RAN-R18-WS-eMBB-Intel - Version 0.0.3
RAN

3GPP TSG RAN Release 18 Workshop RWS-210527

Electronic Meeting, 28th June – 2nd July 2021

Agenda Item: 4.1

Source: Email discussion moderator (Intel)

Title: Report from Email Discussion RAN-R18-WS-eMBB-Intel

Document for: Information

1 Introduction

This document is the report from the email discussion prior to the Rel-18 Workshop of the contributions submitted by Intel to agenda item 4.1 'eMBB-driven Functional Evolution'. As instructed by the chair [RWS-210002], the purpose of the pre workshop email discussions is to provide an opportunity for questions and answers to help better understanding of the proposals among companies.

Intel submitted the following contribution to agenda item 4.1

RWS-210366 Rel-18 NR above 52.6 GHz, Intel

RWS-210370 Rel-18 NR MIMO, Intel

RWS-210375 Views on RAN4 Rel-18 scope, Intel

2 General questions/comments

In addition to the 3 contributions submitted to agenda item 4.1, Intel submitted an overview of Rel-18 to agenda item 4 [RWS-210376]. General questions/comment to Intel related to eMBB functional evolution may be raised in this section.

2.1 Round 1 Questions

Feedback Form 1: General questions/comment related to eMBB evolution functional evolution

1 – ZTE Corporation

For slide 4 regarding "AI/ML enabled RAN", the proposals looks fine.

Our view is to focus on the normative work of prioritized use cases first in Rel-18 WI. And Federate Learning/Distribute learning can be studied in Rel-18, which has impacts on RAN2/RAN3. Also share the

view that potential AI-based use case could be considered in Rel-18, e.g. RAN slicing, QoE optimization.

2.2 Round 1 Answers

2.3 Round 2 Questions

2.4 Round 2 Answers

3 Rel-18 NR above 52.6 GHz

Questions related to RWS-210366 ’Rel-18 NR above 52.6 GHz’ may be raised in this section.

3.1 Round 1 Questions

The document is structured in two sections, one on ’WI for enhancement of NR 52.6 71 GHz’ and one for ’SI for NR extension up to 114.25 GHz’ and a separate feedback form is provided for each section.

Feedback Form 2: Questions related to the section of the document on ’WI for enhancement of NR 52.6 71 GHz’

1 – vivo Mobile Communication Co.

Thanks for your effort on this.

We view coverage enhancement as an important aspect for the commercialization of B52. Thus we also believe these aspects should be further enhanced, especially for the coverage enhancement of PDCCH.

2 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]:

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What sort of beam enhancements for B52.6-71 GHz you think might be needed beyond that is currently specified in B52.6 WI and FeMIMO WI in Rel-17?

3 – ZTE Corporation

For the enhancement of 60GHz, positioning and V2X are mentioned, do you assume those as harmonization issues, or is there any specific enhancement considered? Thanks.

4 – Samsung Electronics Co.

Q1: For the proposed WI for enhancement of NR 52.6-71 GHz, what are the power saving techniques considered to further improve power consumption, comparing to what have been supported in Rel-16/17?

Q2: Coverage enhancement was not included in Rel-17 due to the consideration that Rel-17 has a dedicated WI for discussing coverage enhancement. Could you elaborate more on which aspects about coverage are not sufficient and still need enhancement based on what have been supported in Rel-17?

5 – Samsung Electronics Co.

Q3: Do you think Rel-17 coverage enhancement applying new SCS can be studied for Rel-18 above 52.6 coverage enhancement?

6 – InterDigital Communications

Thanks for the proposals.

Q1. regarding power saving techniques/coverage enhancement, any specific schemes in mind other than what we already supported in Rel-17?

7 – Apple Benelux B.V.

1. For NR support > 71 GHz (up to 114.25 GHz), you seem to advocate a study item for Rel-18 then a WI in Rel-19 timeframe. Do you assume that the 52.6 GHz WI extension and the > 71 GHz study item would run in parallel ?

2. Given that Rel-17 coverage enhancement is on-going, (a) is your assumption that the Rel-17 coverage enhancement schemes will be directly applicable to the > 526 GHz band and (b) what is your idea of the enhancements over these schemes ?

8 – LG Electronics Inc.

Q) Regarding the scope for Rel-18 SI about NR supporting up to 100 GHz, do you consider the outcome of waveform study (e.g., DFT-s-OFDM for DL) can be applicable to NR 52.6-71 GHz as well?

9 – CATT

Do you want to have parallel WI/SI for the two topics, or first have a WI for enhancement of 52.6-71 GHz and then SI for > 71 GHz ?

10 – Sony Europe B.V.

Thank you for the contribution.

We are supportive of considering non-uniform constellations.

Apart from de-mapping complexity what other 'implementation challenge barriers' can you see for 1024QAM?

Feedback Form 3: Questions related to the section of the document on 'SI for NR extension up to 114.25 GHz'

1 – vivo Mobile Communication Co.

The waveform study would be interesting. We have the following two questions:

Q1: it is proposed to have a waveform study for 52.6GHz 100GHz. Can you elaborate more on the rationale of waveform study for the range of below 71GHz? Do we need to agree on new hardware impairment models for such study?

Q2: For >71GHz spectrum, what's the assumption on numerology/sampling rate/FFT size? Are they expected to reuse as much as possible for what is specified for below 71GHz (as a starting point), or it is completely open study?

