RAN-R18-WS-eMBB-Huawei - Version 0.0.5
RAN

3GPP TSG RAN Rel-18 workshop RWS-210526

Electronic Meeting, June 28 – July 2, 2021

Source: Huawei

Title: Email discussion summary for [RAN-R18-WS-eMBB-Huawei]

Agenda item: 4.1

Document for: Information

1 Introduction

Huawei and HiSilicon have provided the following Tdocs for eMBB-driven functionalities in Rel-18:

RWS-210437 NR enhancements for DL MIMO

RWS-210438 NR FR2 enhancements

RWS-210440 5G-Advanced Fixed Wireless Access

RWS-210441 NR Multi-Band Serving Cell

RWS-210449 Further mobility enhancements

RWS-210450 Consideration on PDCP concatenation

RWS-210456 mmWave multi-band BS

RWS-210457 FR2 RRM requirements evolution

RWS-210458 UE advanced receiver for Rel-18

Questions and comments followed responses from Huawei and HiSilicon are collected in this document as per the deadlines provided by the RAN chair. Feedback forms will be opened and closed according to those deadlines.

Round 1 Q&A: Questions: June 14 08:00 UTC – June 17 8:00 UTC; Answers: June 17 8:00 UTC – June 18 23:59 UTC

Round 2 Q&A: Questions: June 21 08:00 UTC – June 23 8:00 UTC; Answers: June 23 8:00 UTC – June 24 18:00 UTC

2 [First round] Q&A

2.1 RWS-210437 NR enhancements for DL MIMO

Feedback Form 1: Comments and questions to RWS-210437

1 – LG Electronics Inc.

Regarding the proposed CJT, it seems that 3 TRP CJT has been assumed in Figure 12 and 13. Is there any specific reason to support 3 TRP case for CJT since Rel-16/17 mTRP features have been assumed only up to 2 TRPs for both eMBB(NCJT) and URLLC?

2 – Beijing Xiaomi Mobile Software

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Q1: We think further discussion on if it is feasible/necessary to enhance the coherent joint transmission is needed.

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Q2: We agree the inter-cell interference of SRS is worth studying.

3 – China Unicom

Thanks for the contribution with detail descriptions on issues and solutions.

We support the DL MIMO enhancement in R18, and the potential enhancement for MIMO enhancements not only for FDD as well as TDD. For CJT solutions, it is worth to support more 2 TRPs in multiple TRP in FDD and TDD considering the deployment scenarios.

4 – Intel Corporation (UK) Ltd

<Intel>

Q1. With accurate CSI feedback (e.g. eType II or TDD) the need of orthogonal DM-RS ports may not be very critical due to efficient interference suppression at gNB. Could you please clarify poor performance of non orthogonal DM-RS ports in this case mentioned in your contribution?

5 – MediaTek Inc.

What is your assumed signal model for coherent joint transmission?

6 – Motorola Mobility UK Ltd.

Thank you for the interesting contribution. My question is related to your proposal in the ***"FDD MIMO enhancement for Multiple TRP"*** section, which reads *"Enhancements on CSI measurement and feedback for FDD Coherent Joint Transmission (CJT) could be in the scope of Rel-18 MIMO enhancements"*. Can you emphasize on the aspects at which the Rel-17 WI on multi-TRP CSI enhancements would fall short for the proposed use case for CSI framework under coherent joint transmission? Also, can you elaborate on the frequency range(s) that this SI/WI targets?

7 – Qualcomm communications-France

On DL MIMO, regarding proposal 6 related to FDD CJT, what are the shortcomings of existing CSI codebooks?

8 – Samsung Research America

(p8) Re coherent joint transmission based on multi-TRP for low band, could you elaborate more on the following things?

- 1. # TRPs per cell for a reasonable cell size (low band)?
- 2. # antenna ports per TRP?
- 3. Measurement of phase difference between two TRPs?

9 – Beijing Lenovo Software Ltd.

Q1 (proposal 2): For DMRS design, do you envision there is any difference between FDD and TDD?

Q2 (Proposal 4): Inter-cell interference can be managed by gNB through implementation. What makes it necessary to specify it for SRS?

Q3 (Proposal 5): What is the time scale considered for time-domain CSI compression?

Q4 (Proposal 6): What is the number of TRPs involved in coherent JT? Is it 2 or more than 2?

10 – Ericsson LM

- On the increase of number of DMRS ports. Is this for both PDSCH and PUSCH? Also, do you consider increasing the DMRS density, i.e. increasing number of ports per OFDM symbol, e.g. comb=4 in Type 1 DMRS?
- Can you elaborate on the sequence design to lower the SRS sequence correlation?
- You mention reducing PRG<2 RB, is the intended use case for this C-JT or have you also observed sTRP channels with such severe frequency selectivity?
- Does the results in Figure 2 include the SINR loss due to channel estimation using the reduced PRG?

