3GPP TSG RAN Release 18 Workshop RWS-210628

Electronic Meeting, 28th June – 2nd July 2021
Agenda Item: 4.3
Source: Discussion Moderator (Lenovo)
Title: Email discussion summary for [RAN-R18-WS-crossFunc-Lenovo]
Document for: Online discussion

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1 Introduction

This document is the template for online discussions related to Lenovo/Motorola Mobility contributions to Agenda 4.3 - Cross functional evolution. The following documents were submitted:

1. RWS-210396 MIMO Enhancements

2. RWS-210395 New Waveform and Extending NR Operation Beyond 71 GHz

3. RWS-210397 Full Duplex Cell Operation

4. RWS-210398 Network Power Savings

5. RWS-210253 Study on RAN Evolution for Distributed Intelligence in Rel-18

6. RWS-210260 Study on AI/ML for physical layer enhancement in Rel-18

7. RWS-210254 Discussion on UAV Swarm Support in NR RAN for Rel-18

Kindly use Section 2 to submit any questions and comments you may have to these above documents in the appropriate feedback forms.

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2 Round 1 Questions/Comments

2.1 RWS-210396 MIMO Enhancements

2.1.1 MIMO Enhancements Section 1 - Prediction-Based Beam Management

Feedback Form 1:

1 – Beijing Xiaomi Mobile Software For ‘Prediction-based beam-management and CSI enhancements’, we think it is better to discuss it in the scope of AI.
2 – Qualcomm communications-France On multi-TRP operation, regarding “support of more than 2 TRPs”, are you primarily considering singleDCI based mTRP or multi-DCI based mTRP? Also, can you elaborate a bit more regarding “dynamic TRPgroupselection”? e.g. isitrelatedtoscheduling(DCI)enhancementsorCSI(measurement)enhancements?

2.1.2 MIMO Enhancements Section 2 - CSI enhancements for high-speed deployment

Feedback Form 2:

2.1.3 MIMO Enhancements Section 3 - Multi-cell/Multi-TRP enhancements

Feedback Form 3:

1 – Beijing Xiaomi Mobile Software

- Q1: For the enh. For the scenarios of asyc. M-TRP operations, more discussion is needed. Joint discussioncanbeheldtogetherwithCoherent-JointTransmissionforfurtherclarification.

- Q2: We think to support more than 2 TRPs needs great spec change, more discussion is needed.

2 – Intel Corporation (UK) Ltd

1. What is scenario that requires support of different numerologies for different TRPs in multi-TRP mode?

2.1.4 MIMO Enhancements Section 4 - Uplink MIMO enhancements

Feedback Form 4:

2.2 RWS-210395 New Waveform and Extending NR Operation Beyond 71 GHz

Feedback Form 5:

1 – NTT DOCOMO INC.

Thanks for the proposal.

For the proposed objective saying ”evaluate and identify if numerology beyond 960 kHz is needed”, are you considering at least OFDM-based waveform (e.g. CR-OFDM or DFT-s-OFDM) as a baseline? Other than OFDM-based waveform is not considered from your perspective?

2 – ZTE Corporation

We are open for the new waveform study mainly for >71GHz. For the coverage enhancement, could you please clarify a bit more if it is about the application of the current CE for FR2, or is there any new considerations specific for higher frequency? And at last what is your view on the market demand for >71GHz spectrum? Thanks!

3 – Samsung Electronics Co.

Q1:It seems the scope is quite large. What's the plan on the total number of TUs for this Rel-18 SI?

4 – LG Electronics Inc.

Q) We have a similar question with NTT's. Do you consider DFT-s-OFDM for DL as a candidate of new waveform for frequency range from 71 GHz to 100 GHz?

5 – Samsung Electronics Polska

Q1:It seems the scope is quite large. What's the plan on the total number of TUs for this Rel-18 SI?

6 – Sony Corporation

Thank you for this interesting contribution, we have some questions would like to get clarify:

Q1: For the spectrum between 71 –114.25, do you think new channel bandwidth would be needed?

Q2: Considering the possible beamwidth of SSBs and the fact that the number of beams identified by CSIRS in Rel-16 is substantially more than 64, Do you foresee that the maximum number of SSB beams would need to be increased for the spectrum above 71 GHz?

7 – Beijing Xiaomi Mobile Software

Thanks for the contribution, one quick question is that why SCS higher than 960kHz is needed compared with the 52.6-71GHz?

2.3 RWS-210397 Full Duplex Cell Operation

Feedback Form 6:

1 – Fraunhofer HHI

Thank you very much for the contribution on FD. regarding the Study objectives listed on page 4 we would like to learn more about "enhanced channel access procedures (unlicensed) with FD operation.

Q1: Is this more about operating FD in unlicensed bands where FD will allow channel observation while a device in transmit mode (Listen-while-talking)? OR

Q2: Is this more for parallel operation of several unlicensed carriers adjacent to each other or overlapping, while operating in very flexible or shifted TDD frame configurations?

2.4 RWS-210398 Network Power Savings

Feedback Form 7:

1 – MediaTek Inc.