2 – NTT DOCOMO INC.

Thanks for the proposal.

We have similar question to vivo's Q1. Now Rel-17 devices will support both CP-OFDM and DFT-s-OFDM in 52.6 - 71 GHz as well as FR1/2 in our understanding. Could you clarify why waveform study would be needed for 52.6 - 71 GHz again?

3 – Motorola Mobility Germany GmbH

[Lenovo, Motorola Mobility]:

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What are your views on two parallel items in Rel-18 including further enhancements for B52.6-71 GHz and extension beyond 71GHz and corresponding timeline?

4 – ZTE Corporation

We are open for the new waveform study mainly for >71GHz, similar to vivo and DCM's queston, it seems that in your proposal the waveform study will also be applied for 52.6 71GHz, is it the correct intention?

5 – MediaTek Inc.

Q1: Regarding enhancing energy efficiency for 52.6 – 71 GHz, is modification to current waveform (e.g., DFTS-OFDM) an option for Intel? How many layers for multi-rank transmission?

Q2:What's the usage scenario for higher order modulations such as 256 QAM or 1024QAM?

Q3:What are the implementation challenge barrier mentioned in the Tdoc for supporting higher order modulations such as 256QAM or 1024QAM?

Q4: Regarding power saving techniques, will the enhancements in Rel-17 power saving WI be the baseline or new features are considered in the proposed scope?

6 – LG Electronics Inc.

Q) Regarding the scope for Rel-18 SI about NR supporting up to 100 GHz, do you consider the outcome of waveform study (e.g., DFT-s-OFDM for DL) can be applicable to NR 52.6-71 GHz as well?

3.2 Round 1 Answers

General comments on enhancements (responses for Apple Q2):

As for applicability of Rel-17 enhancements to 60GHz, we believe many features should be directly applicable. However, some refinements may be needed as 60GHz band does contain unique cases where LBT may be required and this may create inefficiencies in some of the features being developed. We believe Rel-18 WI could potentially try to address these improvements.

Beam Management Aspects: (responses for Motorola Mobility)

For beam management enhancements for B52-71GHz, due to current specification progress and stringent deadline for completion of Rel-17, we expect some leftovers or issues not considered in Rel-17 could be candidates for enhancement in Rel-18. While its difficult to assess what would be the leftovers, one hypothetical example could be optimizations regarding beam management when LBT is used in the system.

None of the FR2 beam management scheme were ever intended to work in unlicensed bands, and certain regulatory domain require LBT usage. Potential improvements for such cases could be an example. Other potential areas for improvement could be optimized beam management for fixed wireless communications. It may be possible to gNB to leverage knowledge that UE is a fixed wireless device, and improvements could be made leveraging this information.

Power Saving Aspects: (responses for Samsung, Interdigital Q1, MediaTek Q4)

For power saving, we expect some minor adaptation of the existing features defined in Rel-16 and currently worked on in Rel-17 may be needed to further seamless work in scenarios where LBT is required. One of the goals of the WI could be trying to identify the potential issues and resolve them so that power saving functionality could be optimized for 60 GHz unlicensed operation. At the moment, we do not have specific new power saving features in mind, rather we expect some refinements of existing features. We think all features defined up to Rel-17 should be baseline for any enhancements and improvements.

Coverage Enhancement Aspects: (responses for Samsung Q2, Apple)

For coverage enhancement, we don't think coverage for standalone deployments necessarily need improving coverage, although it could benefit from coverage improvements. However, in inter-band (and even inter-FR) CA or DC deployments. There could be benefits if the deployments in B52-71 has an increased range such that they can be comparable range (as much as possible) with lower frequency carriers. The ultra-wide band availability in B52 carriers, is quite attractive to leverage high precision positioning and ranging, and generally improving the coverage for B52 carriers could provide benefits such that these cell could be leveraged for measurements, even though achievable data rate could be low due to coverage difference between low frequency band and high carrier frequency band. So in summary, it's not that coverage is necessarily lacking for general eMBB operation, but we think improving coverage could yield in enablement of interesting non-eMBB use cases.

Energy Efficiency Aspects: (responses for MediaTek Q1)

For improving energy efficiency, we believe we can consider some modifications to existing waveform (for example DFT-s-OFDM). In case multi-rank DFT-s-OFDM transmission is considered, we think we may need to consider at least up to rank 4. Rank 4 transmission might not be common for handheld devices types, but form factor devices (including fixed wireless devices) could potentially support larger number of antenna panels and could leverage transmission rank higher than 2.

Peak data rate improvement Aspects: (responses for Sony, MediaTek Q2, Q3)

For supporting even higher order modulations, LOS dominant channel propagation property in some 60GHz deployments create difficulty in improve peak data rates simply by supporting higher rank, as channel would be rank deficient. Therefore, we think leveraging high beam gains in such LOS dominant scenarios to further improve SNR and supporting even higher order modulation is next logical step. Obviously, support of such higher order modulation will be even more impacted by phase noise, and some enhancements to potentially aid support of 256QAM or 1kQAM may need to be investigated as well.

