate

more on how to enable opterators to flexibly configure the service type or slice if we use seperate DCI, P-RNTI or seach space to descriminate them.

2 – China Unicom

Thanks for your contributions and clarification. For the two solutions that can be studied for the load balancing in idle and inactive state, what's the difference between them in terms of implementation complexity and impacts on existing specifications?

3.8.4 Round 2 reply

Feedback Form 33: ZTE's reply to Round 2 comments

1 – ZTE Corporation

To comment #1 from China Telecom

Thanks for your support and follow up questions.

The indication of specific service type and slices can be indicated using the spare bits in Short Message, e.g. by indicating the index of the services type or slices broadcast to be supported in this cell.

Since P-RNTI is now a fixed value, we can define different P-RNTI for different slices or services types and UE can try these P-RNTIs in scrambling and the successful one would tell the corresponding slices or services.

If different paging search spaces are configured for specific service types or slices, UE would monitor paging in these search spaces and the search space in which the paging is received would tell the corresponding slices or services

2 – ZTE Corporation

To comment #2 from China Unicom

Thanks for the questions.

-Solution 1: Enhanced cell reselection with redistribution factor (similar as LTE), with which the UE can be distributed to different cells by cell reselection. Each candidate redistribution target (cell/frequency) configured with redistribution factor and UE chooses redistribution target based on UE ID. Some NR specific features, e.g. SSB/slice/NPN/SDT can also be considered when we design the redistribution factor based mechanism in NR.

-Solution 2: Inter-cell fast initial access (i.e. fast initial access from camped cells to other cells). The UE will acquire the initial access configuration for other cells through the SIB of camped cell, and can switch to the target cell and initiate the access procedure immediately to avoid the load triggered HO or redirection of UE.

Comparison:

In solution 1 (enhanced cell reselection with redistribution factor), UE will perform cell reselection according to the redistribution factor configured and camp on different cells.

In solution 2 (inter-cell fast access), UE can camp on one cell and switch to another cell when initiating MO traffic without performing cell reselection. Phantom cells in solution 2 can avoid SIB transmission, which reduces the power consumption at network side.

Solution 1 mainly impact the cell reselection procedure performed at UE side while the redistribution configuration will also be provided in system information so the 38.331 and 38.304 would be impacted.

Solution 2 would impact the random access procedure while the RACH resources for the target cell will be provided in the serving cell's system information so the 38.331 and 38.321 would be impacted.

3.9 RWS-210486 Network power saving for 5G Advanced

In RWS-210486, it is observed that energy consumed by 5G base station is 3 4 times of 4G base station due to the increased number of RX chains, bandwidth, transmission power, carrier frequency, etc. Therefore, the network power saving techniques should be considered for Release 18 to build a green and sustainable 5G advanced network. The proposed SI scope for network power saving includes the following.

- Evaluation methodology and solutions for gNB Tx/Rx antenna or beam on-off adaptation [RAN1, RAN2]

- Extend periodicity of "always-on" signal/channel, such as SSB [RAN1, RAN2, RAN4]

- UE assistance information [RAN2]

- Network coordination for network power saving

More details on the motivation and potential enhancements can be found in RWS-210486.

3.9.1 Round 1

Feedback Form 34: Round 1 comments to RWS-210486

1 – MediaTek Inc.

Thanks for the quality contribution. Below please find our comments/questions:

- General comment:
  - We are supportive to improve system-wise (NW + UE) energy efficiency that can reduce operator OPEX as well as improving user experience with further reduced UE power consumption. Also, UE cooperation, including timely suspension of UE UL activities and UE assistance information, are useful for effective network power saving.
  - In this regard, network power saving can be rephrased to system energy efficiency enhancement so as to better reflect the joint network-UE considerations.
- Specific comments/questions:
  - On **Proposal 1**, we agree that antenna/beam adaptation will be a useful power saving scheme for gNB. Regarding the popularity of multi-TRP enhancement for MIMO, should we also include multi-TRP scenario in evaluation methodology and solution identification for system-wise power saving?

- On **Proposal 2**, extending periodicity of SSB will impact legacy UE measurement and mobility performance. How to manage the impact?
- On **Proposal 3,** what is expected additional UE assistance information to assist gNB/TRP power saving?

2 – China Unicom

Thanks for this contibution. Our comments are below.

Q1. gNB Tx/Rx antenna, beam on-off adaptation and Extend SSB periodicity, what is the impact on normalization?

Q2. For UE assistance information, what information should be reported?

3 – China Telecomunication Corp.

Thanks a lot for the good contribution for network power saving.