Thanks for the quality contribution. We are supportive to pursue a comprehensive item in R18 for optimizing system-wise energy efficiency (SYS EE) taking into account both network nodes and UEs as well as the following aspects:

- Evaluation methodology should take both gNB/TRP and UE into account. In particular, R18 SYS EE enhancements should ensure minimum impact to legacy UEs (R15/R16/R17), in aspects of coverage, mobility, average packet latency and UE power consumption. This is to avoid loss of user satisfaction and subscription..
- Issues/gaps and enhancements in spatial/time/frequency/network node domains should be comprehensively studied and identified.
2 – CATT We would like to clarify the proposed study of beam sweeping optimization for network energy saving. Beam sweeping is used to provide the blanket coverage for beamformed SSB/SIBs. Dynamic beam sweeping might have impact to the UE initial access and measurements. What is the criteria assumed for Dynamic beam sweeping?
3 – Intel Corporation (UK) Ltd 1. What is impact on UE RRM measurement and also to legacy UEs due to adaptive beam sweeping for broadcast channels?
4 – HUAWEI TECHNOLOGIES Co. Ltd. Thank you very much for the contribution. Please find some questions for clarifications as below: Q1. For enhanced SSB, we think it is more appropriate for FR2, where the impact on legacy UE may be not a big issue. What do you think? Q2. For flexible turn on/off an antenna panel, we think some CSI enhancements to reflect the dynamic change can be considered, what do you think?

2.5 RWS-210253 Study on RAN Evolution for Distributed Intelligence in Rel-18

Feedback Form 8:

1 – ZTE Corporation We share the same view that distributed intelligence needed to be studied in Rel-18. In addtion, at least data sharing and model sharing among network nodes could be the potential study area.
2 – China Telecommunications Thanks for the proposals, we think it worth to study distributed intelligence in RAN in Rel-18, we consider that we need to study the use cases and work flow first, and then discuss the RAN impact on architecture and interfaces.

3 – CATT

Thank you for the qualified contribution. Some comments/questions from our side

1)For distributed intelligence in RAN,we are wondering whether some involvement of core network is also beneficial. For example, the long term information stored in NWDAF may provide assistant information for analysis and prediction.

2)For the case that model shared between devices and RAN node, how to transfer the model related information between NG-RAN and UE?

4 – Beijing Xiaomi Mobile Software

Is AI model handling specified by 3GPP or up to implementation?

5 – China Mobile International Ltd

We want to clarify the relationship with the current SID on AI/MLenabled RAN, whether and how can it be integrated into the framework we are discussing.

6 – LG Electronics France

Q) Regarding RAN "architecture" enhancements, can you elaborate potential examples? Do you consider introducing interfaces between RAN and CN or cloud server for exchanging ML-related signaling and data, or something else?

7 – Huawei Tech.(UK) Co.. Ltd

Thank you for the contribution.

Could you clarify the concept of Distributed Intelligence? Indeed the model described in slide 2 for rel17, does allow collections of data related to any nodes including UE, learning and distribution of the "new learning" and adaptation to all nodes, including UE. This is particularly interesting to centralized the capacity of computation in order as example to avoid the UE power consumption in AI/ML computation. That illustrate how with rel-17 could have distributive intelligence. However they are other AI/ML technics like Ant optimization, Multi-agent learning etc .. where there is no central computation .. could you clarify what do you mean by Distributed Intelligence?

8 – Samsung Electronics Polska

What is RAN architecture evolution? does it require new entity/interface?

9 – NEC Corporation

NEC proposes to have WI in RAN3 as continuation of the current RAN3 SI; to have a new SI in RAN3 as continuation of the current RAN3 SI covering wider scope and use cases. Do you see your proposal on "learning model sharing between UE and RAN node" as part of such RAN3 study or as a separate study?

2.6 RWS-210260 Study on AI/ML for physical layer enhancement in Rel-18

Feedback Form 9:

1 – Futurewei Technologies

FUTUREWEI supports studying common evaluation methodologies for AI/ML-based funct explainedinRWS-210038, https://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_AHs/2021_06_RAN_Rel18_WS/Do 210038. includes:

1. constructing common datasets for performance evaluation
2. defining common performance metrics to evaluate performance and robustness of AI/ML functions

Regarding the general framework for AI/ML at PHY layer, we believe the study of potential improvements in ”each” module within physical layer may not be necessary. Our proposal is to study the input/output and/or interfaces belonging to those modules that have direct impact to other RAN entities or interfaces, while leaving those modules internal to PHY as implementation-dependent.

Feel free to provide feedback on our contribution at: https://nwm-trial.etsi.org/#/documents/4751

2 – Sony Corporation

Thanks for the contribution. We have two questions.

- Could you clarify the role of “*intelligent function*” of Tx/Rx in slide 7?
- The intelligent function has trained AI model for inference to decide any PHY parameters?

3 – NEC Corporation

NEC supports having SI on AI/ML enhanced physical layer.

4 – Nokia Corporation

Thank you for the contribution. Could you please clarify if you propose to have standardized ”intelligent function on PHY layer” and corresponding interfaces to ”RAN modules”?

2.7 RWS-210254 Discussion on UAV Swarm Support in NR RAN for Rel-18

Feedback Form 10:

1 – Beijing Xiaomi Mobile Software

We see the need to have RAN side UAV enhancements. However, we still have questions on what’s the use cases for supporting UAV swarm. Could you please elaborate more on this.

Another question is do you assume a dedicated spectrum for UAV operation or it is a shared spectrum.

2 – China Mobile Com. Corporation

Thanks for your contribution! We are supportive on basic UAV function support in NR system, as in LTE system. And for UAV swarm, we are not clear whether the mechanism of Vehicle Platooning in V2X can be reused in UAV swarm as baseline.