For non-uniform constellations, we believe some study would be needed. Previous studies seem to hint that it could potentially improve performance, which can be also alternatively understood as additional implementation margin for RF impairments. Given that RF impairments in 60GHz are quite stringent, we think we should investigate any proposal that can potentially improve performance for increasing peak data rates. Non-uniform constellation is just one example that could be studied and considered.

Application to various vertical aspects: (responses for ZTE)

As for consideration of positioning and V2X, we don't have specific enhancements targeting 60GHz band. However, we do expect some specification work may be needed to adapt the existing positioning and V2X features to 60GHz, where larger SCS and larger bandwidths are supported. It may be difficult to quantify the required amount of specification work as this may vary for different companies thinking. At least we expect some specification effort in RAN4, as we would need proper requirements applicable to this band.

Waveform study aspects: (responses for Samsung Q3, Apple Q1, LGE, CATT, vivo, Docomo, Motorola, ZTE, LGE)

For the Study of NR above 71GHz, we think it could be studied in parallel as we work on WI for 52-71GHz. Of course, approval of any SI/WI are subject to overall TU allocation, and there should be discussions on prioritization of specific SI/WI. With this said, from a technical perspective, we do not see a hurdle in working in parallel a SI for beyond 71GHz domain while working on WI for 52-71GHz (other than TU constraints). As for whether the outcome of the study being able to be applicable to 52-71GHz band, we think it would be premature to conclude whether it can be applied or not. Essentially, we would need to see the outcome first. We believe this can be handled and discussed when appropriate WI based on the study is being approved, which would be beyond Rel-18 (possibly in Rel-19, or if the study needs to be extended possibly in Rel-20).

As for waveform study to also potentially including 52-71GHz band, we think study could be quite beneficial as we skipped this study in Rel-17 to standardize NR system in timely manner in 60GHz to provide a commercial competitiveness with 11ay that may be available in the Rel-17 deployment timeframe. From our understanding the approval for Rel-17 WI directly was not because waveform study for this band was not useful, but because of timely completion of the specification. With this said, the study could yield useful insights to system operating in 52-71GHz. This could further provide input towards improvements that could be made for NR in 52-71GHz. It may not necessarily in the form of requiring new waveform introduction, although that could also potentially be the case. It is difficult to guess the study outcome without the study, and for this very reason we suggest performing the waveform study for 52-100GHz.

As for whether new hardware impairments model(s) are needed for above 71GHz is bit situational. We know that some impairment models can be extrapolated to higher frequencies (to some extent). However, it is not clear if all models could be done this way. System operating in 71GHz may need to consider potentially different silicon technology for RF systems and this can potentially change the applicability of existing models to this band. These aspects may need to be part of the study as well. Also, we don't currently have specific assumptions of numerology, sampling rates, and FFT sizes. We believe this should be part of the study itself.

3.3 Round 2 Questions

Feedback Form 4: Round 2 questions on RWS-210366 'Rel-18 NR above 52.6 GHz'

1 – Samsung Electronics Co.

Q1: Is it correct understanding that the optimization of beam management for fixed wireless communication is intended to cope with LBT or instantaneous burst interference?

Q2: Thanks for the detailed response. From the response, our understanding is the enhancement on coverage is a general enhancement for both UL and DL, and applicable to all the supported SCSs for FR2-2. Is it a correct understanding?

2 – Huawei Tech.(UK) Co.. Ltd

Thank you for the contribution. Regarding the target of lower latency and higher peak throughput, could you elaborate on the detailed scenario and requirements for devices other than handheld? In R4#99, RAN4 already agree to define TX power for handheld, FWA and vehicular type of UE. Are you thinking about yet another type of UE?

3.4 Round 2 Answers

Response to Samsung's questions

A1) Yes, some enhancements for beam management may be to cope with LBT. Also we expect some enhancements could try to leverage the fact fixed wireless devices have near zero mobility (other than environments moving around effecting channel), so we may be able to optimize further the beam failure recovery and beam tracking aspects.

A2) Yes, general enhancements should be for both UL and DL and should generally apply to all SCS unless there are significant issues identified for specific SCS.

Response to Huawei's questions

A) We expect not all device types will support for example 256QAM, if 256QAM is supported. So, it may not be that RAN4 specifications need to define alternative requirements for power, but that some requirements are not applicable to some devices and only to some other device types. However, some requirements may be optimised depending on what features are supported in the physical layer. For example, use of non-uniform constellation for 256QAM or 1k QAM could potentially results in slightly more relaxed EVM requirements. Of course, whether such change needed is quite dependent on what features are enhanced in the physical layer and study/investigation of whether such changes is needed.

4 Rel-18 NR MIMO

Questions related to RWS-210370 'Rel-18 NR MIMO' may be raised in this section.

4.1 Round 1 Questions

Feedback Form 5: Questions related to RWS-210370 'Rel-18 NR MIMO'

1 – Samsung Research America

- (p2) Could you elaborate more details for multi-CC repetition? (e.g., is it working based on cross-carrier scheduling? Or DCI in each band schedule repetition separately?)

2 – vivo Communication Technology

how does latency decrease with hierarchical beam management?

3 – Guangdong OPPO Mobile Telecom.

Thanks for the contribution.

Q1: For a UE with large propagation delay difference between TRPs (e.g. not cell edge UE), why to schedule it with M-TRP transmission?