We also see the motivation to have a dedicated SI/WI for network energy saving in R18 in order to fully study the potential network energy saving solutions, which is very important for the green and sustainable 5G Advanced network. And we are also interested in the listed four potential objectives for network power saving.

Regarding the description of the first objective, we have a question: Is the 'Evaluation methodology' only for 'gNB Tx/Rx antenna/beam on-off adaptation' OR also considered for other items?

4 – BBC

Sustainability

The BBC supports measures to improve the sustainability of the 5G RAN.

In particular we're keen to see a realistic and standardised methodology for the measurement and modelling of power consumption in networks to help operators to reduce their impact. In addition, as a content provider, the BBC would like the ability to better understand the impact of our content being consumed over these networks to also drive down our impact.

5 – vivo Communication Technology

[vivo]

Generally speaking, we think network power saving is useful for operators to reduce OPEX. Following are some questions for clarifications,

(1) For gNB Tx/Rx antenna or beam on-off adaptation, we would like to know how often does the gNB adapt the Tx/RX antenna and beam. Intuitively speaking, if it is quite often, e.g., ms, the gNB still need to keep some power level. However, it is not quite often, e.g., 100ms or even 1s, gNB can turn off the RF chain quite a while so that the power consumption can be largely saved.

(2) For extending periodicity of "always-on" signal/channel, such as SSB, we would like to know how to keep legacy UE compatibility.

For network coordination for power saving, currently RAN3 has studies for network energy saving, would be better to know the differences between this one and RAN3.

6 – Beijing Lenovo Software Ltd.

Thanks for this interesting topic on network power saving. Generally, in order to help network obtain the power saving, the specific UE assistance information should be identified, and we hope the assistant information from UE side is to be simple and efficient.

7 – Qualcomm communications-France

Q1: For practical deployments, what fraction of time is a gNB in Idle mode, lightly loaded and fully loaded states? What are your views on looking at aggregate power consumption at a gNB over a 24-hour period?

Q2: For mechanisms that aim to turn off certain gNB components (beams, panels, etc.), what time scale do you have in mind for these operations? e.g., per-slot basis?

8 – Apple Italia S.R.L.

Q1: Would extending SSB periodicity affect legacy UEs?

Q2: We assume the network can do some dynamic on/off today based on the traffic load. Do the enhancements mainly focus on additional assistance information from UE that can help the network make better decision?

Q3: what is the time scale being considered for gNB Tx/Rx antenna or beam on-off adaptation?

9 – LG Electronics Polska

In page 4, at network coordination part, could you explain what is ES mode extension?

10 – China Mobile Com. Corporation

Thanks for the contribution. Network energy saving is very important. Regarding the gNB Tx/Rx antenna on-off adaptation, currently only antenna ports are visible in RAN1 spec instead of physical gNB Tx/Rx antennas, and it seems that the gNB Tx/Rx antennas on-off could be realized by reconfigure the antenna ports of CSI-RS or DMRS, so I am wondering what's the spec impact in your view regarding this. Another question is what does 'ES mode' mean?

11 – Spreadtrum Communications

Thanks for the quality contribution. For "Extend periodicity of "always-on" signal/channel, such as SSB", does it have impact on initial access for UEs especially for the legacy UEs?

3.9.2 Round 1 reply

Feedback Form 35: ZTE's reply to Round 1 comments

1 – ZTE Corporation

To comment #1 from MediaTek

Thanks for the comments and questions. We agree that UE energy efficiency is important. Hence, multiple UE power saving techniques have been specified in Rel-15 Rel-17. And we are open to discuss what can be done to further reduce UE power consumption in Rel-18.

Response to Question 1: We also noticed that there are several enhancement on m-TRP being discussed in Rel-17 MIMO. We think these enhancements, such as switching between m-TRP and s-TRP, can be taken

as a good starting point if multi-TRP scenario is considered for power saving.

Response to Question 2: The mobility measurement procedure is determined by many factors, such as RRC state, DRX configuration, RS configuration, etc. Proper adjustment of the SSB doesn't necessarily have significant negative impact on measurements. Meanwhile, we think we can also discuss how to minimize the UE measurement and mobility performance, for example, by conditioned extension of SSB occasion, etc.

Response to Question 3: The UE assistance information can be UE mobility information, traffic pattern, or other UE assistance information that is beneficial for NW to evaluate UE population, traffic load etc.

2 – ZTE Corporation

To comment #2 from China Unicom

Thanks for the discussion and comments.

Response to Question 1:One of the potential impacts can be introducing an indication from NW to UE to minimize the impact on system performance, or allow UE to adapt to different configurations.