3 – ZTE Corporation Thanks for your proposal. We are also interested in this topic as mentioned in our contribution (RWS210474). W.r.t your proposal, porting the basic UAV functionality based on the discussion in Rel-15 for LTE is fine as objective 1. For the objective 2, clarification on following aspects are preferred Q1: For the interference reduction issue, does it refer to the interference cross the link between UAV or other interference type, e.g., interference to other BS or cross-link interference will also be considered? Q2: For the mobility enhancement, in addition to the solution defined in LTE, any specific solutions are considered? Moreover, as mentioned by many companies including us, the enhancement to enable the better beam management for UAV should be considered. In our view, with this approach, the mobility issue can also be improved since the coverage hole is alleviated. Any views on this aspect? Q3: W.r.t the support on UAV swarm, any views from your side w.r.t the link between UAV?
4 – Nokia Corporation We are also interested in addressed UAVs in Release 18. Regarding the interference manager for UAV Swarn, we would see the natural start with single UAV interference management first (example UAV with HD camera) and once than being addressed then consider swarn specific issues. Is it also your understanding that the solution would need to be usable also for individual UAVs?
5 – HUAWEI TECHNOLOGIES Co. Ltd. [Huawei, HiSilicon] Thank you for the paper. We would like clarifications on the following: 1) Group handover applicability to these scenarios 2) Differences to PC5 based platooning as inV2X 3) Any more information on specification impacts for those PC5 aspects?
6 – Intel Corporation (UK) Ltd 1. For the UAV swarm, do you expect impact on Uu or sidelink only?

3 Round 1 Answers from Lenovo/Motorola Mobility

3.1 RWS-210396 MIMO Enhancements

3.1.1 MIMO Enhancements Section 1 - Prediction-Based Beam Management

Feedback Form 11:

1 – Motorola Mobility Germany GmbH

Reply to Beijing Xiaomi Mobile Software

Question:

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For 'Prediction-based beam-management and CSI enhancements', we think it is better to discuss it in the scope of AI.

Answer:

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In our contribution, we identified deployment scenarios that are relatively controlled in terms of their path of movement and speed. We think that for such scenarios, it is relatively easier to determine the future beams (also utilizing the information from other UEs in the system with similar movement). Therefore, we think that this can be considered separately within the MIMO WI scope in Rel-18

3.1.2 MIMO Enhancements Section 2 - CSI enhancements for high-speed deployment

Feedback Form 12:

3.1.3 MIMO Enhancements Section 3 - Multi-cell/Multi-TRP enhancements

Feedback Form 13:

1 – Beijing Lenovo Software Ltd.

Thanks for all your valuable comments/questions on our proposals and looks forward to see your further comments.

•#1 To Qualcomm

We think both single-DCI and multi-DCI based multi-TRP operation can be considered in more than two TRPs scenario.

On 'dynamic TRP-group selection', we are thinking about the scenarios that more than two TRPs are configured for the UE while the gNB only select two of them for multi-TRP transmission. Enhancements on beam management and CSI measurement/report for dynamic TRP pairing are required.

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•#2 To Xiaomi

We are open to consider coherent joint transmission in multi-TRP scenario as well.

For the support of more than two TRPs, one potential case is that more then two TRPs can be configured for the UE for CSI and beam measurement, while only two out of them are selected for PDSCH scheduling.

#3 To Intel

One potential scenario is that different TRPs scheduling different PDSCHs for different traffic having different latency requirements, e.g., one for eMBB and the other for URLLC.

For the UE to receive multiple PDSCHs in a carrier with different numerologies, synchronous PDSCHs can be decoded with single FFT processor using higher sampling rate, and asynchronous PDSCHs can be decoded with multiple FFT processors for different panels.

3.1.4 MIMO Enhancements Section 4 - Uplink MIMO enhancements

Feedback Form 14:

3.2 RWS-210395 New Waveform and Extending NR Operation Beyond 71 GHz

Feedback Form 15:

1 – Motorola Mobility Germany GmbH

Reply to NTT DOCOMO

Question:

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Thanks for the proposal.

For the proposed objective saying ”evaluate and identify if numerology beyond 960 kHz is needed”, are you considering at least OFDM-based waveform (e.g. CR-OFDM or DFT-s-OFDM) as a baseline? Other than OFDM-based waveform is not considered from your perspective?

Answer:

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For beyond 71GHz, yes, we should consider OFDM-based waveform as a baseline reference (for example DFT-s-OFDM for DL). With OFDM-based waveform, PN issue might escalate even more for beyond 71GHz, so we think it makes sense to also evaluate higher numerology (>960kHz) for OFDM-based waveform.

For waveform consideration, we think that single carrier waveform candidates should also be considered. However, the performance should be compared with DFT-s-OFDM and CP-OFDM for both downlink and uplink

Reply to ZTE Corporation

Question:

_____

We are open for the new waveform study mainly for >71GHz. For the coverage enhancement, could you please clarify a bit more if it is about the application of the current CE for FR2, or is there any new considerations specific for higher frequency? And at last what is your view on the market demand for >71GHz spectrum? Thanks!

Answer:

_____

Regarding the coverage enhancement aspect, discussion was out scoped in current WI for beyond 52.6GHz. Furthermore, in the CE WI, the enhancements are mainly limited to PUSCH and PUCCH. In our view, we need to consider both DL and UL channels and evaluate if existing specifications can support coverage requirements for deployment scenarios such as FWA and backhaul for beyond 71GHz.