4 – Beijing Xiaomi Mobile Software

- Q1: For the enh. for the scenarios of asyc. M-TRP operations, more discussion is needed. Joint discussion can be held together with Coherent-Joint Transmission for further clarification.
- Q2: If UL-only nodes are introduced, many issues should be reconsidered. The scenarios and benefits needs to be further discussed...
- Q3: For 'multi-CC repetition schemes', it is better to discuss it in the scope of other topics.

5 – ZTE Corporation

Thanks so much for sharing this contribution. Please find our following comment(s) for clarification.

- On P3, for asymmetric deployment, we wonder why/how to complete separate beam reporting for UL. In such case, we think that we do not have any DL RS to be used for beam measurement in UL-only TRP. UL power control seems to be a big issues, e.g., for PL-RS measurement.

6 – Futurewei Technologies

Thank you for your nice contribution and proposals. FUTUREWEI share the same view on enhancement for multi-TA for mTRP, CSI for URLLC, UL multi-panel transmission, and beam acquisition latency reduction. In addition, we proposed to work on cooperative MIMO schemes to improve system capacity for XR, FWA and other challenging services. Please take a look at our contribution RWS-210036 (https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_AHs/2021_06_RAN_Rel18_WS/Docs/RWS-210036.zip) and feel free to comment at: https://nwm-trial.etsi.org/#/documents/4580

7 – HuaWei Technologies Co.

Thanks for the contribution, we have the following questions:

1. We agree CSI enhancement for M-TRP is valuable to be considered in Rel-18, especially for CJT cases. Whether both Codebook-based and SRS-based CSI enhancement are included for FDD and TDD scenarios

2. On Page 2: By "Single FFT with isolation for FR2", do you mean that after some shifting in time and combining of signals received from different UE panel/beams, a single FFT can be used to demodulate the combined signal?

8 – Qualcomm communications-France

Regarding "TRPs with Rx capability only", the use case and benefits are clear to us. In addition to the potential enhancements listed in your contribution, do you think initial access / RACH procedures also require enhancements? Or is it assumed that initial access is always toward the DL TRP ("UL dense deployment" mode will be enabled after initial access)? On P6, could you please elaborate a bit more on "additional QCL assistance to reduce beam acquisition latency"? Also, any detailed explanation on enhancement for hierarchical BM?

9 – NTT DOCOMO INC.

For non-perfect sync TRPs in P2, we understand the spec. impact of multiple TAs. But what is the spec. impact for 'Single FFT with isolation for FR2, multiple FFT for FR1, etc'? By saying 'Single DCI and multiple DCIs', do you mean additional enhancement is needed based on current single-DCI based multi-DCI based framework? If so, what additional enhancement is needed for such async TRPs scenario?

In P6, what do you mean 'e.g., additional QCL assistance to reduce beam acquisition latency'?

10 – CATT

Proposal 1: Is there any numerical result on the probability of a UE in inter-TRP operation observing timing difference large than CP from two TRPs? Previous CoMP studies (in LTE) showed that CoMP UEs tend to have small RSRP difference across TRPs, so they tend to locate at cell edge with similar distance to both TRPs. Also for adjacent TRP to engage in cooperation, synchronous operation may be a typical assumption.

11 – Beijing Lenovo Software Ltd.

Q1 (p2): can you provide more details of the multi-CC repetition for URLLC?

Q2 (p3): what is the benefit for having Rx only TRP versus TxRx TRP? The deployment costs (power supply, fronthaul) of the two are similar, but Rx only TRP does not provide DL and introduces many issues.

Q3 (p4): What aspect of CSI feedback needs enhancement for URLLC in mTRP?

Q4 (p6): What type of QCL is missing from the current spec? Can you provide some details on additional QCL?

4.2 Round 1 Answers

1 – Samsung Research America

(p2) Could you elaborate more details for multi-CC repetition? (e.g., is it working based on cross-carrier scheduling? Or DCI in each band schedule repetition separately?)

Answer: Thank you very much for the question. At this stage we don't have specific preference for solution to enable multi-CC repetition and it may also depend on the target physical channel that should support corresponding repetition. For example, PDCCH can be enhanced by considering two PDCCH transmission on different CC with self-carrier and cross-carrier scheduling for the same PDSCH / PUSCH. We propose to discuss possible approaches to support repetition across multiple CCs in RAN1 for each physical channel separately. We note that PUSCH and PUCCH with carrier switching should be also considered.

2 – vivo Communication Technology

how does latency decrease with hierarchical beam management?

Answer: Thank you very much for the question. For hierarchical beam management, it is possible to support tracking of the TRP/UE beam pair using smaller number of measurements instead of full beam sweep at both sides. In addition, beam indication for hierarchical beam management may not be required, if flexible beam mapping is used on BM CSI-RS configured for the active TCI state. One example of the enhancement is support P3+U3 for UE/TRP beam refinement procedure instead of the existing P2 + CRI report for TRP beam refinement and P3 for UE beam refinement. Since CRI is not reported in P3+U3, the latency of the beam acquisition in the beam tracking mode can be noticeably reduced. Please refer to R1-2008977 for additional details including evaluation results.

3 – Guangdong OPPO Mobile Telecom.