Response to Question 2:As to the UE assistance information, please see our reply to MTK.

3 – ZTE Corporation

To comment #3 from China Telecom

Thanks for the questions and comments.

Regarding the evaluation methodology, we think developing a general methodology/model which is also applicable to other power saving solutions is better to evaluate the PS gain from different schemes.

4 – ZTE Corporation

To comment #4 from BBC

Thanks for the comments. We do share same view as you that to achieve sustainability for 5G NR is critical.

5 – ZTE Corporation

To comment #5 from vivo

Thanks for the comments and questions.

Response to Question 1: How often gNB adapt the antenna and beam depends on many factors, such as UE population, traffic mode, etc. We agree that how much power can be saved by gNB is relevant to how long/often the antenna and beam adaptation is. Hence, at least for the evaluation methodology, we may need to define different sleeping states as it has been done in TR 38.840.

Response to Question 2: We think the impacts on UE can be minimized by, for example, introducing an indication from network. And we are also open to discuss other solutions.

Response to Question 3: The new NW energy saving schemes may require coordination information exchanging between gNBs. Furthermore, for the AI enabled network power saving, the network coordination is mainly focused on the exchange of input/output data for AI function. While for this proposal, our intention is to exchange the needed information due to, for example, the predicted cell load, the enhancement of cell activation/de-activation, e.g., energy saving(ES) mode extension.

6 – ZTE Corporation

To comment #6 from Lenovo

Thanks for the comments. We agree that we need to consider the simple and also effective UE assistance information for network energy saving.

7 – ZTE Corporation

To comment #7 from Qualcomm

Thanks for the questions and comments.

Response to Question 1:

We are not sure about whether we have the same understanding of gNB's idle, lightly loaded and fully loaded states. The fraction of time of different gNB states depends on the deployment/scenarios. For example, for a gNB set up in the shopping mall, the time distribution of different states would be quite different with another gNB located in the neighborhood.

Response to Question 2: As to the time scale of the gNB on-off operation, we think it depends on which component is turned off. For example, for gNB antenna/beam adaptation, it is more dynamic. While for the enhancement of cell activation/de-activation, it is more semi-static. In general, the time scale can be in a range of several symbols to tens of milliseconds.

8 – ZTE Corporation

To comment #8 from Apple

Thanks for the comments and questions.

Response to Question 1:There would be some impact on the legacy UE, such as initial access. But we are open to discuss solutions that can minimize the impacts.

Response to Question 2: UE assistance information is one of the potential enhancements. In addition to that, indication from NW about the dynamic adaptation can be also considered to assist UE to be aware of the gNB adaptation.

Response to Question 3: For the time scale of gNB antenna/beam adaptation, please see our reply to Qualcomm.

9 – ZTE Corporation

To comment #9 from LG

Thanks for your question.

Regarding ES(energy saving) mode□we expect more toolboxes can be introduced in Rel-18 in addition to cell activation/de-activation. The toolboxes can be symbol-level shutdown, slot-level shutdown, channel shutdown. etc.

10 – ZTE Corporation

To comment #10 from CMCC

Thanks for the comments and questions. The current mechanism needs to trigger reconfiguration procedure, which is semi-static and also causes an ambiguity period between gNB and UE. Hence, a more dynamic scheme is preferred, which is more beneficial to gNB power saving.

Regarding ES(energy saving) mode□please see our response to LG as given above.

11 – ZTE Corporation

To comment #11 from Spreadtrum

Thanks for the comments and questions. In our views, there would be some impact on the legacy UE initial access. But we are open to discuss solutions that can minimize the impacts.

3.9.3 Round 2

Feedback Form 36: Round 2 comments to RWS-210486

1 – China Unicom

For UE to adapt to different configurations according to the gNB Tx/Rx antenna, beam on-off adaptation and Extend SSB periodicity change, whether can reuse the RRC reconfiguration message(Maximum MIMO configration, SSB periodicity configuration,etc.)?

2 – China Telecomunication Corp.

Thanks for the clarification. We think it maybe more clear to separate the description of 'Evaluation methodology' and 'solutions for gNB Tx/Rx antenna or beam on-off adaptation' since the 'Evaluation methodology' also applies to other network energy saving mechanisms.

3 – Spreadtrum Communications

Thanks for the clarification. In our view, with the extending the periodicity of periodic RS, gNB should send the aperidic RS to assist UE sync up, as being specified fast Scell activation in R17. It can guarantee the synchronization at UE side. The impact to the legacy UE, especially for initial access, would be present, but could be mitigated gNB implementation, e.g. guarantee PCell with the fine periodicity of SSB/TRS. It seems that we have discussed the periodicity of SSB in PCell in R15, and gNB vendor promised to deploy 5 20ms periodicity of SSB in PCell for macro deployment.