Regarding market demand, expanding beyond 71GHz will open ultra-wide contiguous spectrum in E and W bands. This will naturally facilitate use cases with extremely high throughput requirements. Furthermore, we see this SI as a pre-cursor to further long-term vision of expanding into sub-THz range.

Reply to Samsung Electronics Co., Ltd Question:

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Q1:It seems the scope is quite large. What’s the plan on the total number of TUs for this Rel-18 SI?

Answer:

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In our view, the scope and corresponding TUs should be comparable to the SI/WI for beyond 52.6 in Rel-17. We would be open to discuss the essential items that should be within Rel-18 scope.

Reply to LG Electronics Inc.

Question:

_____

Q) We have a similar question with NTT's. Do you consider DFT-s-OFDM for DL as a candidate of new waveform for frequency range from 71 GHz to 100 GHz?

Answer:

_____

For waveform consideration, we think that single carrier waveform candidates should also be considered. However, the performance should be compared with DFT-s-OFDM and CP-OFDM for both downlink and uplink

Samsung Electronics Polska Question:

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Q1:It seems the scope is quite large. What's the plan on the total number of TUs for this Rel-18 SI?

Answer:

In our view, the scope and corresponding TUs should be comparable to the SI/WI for beyond 52.6 in Rel-17. We would be open to discuss the essential items that should be within Rel-18 scope. **Sony Corporation**

Question:

_____

Thank you for this interesting contribution, we have some questions would like to get clarify:

Q1: For the spectrum between 71 –114.25, do you think new channel bandwidth would be needed?

Q2: Considering the possible beamwidth of SSBs and the fact that the number of beams identified by CSIRS in Rel-16 is substantially more than 64, Do you foresee that the maximum number of SSB beams would need to be increased for the spectrum above 71 GHz?

Answer:

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A1: In our view, we should be open to consider the possibility of even wider channel bandwidth than what we currently have (including or 52.6-71GHz)

A2: Although, this was out scoped for current WI for 52.6-71GHz, but we think that increasing beyond 64 SSB beams should be considered for beyond 71GHz. This could possibly allow for better SSB coverage with more narrow and increased number of beams.

Beijing Xiaomi Mobile Software Question:

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Thanks for the contribution, one quick question is that why SCS higher than 960kHz is needed compared with the 52.6-71GHz?

Answer:

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In our view, the PN issue will be even more pronounced for 71-114.25GHz if OFDM-based waveform is used. Therefore, it makes sense to see if existing numerologies up to 960kHz can suffice or even higher SCS are needed.

3.3 RWS-210397 Full Duplex Cell Operation

Feedback Form 16:

1 – Motorola Mobility UK Ltd.

Thanks for your question. We consider enhancements to existing channel access procedures to take advantage of FD operation at the gNB side. This includes listen-while-talking at gNB as well as mechanisms to enable simultaneous UL transmission from UE and gNB DL data transmission to other UEs within a COT. We think interference issues between adjacent carriers/spectrum due to gNB's full duplexing or flexible TDD operation need to be addressed for both licensed and unlicensed carriers.

3.4 RWS-210398 Network Power Savings

Feedback Form 17:

1 – Motorola Mobility UK Ltd.

Thank you for the questions. Please find our replies below in the order of questions:

1. MediaTek

We also think that both network and UE sides energy efficiency should be considered and impact on legacy UEs needs to be carefully studied. This can be part of the study objectives.

2. CATT

In Rel-18 and beyond timeframe, it is expected that there will be many implementation based enablers (e.g. AI/ML) to make networks be able to determine/predict UE locations/distributions and traffics. Networks can initiate adaptation accordingly based on these capabilities.

3. Intel

Studying impact on legacy UEs and avoiding any potential negative impact on legacy UEs can be part of study objectives.

4. Huawei

Q1: Beam sweeping adaptation in FR2 is certainly more relevant than in FR1. Given that FR2 has been supported since Rel-15 NR, we may still need to consider the impact on legacy UEs in FR2.

Q2: We are open to further discuss whether any CSI enhancement needs to be studied for network power saving. Aperiodic CSI can be a baseline for comparison.

3.5 RWS-210253 Study on RAN Evolution for Distributed Intelligence in Rel-18

Feedback Form 18:

1 – Lenovo Mobile Com. Technology

To ZTE:

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Yes. Including how to distribute model and link one model to another, e.g. the output of one model may be the input of another model.

To China Telecom:

- yes. we also think the potential use cases of distributed intelligence should be studied.

To CATT:

- It has to be studied case by case, e.g. which AI use case requires interaction between RAN node and NWDAF.

- it can be further studied whether the model is transferred using UP or CP, or RAN introduce a new e.g. computing plane, to dedicatedly handle AI model distribution and management between RAN node and UE.

To Xiaomi:

- Letting 3gpp specify a certain AI model would be very challenging considering there are variety of algorithms available. So in our view, as baseline, 3GPP shall avoid touching the exact AI algorithm. Then we need proper framework for model distribution and management which may have standard impact for inter- vendor operations and potential interaction between UE and network.

To CMCC:

- in R17, it's about how to use AI for network operation, and focusing on selected use cases. R17 outcome can be start point and we can look into more AI for network use cases in R18. Besides, the R17 framework can evolve to support generic AI use cases (so called network for AI), e.g. XR rendering and autonomous driving, besides those for network operation. For example, some training/inference work for XR rendering can be done by the RAN node.