Q1*: For a UE with large propagation delay difference between TRPs (e.g. not cell edge UE), why to schedule it with M-TRP transmission?*

Answer: Thank you very much for the questions. In the figure below we provided system-level analysis to evaluate propagation delay difference from TRPs to the UE configured in mTRP operation. For configuration of mTRP at the UE, we used conventional approach, where RSRP difference between TRPs should not exceed certain threshold, e.g., 6dB. We observed for UEs the propagation delay difference from TRPs of a similar RSRP can be substantial relative to CP duration. In this case, even if NW is perfectly synchronized, we should expect Rx timing difference at the UE that, depending on SCS, may noticeably exceed CP duration.

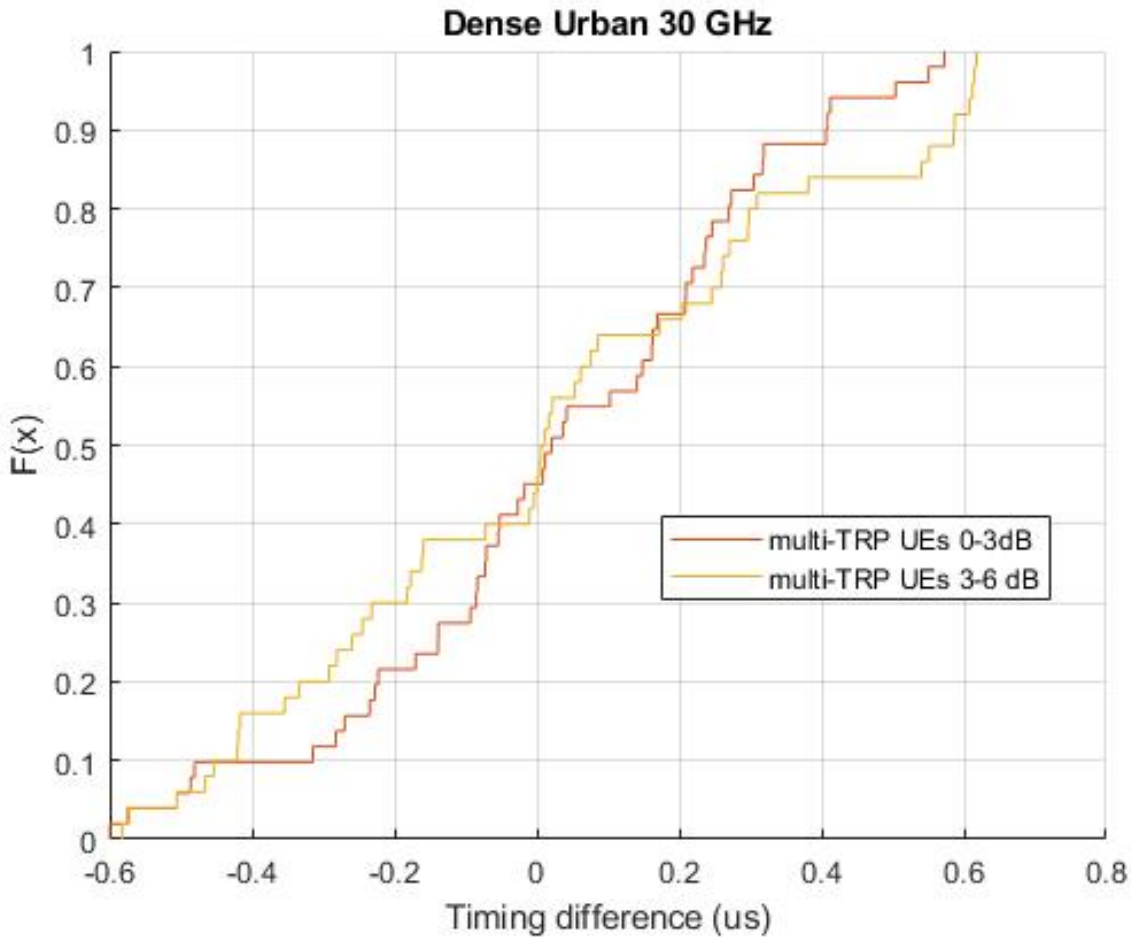

Figure 1:

4 – Beijing Xiaomi Mobile Software

Q1: For the enh. for the scenarios of asyc. M-TRP operations, more discussion is needed. Joint discussion can be held together with Coherent-Joint Transmission for further clarification.

Q2: If UL-only nodes are introduced, many issues should be reconsidered. The scenarios and benefits needs to be further discussed...

Q3: For 'multi-CC repetition schemes', it is better to discuss it in the scope of other topics.

Answer:

Thank you very much for the questions. Please find our response below.

A1: For asynchronous scenario we are considering enhancements to the existing mTRP schemes (e.g. NC-JT). Support of coherent JT in such scenario is much more challenging in our view due to significant phase variation across TRPs due to timing difference. We are open to have further discussion / study on feasibility of supporting coherent JT in async scenarios.

A2: UL only capability of TRP is a very attractive approach. Several operators expressed interest in such deployment due to lower cost of TRP and more loose regulation requirements for such deployment (without any transmission). We propose to have study in RAN1 on the required specification support for such deployment scenario.

A3: We don't have strong view where to treat the corresponding enhancement.

5 – ZTE Corporation

On P3, for asymmetric deployment, we wonder why/how to complete separate beam reporting for UL. In such case, we think that we do not have any DL RS to be used for beam measurement in UL-only TRP. UL power control seems to be a big issues, e.g., for PL-RS measurement.