4 – HUAWEI TECHNOLOGIES Co. Ltd.

Thank you very much for the contribution. For gNB Tx/Rx antenna or beam on-off adaptation, we think some CSI enhancements to reflect the dynamic change can be considered, what do you think?

3.9.4 Round 2 reply

Feedback Form 37: ZTE's reply to Round 2 comments

1 – ZTE Corporation

To comment #1 from China Unicom:

Thank for your questions. We agree that some of the adaptation schemes can be implemented by RRC reconfiguration. However, compared with the semi-static way, a dynamic adaptation is preferred to provide network with more chance to switch off the antenna/beam depending on the UE population, traffic, etc. Meanwhile, with the dynamic adaptation scheme, the ambiguity period between NW and UE can be reduced and the impact on data delivery can be minimized.

2 – ZTE Corporation

To comment #2 from China Telecomunication Corp.:

Thanks for the comments and suggestions. We agree that it is better to have a separate objective for evaluation methodology.

3 – ZTE Corporation

To comment #3 from Spreadtrum Communications:

Thanks for the comments and suggestions of the solutions to relieve the impacts on legacy UEs. We will take them into consideration.

4 – ZTE Corporation

To comment #4 from HUAWEI TECHNOLOGIES Co. Ltd.:

Thank for the comments and questions. As to the impact of dynamic gNB adaptation, we think CSI enhancement is one of the possible directions, we are open to discuss it.

3.10 RWS-210487 Cross-link interference coordination in Rel-18

In RWS-210487, we suggest a WI for Further enhancement of Cross-link interference coordination in Rel-18. Although this normative work is mostly done in RAN3, coordination with RAN1 and RAN2 is needed.

The first reason is with the large-scale deployment of 5G network in R16-17, the CLI problem will become more and more serious. With semi-static solution (Intended Uplink/Downlink TDD pattern) and implementation solution for measurement result (SRS Resource exchange) would not be able to meet the challenge of network situation in Rel-18. Second reason is for new feature in Rel-18. One preeminent feature in Rel-18 is XR.

XR is one vertical use case (with large DL packet) which requires both stringent PDB (packet delay budget) and high reliability, while the inter-cell interference would impact the CSI measurement accuracy and the scheduling strategies including MCS, etc, which would finally degrade the reliable transmission of data packet. The current specification for CLI cannot meet the requirement of XR.

In addition, another possible feature is going to be discussed in Rel-18 is to support full duplex. For full duplex, each cell would have DL and UL transmission simultaneously, as shown in the following figure. Hence, UE-UE interference, and gNB-gNB interference would occur more often, and is more difficult to mitigate. Even though it can be restricted to subband full duplex in the initial stage, dynamic TDD should be assumed at least for small cells in order to obtain full gain of duplexing flexibility. In such cases, cross-link interference coordination will become more important to ensure the gain obtained from subband full duplex. Also, it is more desirable to standardize this kind of coordination so that it can be applicable to more scenariosthe potential enhancement aspects include:

Based on above, more information exchange between NG-RAN node to mitigate the CLI issue is necessary.

Therefore, from our view, the following information can be taken into account in RAN3 for normative work in Rel-18:

1: SRS resource information exchange (Measurement resource exchange).

2: Measurement report information : exchange of measurement results and identified aggressor and/or victim UEs.

3: Protected zone information : exchange of resources (in frequency and time) which should be protected from CLI.

4: Intended beam scheduling information: exchange of beam-specific information of aggressor UEs (e.g., UE's Tx beam index, set of RBs, and slot index)

5: Scheduling information : exchange of resource allocation and scheduling, based on exchanged resource allocation and scheduling decisions, a gNB could avoid scheduling a victim UE on the same time-frequency resource as its aggressor UE, and vice versa.

6: Transmit power information: exchange of power control parameters (e.g., power backoff level, power boosting level, number of symbols) for coordinate power of aggressor UE and/or victim UEs by reducing and/or boosting Tx power.

7: CLI sensitivity vector: intended to inform other gNBs how sensitive the different slots (in the radio frame configuration) are to CLI.

3.10.1 Round 1

Feedback Form 38: Round 1 comments to RWS-210487

1 – Futurewei Technologies

We think the contribution has a good proposal that listed 7 types of information that can be taken into normative work for corss link interference;

However, as the contribution does not talk much about the use cases, we are not sure whether the proposal applied equally to all possible use cases or is that different use case corresponds to different information?