To LGE and Samsung:

- the exact solution can be further discussed. One possibility is to introduce a new computing plane, besides CP and UP, to dedicatedly handle AI model distribution and management.

- In general, we believe the RAN architecture can evolve to support generic AI use cases (so called network for AI), e.g. XR rendering and autonomous driving, besides those use cases discussed in R17 for network operation.

To Huawei:

- considering the dense deployment of RAN nodes and UE device, it seems beneficial to distribute the computation task among RAN nodes and UE device. Thus, in our understanding 3gpp shall look into how to better support distributed learning schemes such as federated learning, ant optimization, multi-agent learning etc. In SA TR 22.874, many use cases have been studied by SA for 5G system to better support distributed AI/ML operations among UEs and cloud/edge servers such as:
○ Split AI/ML operation between AI/ML endpoints
○ AI/ML model/data distribution and sharing over 5G system
○ Distributed/Federated Learning over 5G system To NEC:
it is partially our intention to have a new SI in RAN3 to cover wider scope and use cases.

3.6 RWS-210260 Study on AI/ML for physical layer enhancement in Rel-18

Feedback Form 19:

1 – Lenovo (Beijing) Ltd

First of all, many thanks for your comments/questions on our proposals and looking forward to your feedback in Round 2.

#1 Futurewei Technologies

Agree. Though each module could be improved via AI/ML, it is impossible in 3GPP to investigate all possibilities. A pilot use-case study on one module is more promising if the SI is set-up. Similar with your proposals, we also believe it makes sense to define the input/outputs and relevant interfaces, which we consider as an *intelligent function* in our proposal. Thus, no matter which use-case (e.g., CSI compression) is selected, the study scope can be better defined without touching the detailed AI model constructions.

#2 Sony Corporation

We think it should be avoided to study the AI/ML models in details in this SI, but we still need to consider the overhead/procedures when being compared with the baseline. Thus, we'd like to involve all AI/MLrelevant features (e.g., input/output, parameters, training, inference, monitoring) into an isolated function, termed as '*intelligent function*', which is supposed to facilitate the evaluation on the AI/ML-assisted module.

Yes, the function could include the training and inference, and it can also include other methods to derive the model according to implementation.

#3 NEC Corporation

Thanks.

#4 Nokia Corporation

No, we don't propose to standardize 'intelligent function'. We'd like to introduce such function to facilitate the evaluation work if the SI is set-up. Because we think it should be avoided to study the AI/ML models
in details, but we still need to consider the overhead/procedures of AI/ML when being compared with the baseline. Thus, we'd like to involve all AI/ML-relevant features (e.g., input/output, parameters, training, inference, monitoring) into an *isolated* function. Therefore, we can evaluate the 'gains' from the concerned physical module and 'pains' from the isolated function.

3.7 RWS-210254 Discussion on UAV Swarm Support in NR RAN for Rel-18

Feedback Form 20:

1 – Lenovo Mobile Com. Technology

Response to Xiaomi: Thanks for the comments! The use case for UAV swarm we see including e.g. logistics that a swarm of UAVs to delivery cargos, agriculture that the swarm of UAVs used for plant protection, aerial mapping, emergency rescue etc. And we assume UAV will use a shared spectrum as terrestrial UEs.

2 – Lenovo Mobile Com. Technology

Response to CMCC: Thanks for the comments! We also think vehicle platooning can be used as a baseline solution for UAV swarm management. From RAN point of view, we think further optimization based on basic UAV function could be helpful to reduce the interference and signaling overhead from a group of
UAV UEs to gNB

3 – Lenovo Mobile Com. Technology

Response to ZTE: Thanks for the comments! For Q1, actually we are open on this, all interference could be considered. From our point of view, at least the UL interference from UAV need to be addressed. For Q2, for single UAV case, we are also interested in the mobility enhancement consider beam management. Further for a group of UAV UEs i.e. UAV swarm, we are thinking further optimization maybe helpful for gNB better management of the mobility of a group of UAVs, e.g. more information for gNB to realize UAV swarm situation. For Q3, for the link between UAVs, we think existing NR sidelink structure can be reused. And even sidelink relay structure can be considered.

4 – Lenovo Mobile Com. Technology

Response to Nokia: Thanks for the comments! we agree that single UAV case needs to be addressed especially for those basic UAV function. Based on that, consider the UAV swarm use case is more and more popular in reality, we think UAV swarm scenario can also be considered and studied, e.g. for a group of UAV, whether the measurement report in airborne status will cause more interference compared with single UAV, which is also for mobility case. And whether more information relates to UAV swarm needs to be reported to gNB.

5 – Lenovo Mobile Com. Technology

Response to Huawei: Thanks for the comments! For 1), we have no intention to touch group handover in this topic to avoid too large scope. For 2), PC5 based platooning in V2X could be reused as a baseline solution, and from RAN point of view, we think further optimization based on basic UAV function could be helpful to reduce the interference and signaling overhead from a group of UAV UEs to gNB. For 3), existing PC5 is assumed to be reused as much as possible. Further study could be carried for UAV swarm e.g. inter-coordination of measurement report, collision avoidance etc.

6 – Lenovo Mobile Com. Technology

Response to Intel: from our point of view, we think both could be impacted. For Uu, based on basic UAV function, further optimization could be addressed for UAV swarm e.g. for measurement report, flight path report etc. For sidelink, study could be carried for UAV swarm e.g. inter-coordination of measurement report, collision avoidance etc.