Answer: Thank you very much for the questions. There may be several deployment options for TRP with Rx capability only including deployment with single beam. The beam management in such deployment can be carried out using SRS. Power control may rely on closed loop with some enhancements. We propose to study such deployment scenario in RAN1including required enhancement.

6 – Futurewei Technologies

Thank you for your nice contribution and proposals. FUTUREWEI share the same view on enhance-ment for multi-TA for mTRP, CSI for URLLC, UL multi-panel transmission, and beam acquisition la-tency reduction. In addition, we proposed to work on cooperative MIMO schemes to improve system capacity for XR, FWA and other challenging services. Please take a look at our contribution RWS-210036 (https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_AHs/2021_06_RAN_Rel18_WS/Docs/RWS-210036.zip) and feel free to comment at: https://nwm-trial.etsi.org/#/documents/4580

Answer: Thank you very much for the comment. Looking forward for further cooperation on the corresponding enhancements.

7 – HuaWei Technologies Co.

1. We agree CSI enhancement for M-TRP is valuable to be considered in Rel-18, especially for CJT cases. Whether both Codebook-based and SRS-based CSI enhancement are included for FDD and TDD scenarios

2. On Page 2: By "Single FFT with isolation for FR2", do you mean that after some shifting in time and combining of signals received from different UE panel/beams, a single FFT can be used to demodulate the combined signal?

Answer: Thank you very much for the questions. Please find our response below.

A1: We agree that both TDD and FDD scenarios should be considered for URLLC scenario.

A2: Sorry for the possible confusion from the wording in the slides. Just to clarify that for FR2, due to spatial isolation across panels, it should be sufficient to implement panel specific FFT setting. We are not considering joint processing of the signals received on different panels in such case.

8 – Qualcomm communications-France

Regarding "TRPs with Rx capability only", the use case and benefits are clear to us. In addition to the potential enhancements listed in your contribution, do you think initial access / RACH procedures also require enhancements? Or is it assumed that initial access is always toward the DL TRP ("UL dense deployment" mode will be enabled after initial access)? On P6, could you please elaborate a bit more on "additional QCL assistance to reduce beam acquisition latency"? Also, any detailed explanation on enhancement for hierarchical BM?

Answer: Thank you very much for the questions. Please find our response below.

A1: Regarding 'TRPs with Rx capability only". Thank you very much for raising good point. We think initial access / RACH procedures should be included as part of study on the corresponding deployment scenario.

A2: We are considering enhancements to the beam tracking operation using CSI-RS with flexible beam mapping on CSI-RS. Such scenario is very attractive as it relies on the limited number of measurements on CSI-RS and may not require TCI state updates (CSI-RS resource ID can be the same, but beam can be updated as part of tacking mode). One example of the enhancement is support P3+U3 procedure for UE/TRP beam refinement instead of P2 + CRI report for TRP beam refinement and P3 for UE beam refinement. Since CRI is not reported in P3+U3, the processing and therefore latency of the beam acquisition in the tracking mode can be noticeably reduced.

9 – NTT DOCOMO INC.

For non-perfect sync TRPs in P2, we understand the spec. impact of multiple TAs. But what is the spec. impact for 'Single FFT with isolation for FR2, multiple FFT for FR1, etc'? By saying 'Single DCI and multiple DCIs', do you mean additional enhancement is needed based on current single-DCI based multi-DCI based framework? If so, what additional enhancement is needed for such async TRPs scenario?

In P6, what do you mean 'e.g., additional QCL assistance to reduce beam acquisition latency'?

Answer: Thank you very much for the questions. Please find our response below.

A1: Sorry for the possible confusion due to wording in our slides. For "single FFT with isolation in FR2", we are mainly considering beam selection that reduces cross-panel interference to operate in such async mode. For FR1 we are considering processing the same signal using multiple FFTs with FDM multiplexing of the signals from different TRPs. Both single DCI and multiple DCIs transmission schemes should be supported in

such scenario.

A2: We can consider indication of the beam's spatial relation on the SSBs from one TRP on the same CC as well as beams relation on SSB across CCs to perform more efficient beam acquisition procedure. For example, TRP may employ beam oversampling to avoid possible coverage loss in certain directions. The information about spatial beam relation can be exploited at the UE for more efficient beam acquisition. For multi-panel TRP, it is possible to transmit SSBs (on the same symbol) on different CCs using different beams, which can be also used to reduce beam acquisition time.

10 – CATT

Proposal 1: Is there any numerical result on the probability of a UE in inter-TRP operation observing timing difference large than CP from two TRPs? Previous CoMP studies (in LTE) showed that CoMP UEs tend to have small RSRP difference across TRPs, so they tend to locate at cell edge with similar distance to both TRPs. Also for adjacent TRP to engage in cooperation, synchronous operation may be a typical assumption.

Answer: Thank you very much for the question.

Please refer to our response to OPPO, where we provided evaluation results illustrating propagation delay difference from TRPs with similar RSRP. Due to different propagation conditions, e.g. LOS / NLOS, shadow fading, etc, it is possible that UE observing similar RSRP from two TRPs may not be strictly located in the middle position between these TRPs.

11 – Beijing Lenovo Software Ltd.

Q1 (p2): can you provide more details of the multi-CC repetition for URLLC?