We also would like to know the priorities associated with the proposed 7 types of information. Also, regarding CLI sensitive vector, it is better to include a definition;

We are interested in the study and we think CLI coordination is important especially if flexible duplex is considered. Please take a look at our contribution RWS-210036 (https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_AHs/20 210036.zip) and feel free to comment at: https://nwm-trial.etsi.org/#/documents/4580

2 – China Unicom

Thanks for providing this contribution.

We support cross link interference coordination and it is worth to solve the CLI issue in cellular networks, we have the following questions for clarification:

1. The information exchange includes SRS resource information, measurement results, intended beam scheduling information, etc. Which information is applied for UE-UE interference case? and which one is applied for gNB-gNB interference case?

2. The coordination information is transmitted via NG or some other interfance?

3 – Samsung Electronics Polska

'Page 20: for 1st sub-bullet, it seems you suggest that some PHY channels/signals can work with full duplex while other signals can only work with half duplex mode. Do you assume UE can differentiate different mode, and use different receiver for these signals in different mode ?

3.10.2 Round 1 reply

Feedback Form 39: ZTE's reply to Round 1 comments

1 – ZTE Corporation

To comment from Futurewei:

Thanks very much for your questions. The priority decreases with the serial number. It means the most important item is on the top of the list. CLI sensitive vector is used to inform other gNBs how sensitive the different slots/time periods are to CLI.

2 – ZTE Corporation

To comment from China Unicom:

Thanks for your question.

A1: For exchange of the measurement resource, measurement results, and intended beam scheduling information can be applicable to both UE-UE interference and gNB-gNB interference, if the gNB-gNB interference management is also considered in Rel-18. And to be specific, the SRS resource is used for UE-UE interference measurement according to Rel-16 CLI WI, hence, the exchange of SRS resource is to suppress UE-UE interference.

A2: Same as what we already supported in Rel-16, the information can be transmitted in XnAP and F1AP.

3 – ZTE Corporation

To comment from Samsung Electronics Polska:

Thanks for your question. For full duplex, each cell would have DL and UL transmission simultaneously. Hence, UE-UE interference, and gNB-gNB interference would occur more often, and is more difficult to mitigate. Even though it can be restricted to subband full duplex in the initial stage, dynamic TDD should be assumed at least for small cells in order to obtain full gain of duplexing flexibility. In this sense, there is no need for UE to differentiate duplex modes as they would incur CLI anyway.

3.10.3 Round 2

Feedback Form 40: Round 2 comments to RWS-210487

1 – Samsung Electronics Polska

Thanks for your reply, we understand your motivation for CLI enhancements. One other comment for dynamic TDD, even for small cell, it is not easy to deploy dynamic TDD due to cross-operator interference.

3.10.4 Round 2 reply

Feedback Form 41: ZTE's reply to Round 2 comments

1 – ZTE Corporation

To comment from Samsung Electronics Polska:

Thanks for the comments. We agree that it is not easy to handle cross-operator interference. One possible solution is to consider sub-band full duplex(or XDD) to mitigate the inter-operator interference. In this sense, the remaining interference issues to be handled are UE-UE interference, gNB-gNB interference, etc. For UE-UE interference, some enhancements, such as more exchange information discussed in our Tdoc RWS-210487, are needed for better CLI management.

4 Summary

Ten contributions from ZTE are submitted to agenda item 4.3 cross functionalities. During the 2 rounds of NWM discussion, ZTE has received

- For RWS-210478, Support of Artificial Intelligence Applications for 5G Advanced, 20 comments from 18 companies;

- For RWS-210481, Enhancements on predictable mobility for beam management, 10 comments from 7 companies;

- For RWS-210483, Enhancement for data collection for AI in NR and EN-DC, 9 comments from 8 companies;

- For RWS-210479, Uplink Enhancements for 5G Advanced, 24 comments from 19 companies;

- For RWS-210480, Support of Blockchain for 5G Advanced, 5 comments from 5 companies;

- For RWS-210482, Further enhancement of RAN slicing, 7 comments from 7 companies;

- For RWS-210484, Discussion on Network Coding for 5G Advanced, 3 comments from 3 companies;

- For RWS-210485, Further enhancement for IDLE/INACTIVE, 12 comments from 10 companies;

- For RWS-210486, Discussion on network power saving for 5G Advanced, 15 comments from 12 companies;

- For RWS-210487, Cross-link interference coordination, 4 comments from 3 companies.

ZTE has provided answers to all the comments above.