4 Round 2 Questions/Comments

Thank you for your questions and comments to our proposals on crossFunc evolution in R18. We have provided answers and comments where appropriate in section 3. Kindly input any further questions and comments you may have in this section.

4.1 RWS-210396 MIMO Enhancements

4.1.1 MIMO Enhancements Section 1 - Prediction-Based Beam Management

Feedback Form 21:

1 – Samsung Research America

Slide 14: Please comment on the expected interruption time due to higher layer protocols when switching the UE context from one DU to the next in case of inter-cell mobility.

Slide 14: What scenarios do you envision will require inter-cell inter-frequency mobility?

2 – HuaWei Technologies Co.

Regarding BM enhancements, narrower beam and shorter beam dwelling time are mentioned. We also think large antenna array and narrow beam discussion is important for high frequency band shown in RWS-210438). Is the narrower beam formed with large antenna array in your discussion?

4.1.2 MIMO Enhancements Section 2 - CSI enhancements for high-speed deployment

Feedback Form 22:

4.1.3 MIMO Enhancements Section 3 - Multi-cell/Multi-TRP enhancements

Feedback Form 23:

1 – Samsung Research America

Slide 14: Please comment on the expected interruption time due to higher layer protocols when switching the UE context from one DU to the next in case of inter-cell mobility.

Slide 14: What scenarios do you envision will require inter-cell inter-frequency mobility?

Slide 17: Regarding multi-panel transmission can you please clarify if this is to the same TRP or to different
TRPs?

4.1.4 MIMO Enhancements Section 4 - Uplink MIMO enhancements

Feedback Form 24:

4.2 RWS-210395 New Waveform and Extending NR Operation Beyond 71 GHz

Feedback Form 25:

1 – Huawei Tech.(UK) Co.. Ltd

Thank you for the contribution. We wonder why the beam management aspects (Study need for introducing larger number of beams (> 64 SSB beams)) are considered as part of the study. Do you expect any relation with the study of waveform and numerology? Should increase the number of SSB beams be rather considered under the scope of MIMO?

4.3 RWS-210397 Full Duplex Cell Operation

Feedback Form 26:

4.4 RWS-210398 Network Power Savings

Feedback Form 27:

1 – HUAWEI TECHNOLOGIES Co. Ltd.

Thank you very much for your answer to our question in the first round. Our thinking is that in practice there is not much real commercial use case. Therefore, the impact on legacy UE would not be that much.

4.5 RWS-210253 Study on RAN Evolution for Distributed Intelligence in Rel-18

Feedback Form 28:

1 – China Telecommunications

Thanks for the response, we have one more concern about the UE power consumption and network signaling, it seems that the *RAN intelligent function* may require more data interactions between networks and between networks and devices, what's more, the UE may need to do some data training/inference itself which may increase UE energy consumption. What's your opinion on that?

2 – China Unicom

For RAN interfaces to support distributed intelligence, a lot of data need to be transferred, do these all need to be normative in the RAN interfaces?

Please clarify the AI Computing Plane for air interface? What the normative impact on RRC/RLC/MAC entity for different channel?

4.6 RWS-210260 Study on AI/ML for physical layer enhancement in Rel-18

Feedback Form 29:

1 – Samsung Electronics Polska

1. What does "AI general framework to involve AI functions within PHY" mean?Do you want to introduce one AI model can solve all PHY use cases, with inputs/outputs of AI function will change from case to case? With different inputs/outputs, AI models or even training data sets, how is it beneficial from definition of AI general framework?

4.7 RWS-210254 Discussion on UAV Swarm Support in NR RAN for Rel-18

Feedback Form 30:

1 – ZTE Corporation

Thanks for your replies. As following up questions, can you clarify more on the "more information for gNB to realize UAV swarm situation". Do we assume that the decision on handover is made based on the gathered measurement results from all UAVs instead of single or dominated one? Moreover, for the sidelink issue, any views from your side w.r.t the cast type among UAVs, e.g., broadcast only or unicast is also needed. For the sidelink relay part it seems that potential overlapping with corresponding topic in TN is expected, do you plan just to reuse the conclusion or any specific enhancement will be considered in the UAV item.

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5 Round 2 Answers

5.1 RWS-210396 MIMO Enhancements

5.1.1 MIMO Enhancements Section 1 - Prediction-Based Beam Management

Feedback Form 31:

1 – Motorola Mobility Germany GmbH

Reply to HuaWei Technologies Co., Ltd

Question:

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Regarding BM enhancements, narrower beam and shorter beam dwelling time are mentioned. We also think large antenna array and narrow beam discussion is important for high frequency band shown in RWS-210438). Is the narrower beam formed with large antenna array in your discussion?

Answer:

_____

We agree that large antenna array is essential for narrow beams. However, for our analysis in the contribution, we assumed the narrow beamwidth (without actually simulating the beams with large antenna array) and used it to determine the requirements in terms of beam dwelling time, CSI-RS overhead and CSI reporting overhead.

2 – Beijing Lenovo Software Ltd.

Thanks Samsung and Huawer for your valuable comments and questions. Please kindly check our response below.

Response to Samsung:

Q:Slide14: Pleasecommentontheexpectedinterruptiontimeduetohigherlayerprotocolswhenswitching the UE context from one DU to the next in case of inter-cell mobility.

Answer: After UE connects to new cell in the case of inter-DU, DU may fetch the UE context from CU via F1 interface. Our understanding is that CU can transfer the UE context to the candidate DU when transmitting the pre-configuration to UE. the candidate DU will store the UE context before UE accesses, which has no interruption time for UE context fetching.