Q2 (p3): what is the benefit for having Rx only TRP versus TxRx TRP? The deployment costs (power supply, fronthaul) of the two are similar, but Rx only TRP does not provide DL and introduces many issues.

Q3 (p4): What aspect of CSI feedback needs enhancement for URLLC in mTRP?

Q4 (p6): What type of QCL is missing from the current spec? Can you provide some details on additional QCL?

Answers: Thank you very much for the questions. Please find our response below.

A1: In CA scenario especially inter-band, different CCs experience different propagation conditions even from the same TRP. This dimension (i.e. CCs), however, was not exploited in NR to enhance the reliability performance. For repetition enhancement we are considering different physical channels i.e., PDCCH, PUCCH, PDSCH and PUSCH. For example, the same PDSCH can be scheduled by DCI transmitted in different CCs to improve reliability of control channel transmission.

A2: Comparing to low power TRP deployment, the key benefits of TRP with Rx only capability are further cost reduction of TRP and simpler deployment from regulation perspective (no transmission capability of TRP).

A3: Accurate CSI (especially CQI) is very important for URLLC type of transmission (may be even more important than for eMBB). Outer-loop link adaptation is not efficient due to very low target BLER, which would require a lot of transmission for convergence. Although NW-based MCS selection using per-TRP CQI is possible, in our view it doesn't work from accuracy perspective. Moreover, it is possible that RI reported per each TRP may not be the same, which makes the task of selecting MCS based on CQI even more difficult

due need to perform rank overriding issue. We think CSI issue for mTRP URLLC was overlooked in Rel-17 and should be addressed as soon as possible to make mTRP feature work.

A4: Please refer to our reply (A2) in response to NTT DOCOMO question.

4.3 Round 2 Questions

Feedback Form 6: Round 2 questions to RWS-210370 'Rel-18 NR MIMO'

1 – Beijing Xiaomi Mobile Software

Thanks for your answers. Please see our further questions below:

Q1: We also have concerns on power control mechanism for UL-only nodes.

Q2: For 'multi-CC repetition schemes', I noticed that you intend to support repetition across multiple CCs in RAN1 for each physical channel separately. We want to know the benefits, e.g., for PDCCH transmission. In this case, UE need to monitor CORESETs on different CC to obtain one DCI. In addition, the cell specific beam failure recovery also need to be changed.

2 – Samsung Research America

- (p2) For non-perf synchronized TRPs at FR1 or FR2, the DL timing difference (including true timing difference and propagation delay) can be measured, reported by the UE, and compensated at the network side. If that is the case, what would be the benefit of the restriction on single FFT per panel at FR2 and multiple FFTs at FR1? Besides, how is panel isolation characterized at FR2?

-(p6) Please describe what additional QCL assistance information you envision to reduce beam acquisition latency.

3 – HuaWei Technologies Co.

Thanks for the clarification that both FDD and TDD are included for MTRP enhancement. But to exploit the benefits of MTRP, do you mean only for URLLC purpose or both URLLC and eMBB? In our understanding, it is more valuable to exploit the high spectrum efficiency from M-TRP deployment in eMBB.

4 – ZTE Corporation

Regarding beam acquisition latency reduction, how to find/track Tx beam change based on normal DL beam measurement is much tough, and, in our views, some prediction approach should be considered.

Besides, for hierarchical beam management, from gNB perspective, the RS overhead for UE-specific beam training is very huge and unacceptable.

4.4 Round 2 Answers

1 - Beijing Xiaomi Mobile Software

Thanks for your answers. Please see our further questions below:

Q1: We also have concerns on power control mechanism for UL-only nodes.

Q2: For 'multi-CC repetition schemes', I noticed that you intend to support repetition across multiple CCs in RAN1 for each physical channel separately. We want to know the benefits, e.g., for PDCCH transmission. In this case, UE need to monitor CORESETs on different CC to obtain one DCI. In addition, the cell specific beam failure recovery also need to be changed.

2 - Answer:

A1: There should be no significant issue for power control. UE can determine Tx power based on DL RS measurement from TRP that has Tx capability (similar to the legacy system without TRPs with UL only capability). Then the closed loop power control can be used to reduce the Tx power of UE to the smaller values. This should provide benefit comparing to the legacy deployment without TRPs with UL only capability.

A2: The control channel was provided as an example. We are looking for the corresponding enhancement for all physical channels to take advantage of different propagation conditions on different CCs transmitted on different bands. The enhancement areas (e.g. BFR) you have provided are valid and should be discussed as part of RAN1 work.

3 - Samsung Research America

- (p2) For non-perf synchronized TRPs at FR1 or FR2, the DL timing difference (including true timing difference and propagation delay) can be measured, reported by the UE, and compensated at the network side. If that is the case, what would be the benefit of the restriction on single FFT per panel at FR2 and multiple FFTs at FR1? Besides, how is panel isolation characterized at FR2?

-(p6) Please describe what additional QCL assistance information you envision to reduce beam acquisition latency.

Answer:

A1: We are not sure whether compensation at TRP would be simple / feasible taking into account different propagation condition to different UEs from the same TRP. This seems very challenging for implementation as it requires multiple Tx chains (including FFT processing) for the generation of the Tx signals for each user (even when users are scheduled in TDM) due to the different transmission timing. In FR2, it may also require time gaps to perform beam switch, if the Tx signals for TDM-eds UEs, after timing pre-compensation start to overlap with each other.