Q: Slide 14: What scenarios do you envision will require inter-cell inter-frequency mobility?

Answer: We think different cells with different frequency under a same CU in FR2 is an important scenario. When the UE moves across different cells with different frequencies in FR2 under a same CU, L1/L2-centric inter-cell mobility can also provide benefit and flexibility. Additional measurement gaps are required for this scenario.

Response to Huawei:

Q: Regarding BM enhancements, narrower beam and shorter beam dwelling time are mentioned. We also think large antenna array and narrow beam discussion is important for high frequency band shown in RWS-210438). Is the narrower beam formed with large antenna array in your discussion?

Answer: We agree with you that larger antenna array could provide additional gains on coverage and system capacity. And larger antenna array is required for higher frequency band, e.g., beyond 71GHz. So we also propose to considered the enhancements on beam management with larger narrower beams in RWS-210395 for beyond 71GHz. Basically, more efficient beam management is always required for higher frequency operation consider more and more narrower beams.

3 – Beijing Lenovo Software Ltd.

#1 Response to Samsung:

Q: Slide 17: Regarding multi-panel transmission can you please clarify if this is to the same TRP or to different TRPs?

Answer: Our preferred scenario is the simultaneous multi-panel UL transmission targeting different TRPs for higher data rate and higher reliability traffics, where each panel can transmit some layers to one TRP FDM base scheme can be considered as well as CDM based scheme. While multi-panel UL transmission targeting single TRP with dynamic panel/TRP selection can also be considered if it cannot be completed in Rel-17.

5.1.2 MIMO Enhancements Section 2 - CSI enhancements for high-speed deployment

Feedback Form 32:

5.1.3 MIMO Enhancements Section 3 - Multi-cell/Multi-TRP enhancements

Feedback Form 33:

1 – Motorola Mobility UK Ltd.

Answer To Samsung

Thank you Samsung for your valuable comments and questions. Please kindly check our response below.

Q:Slide14: Pleasecommentontheexpectedinterruptiontimeduetohigherlayerprotocolswhenswitching the UE context from one DU to the next in case of inter-cell mobility.

Answer: After UE connects to new cell in the case of inter-DU, DU may fetch the UE context from CU via F1 interface. Our understanding is that CU can transfer the UE context to the candidate DU when transmitting the pre-configuration to UE. the candidate DU will store the UE context before UE accesses, which has no interruption time for UE context fetching.

Q: Slide 14: What scenarios do you envision will require inter-cell inter-frequency mobility?

Answer: We think different cells with different frequency under a same CU in FR2 is an important scenario. When the UE moves across different cells with different frequencies in FR2 under a same CU, L1/L2-centric inter-cell mobility can also provide benefit and flexibility. Additional measurement gaps are required for this scenario.

5.1.4 MIMO Enhancements Section 4 - Uplink MIMO enhancements

Feedback Form 34:

1 – Motorola Mobility UK Ltd.

Answer to Samsung:

Thank you Samsung for your valuable comments and questions. Please kindly check our response below.

Q: Slide 17: Regarding multi-panel transmission can you please clarify if this is to the same TRP or to different TRPs?

Answer: Our preferred scenario is the simultaneous multi-panel UL transmission targeting different TRPs for higher data rate and higher reliability traffics, where each panel can transmit some layers to one TRP FDM base scheme can be considered as well as CDM based scheme. While multi-panel UL transmission targeting single TRP with dynamic panel/TRP selection can also be considered if it cannot be completed in Rel-17.

5.2 RWS-210395 New Waveform and Extending NR Operation Beyond 71 GHz

Feedback Form 35:

1 – Motorola Mobility Germany GmbH

Reply to Huawei Tech.(UK) Co.. Ltd

Question:

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Thank you for the contribution. We wonder why the beam management aspects (Study need for introducing larger number of beams (> 64 SSB beams)) are considered as part of the study. Do you expect any relation with the study of waveform and numerology? Should increase the number of SSB beams be rather considered under the scope of MIMO?

Answer:

_____

The main reason for considering larger number of beams is primarily related to the higher frequency range (FR2-1 and beyond). Therefore, we think that it is more suitable to deal with these aspects in a SI/WI for beyond 71GHz. Also, in current WI for NR operation up to 71GHz, we are dealing with beam-management enhancements that are specific to this topic. We expect similar approach for this SI/WI.

5.3 RWS-210397 Full Duplex Cell Operation

Feedback Form 36:

5.4 RWS-210398 Network Power Savings

Feedback Form 37:

1 – Motorola Mobility UK Ltd.

Rel-15 NR has been deployed in FR2 in major markets (e.g. North America). Thus, we think solutions to avoid any negative impact on legacy UEs need to be studied.

5.5 RWS-210253 Study on RAN Evolution for Distributed Intelligence in Rel-18

Feedback Form 38:

1 – Lenovo Mobile Com. Technology

To China Telecom:

Whether it is beneficial to adopt distributed intelligence and distributed learning approach depends on use cases. In those cases where data privacy is required and each client does not want to share training data or inference data to other clients/nodes, distributed learning approach can help. Of course, it comes with the cost of more traffic and power consumption from UE side.

From another aspect, we also believe the overall power consumption and traffic load shall be considered as metrics to tell whether the AI/ML approach works well. We should avoid using an AI/ML approach which consumes a lot of power and traffic but the gain is neglectable.