A2: We consider indication of the beam's spatial relation on the SSBs from one TRP on the same CC as well as beams relation on SSB across CCs to perform more efficient beam acquisition procedure. For example, TRP may employ beam oversampling to avoid possible coverage loss in certain directions. The information about such spatial beam relation can be exploited at the UE for more efficient beam acquisition. For multi-panels TRP, it is possible to transmit SSBs (on the same symbol) on different CCs using different beams, which can be also used at the UE to reduce beam acquisition time.

HuaWei Technologies Co., Ltd

Thanks for the clarification that both FDD and TDD are included for MTRP enhancement. But to exploit the benefits of MTRP, do you mean only for URLLC purpose or both URLLC and eMBB? In our understanding, it is more valuable to exploit the high spectrum efficiency from M-TRP deployment in eMBB.

Answer: CSI enhancements for eMBB mTRP are being defined in Rel-17. So Rel-18 should focus on URLLC mTRP enhancements due to more stringent requirement on the accuracy of link adaption procedures

comparing to eMBB. We are open to discuss possible CSI enhancements for eMBB, but this should have lower priority considering ongoing Rel-17 work.

4 - ZTE Corporation

Regarding beam acquisition latency reduction, how to find/track Tx beam change based on normal DL beam measurement is much tough, and, in our views, some prediction approach should be considered.

Besides, for hierarchical beam management, from gNB perspective, the RS overhead for UE-specific beam training is very huge and unacceptable.

Answers:

A1: It would be great to understand your concern in more details, but we have different view regarding complexity of tracking procedure based on normal DL beam management. In particular, beam management using periodic SSB should provide information to the NW about possible rough beam directions. Then aperiodic CSI-RS / SRS measurements on the neighbouring beams can be used for beam refinement and tracking. If new beam direction is identified by NW based on SSB measurements, NW can always trigger CSI-RS / SRS transmission with QCL reference to the new SSB beam for refinement purposes.

Beam prediction can be used as complimentary solution, but we also see some challenges for some prediction approaches. In particular, for TRP beam prediction at the UE, lack of information about beam assignment to the reference signals, e.g. on SSBs, makes it very difficult for the UE to perform beam prediction.

A2: We have different view on the RS overhead issue for hierarchical beam management. Beam refinement requires measurement over neighbouring beams only (e.g. over 3 beams either in azimuth or vertical dimension) that only consumes 3 OFDM symbols per one refinement occasion. In addition, aperiodic triggering of CSI-RS provides opportunity to control rate of CSI-RS triggering depending on the user mobility.

5 Views on RAN4 Rel-18 scope

Questions related to RWS-210375 'Views on RAN4 Rel-18 scope' may be raised in this section.

5.1 Round 1 Questions

Feedback Form 7: Questions related to RWS-210375 'Views on RAN4 Rel-18 scope'

1 – Samsung Electronics Co.

Based on proposal 1 and 5, spectrum related WI are supposed to be approved in Dec 2021?

5.2 Round 1 Answers

1 - Samsung Electronics Co.

Q1: Based on proposal 1 and 5, spectrum related WI are supposed to be approved in Dec 2021?

Answer: Yes, the proposal is to start from spectrum WIs approval in Dec 2021. Additional spectrum WIs can be approved in June 2022 and Dec 2022. The non-spectrum WIs are proposed to be approved as a package in March 2022.

5.3 Round 2 Questions

Feedback Form 8: Round 2 questions to RWS-210375 'Views on RAN4 Rel-18 scope'

1 – CATT Thanks for Intel for the overall consideration on Rel-18 RAN4 package. A follow-up question from my side. Since Dec 2021 is still with Rel-17 time frame for RAN4 work. If we allow approval of Rel-18 spectrum in Dec 2021, how to handle all the Rel-17 spectrum basket WI? Do we need to switch all basket WI to Rel-18 in Dec 2021?
2 – CATT Thanks Intel for the overall consideration on RAN4 Rel-18 package. A follow-up question from my side. Since Dec 2021 is still within Rel-17 time frame for RAN4 work. If we allow approval of Rel-18 spectrum in Dec 2021, how to handle all the Rel-17 spectrum basket WI? Do we need to switch all basket WI to Rel-18 in Dec 2021?
3 – vivo Communication Technology On UE demodulation, what kind of assitance information do you have in mind? In LTE, advanced receiver was introduced with assitance information however never implemented.

5.4 Round 2 Answers

Response to CATT:

Thank you for the question. In our view the new basket WIs can be approved in Dec 2021. Meantime, RAN4 can continue work to finalize the Rel-17 basket WIs in Q1'2022. Further extension of the contents of basket WIs can take place in March 2022 following the regular procedure. Also, we would like to clarify that our proposal on spectrum items does not apply to CA/DC Basket WIs and we expect updates can happen with regular periodicity.

Response to vivo:

For LTE MUST receivers – the enhancements were introduced in the late stage. To ensure improved NR performance it is preferable to consider enhancements in Rel-18 so that they are implemented in a timely manner. For DL MU-MIMO receivers the required network assistance depends on reference receiver. For E-MMSE-IRC we think that current information can be most likely sufficient. For R-ML receivers the information on co-scheduled UEs modulation is required.