To China Unicom:

In our view, in the future, RAN can be capable of supporting generic AI/ML tasks e.g. autonomous driving. There does not seem needed to specify exact AI/ML model or data needs to be transferred.

Instead, it could be beneficial to specify dedicated LCH/RBs that are used only for AI/ML functions e.g. AI/ML model, training data, and inference data transferring.

5.6 RWS-210260 Study on AI/ML for physical layer enhancement in Rel-18

Feedback Form 39:

1 – Lenovo (Beijing) Ltd

To Samsung Electronics Polska:

No, we'd like to introduce a framework with an 'intelligent function' (*not* an AI model) to facilitate any evaluation work. The reason is that no matter which use case will be selected for study, it should be avoided to optimize the AI/ML model itself. However, we still need to consider the overhead and procedure of the AI/ML model, when comparing with the baseline. Thus, we think it would make sense to involve all AI/ML-relevant features (e.g., input/output, parameters, training, inference, monitoring) into an *isolated function*. In this way, we can better evaluate the 'gains' from the concerned physical module and 'pains' from the isolated function within this framework.

5.7 RWS-210254 Discussion on UAV Swarm Support in NR RAN for Rel-18

Feedback Form 40:

1 – Lenovo Mobile Com. Technology

Response to ZTE: Thanks for the further comments. For "more information for gNB to realize UAV swarm situation", we think your comments could be one example, that handover or handover preparation may consider the measurement resutls from all UAVs, or flight path information of all UAVs. For sidelink issues, we are open for all cast types, and think no need to restrict to only broadcast if we consider sidelink among UAVs in the swarm. For sidelink relay, we have another proposal in *RWS-210255 Motivations for vehicle/drone mounted relay in Rel-18*, so we do not have plan to have specific enhancement here.

6 Summary

MIMO Enhancements

1. **Prediction-based beam-management in Rel-18:** There seems to be a common understanding that further enhancements are needed in Rel-18 to deal with the issues of latency and overhead for beam-management procedures. Some enhancements discussed include UE-initiated beam update/reporting, prediction-based beam-management and sharing/grouping of beam measurements/reporting across multiple UEs. One contention point was on whether to treat prediction-based beam-management in potential AI/ML SI or under potential MIMO WI in Rel-18**.**
2. **MIMO CSI enhancements:** Similar views can be seen among many companies on proposals to study and, if needed, specify CSI enhancements for moderate-high speed UEs. Proposals that address bundled CSI-RS transmission and bundled CSI Reporting, UE-initiated CSI feedback, UE-assisted CSI reporting configuration, event-based CSI feedback, and faster CSI acquisition after re-configuration can be studied.
3. **Multi-cell/Multi-TRP Enhancements:** Some clarifications were asked regarding scenarios being considered – for different numerologies and single/ multi-DCI based mTRP. It was clarified that the

potential use cases include more than two TRPs configured for the UE for CSI and beam measurement, while only two out of them are selected for PDSCH scheduling, and different TRPs scheduling different PDSCHs for different traffic having different latency requirements. There was also discussion regarding interruption time in inter-cell mobility and the scenarios to be covered for inter-frequency inter-cell mobility including the scenario of different cells with different frequency under a same CU in FR2.

4. **UL MIMO Enhancements:** A clarification was asked on whether multi-panel transmission is to the same TRP or to different TRPs. It was clarified a scenario with simultaneous multi-panel UL transmission targeting different TRPs for higher data rate and higher reliability traffics, where each panel can transmit some layers to one TRP in FDM/CDM.

New Waveform, Extending NR beyond 71 GHz: Further extension of NR operation beyond 71GHz is supported by several companies. However, there were mixed views regarding the timeline for commencing a SI for NR extension beyond 71GHz, ranging from early start in Rel-18 to later start in Rel-18 or postponing beyond Rel-18, including study of new waveforms. Some companies expressed the need to further enhance some aspects (including potential leftovers from Rel-17) for NR operation from 52.6 – 71 GHz.

Full Duplex Cell Operation: It was clarified that the proposed study on enhanced channel access procedure in unlicensed spectrum for full duplex cell operation includes listen-while-talking at gNB as well as mechanisms to enable simultaneous UL transmission from UE and gNB DL data transmission to other UEs within a COT.

Network Power Savings: Companies shared similar views that both network and UE energy efficiency should be considered and impact on legacy UEs needs to be carefully studied. It was clarified that enhanced SSB in FR2 could be of interest since Rel-15 NR has been deployed in FR2 in major markets (e.g. North America). It was also clarified that networks can initiate power saving adaptation using implementation (e.g. AI/ML) based capabilities to determine/predict UE locations/distributions and traffics.

RAN Evolution for Distributed Intelligence: Many companies showed their interest and support on the study distributed intelligence in Rel-18, e.g. common interfaces and procedures to support the data sharing and model sharing among network nodes is the potential study area. Some companies questioned whether it is a continuation of the current RAN3 SI or a new SI. Some companies showed some concerns on the potential impact on existing RAN architecture.

AI/ML for PHY Enhancement: There is significant interest in pursuing work in this area. The email discussion focused on understanding the role of the "intelligent function" proposal. In the replies, we clarified that this function is introduced within a framework to facilitate the evaluation work on the AI/ML-assisted methods.

UAV swarm Support in NR RAN: Some support was indicated for designing UAV swarm functionality. It was pointed out that UAV features should be first further enhanced and that potentially vehicle platooning could be used as baseline functionality.