11 – China Mobile Com. Corporation

Regarding high resolution precoding for high frequency selective fading, I think there is a trade-off between the channel estimation accuracy and the frequency selective precoding gain, I want to know how to achieve such kind of trade-off in your view.

Regarding SRS enhancement, increasing the SRS capacity without reducing channel estimation performance is always helpful and welcome. I am wondering how to further enhance the capacity without increasing time and frequency resources, and how to maintain backward compatibility.

Regarding DMRS enhancement supporting more than 12 ports, in your evaluation, have you consider to separate the UEs in spatial domain as much as possible when they are using the same antenna port? In our understanding, even only with 12 ports, more than 12 UEs can be multiplexed if they can be separated into e.g., two spatially less corelated groups.

12 – vivo Communication Technology

1) on finer precoding granularity, have you considered channel estimation gain compared to PRB bundling of 2 or 4 PRBs?

2) more orthogonal DMRS ports is desirable from MU perspective, on the other hand how about demodulation performance?

3) what other SRS capacity enhancement on top of Rel-17 enhancment is envisioned?

4) on CSI for FDD coherent JT, new codebook design is required? what is the assumption on antenna structure?

13 – Guangdong OPPO Mobile Telecom.

Thanks for the contribution. We have some comments as blow

1. We share the same view that CSI compression via time domain correlation is a promising technology to further improve CSI feedback
2. Regarding to the proposal, how to deal with the impact of imblanced pathloss on the CSI feedback?

2.1.1 Answers

Feedback Form 2: Answers from Huawei to questions and comments on RWS-210437

1 – HuaWei Technologies Co.

1. LG Electronics:

Regarding the proposed CJT, it seems that 3 TRP CJT has been assumed in Figure 12 and 13. Is there any specific reason to support 3 TRP case for CJT since Rel-16/17 mTRP features have been assumed only up to 2 TRPs for both eMBB(NCJT) and URLLC?

[Huawei] In the preliminary simulations, the number of TRPs for coherent joint transmission is up to 3, but the number will be different for different UEs and decided according to a RSRP gap threshold from different TRPs. Note that, in practical scenarios, generally 3 or more than 3 TRPs will be connected to a BBU with ideal backhaul.

In Rel-16/17, the discussion on M-TRP mainly focus on non-coherent Joint transmission with two DCIs and URLLC with single DCI. With considering of UE complexity on multi-PDCCH decoding, only focus on two-TRPs before. Then, for Coherent joint transmission with ideal backhaul, only one PDCCH is required, so the complexity for supporting more than 2 TRPs is not an issue. In addition, we are open to discuss more than two TRPs for NCJT and URLLC as well.

2. Beijing Xiaomi Mobile Software

Q1: We think further discussion on if it is feasible/necessary to enhance the coherent joint transmission is needed.

[Huawei] In practical scenarios, C-RAN structure is widely used due to low cost and fast deployment, where coherent joint transmission can be enabled. With coherent joint transmission, more MU layers can be paired and more powerful for interference mitigation.

Q2: We agree the inter-cell interference of SRS is worth studying.

[Huawei] Yes, to reduce inter-cell interference for SRS is important aspect for both S-TRP and M-TRP, especially for obtaining the benefits of coherent joint transmission.

3. China Unicom

We support the DL MIMO enhancement in R18, and the potential enhancement for MIMO enhancements not only for FDD as well as TDD. For CJT solutions, it is worth to support more 2 TRPs in multiple TRP in FDD and TDD considering the deployment scenarios.

[Huawei] Thanks operator to confirm the use case. Coherent-joint transmission is worth to be investigated for both FDD and TDD, and more than 2 TRPs for coherent joint transmission are also in practical scenarios.

4. Intel Corporation (UK) Ltd

With accurate CSI feedback (e.g. eType II or TDD) the need of orthogonal DM-RS ports may not be very critical due to efficient interference suppression at gNB. Could you please clarify poor performance of non orthogonal DM-RS ports in this case mentioned in your contribution?

[Huawei] For the high order MU transmission, the interference for each layer will be accumulated as the MU pairing number increases, especially when the MU paring exceed 12 layers. Even with the accurate CSI (we use TDD SRS in the simulation), the interference for high order MU is still an issue. It can be verified in Figured 4, when MU paring increases from 16 to 24 layers, the performance loss for current DMRS becomes worse.

5. MediaTek.

What is your assumed signal model for coherent joint transmission?

[Huawei] In the simulation, up to 3 TRPs (depend on RSRP gap, may be 1 or 2) are assumed for coherent joint transmission. Other simulation details are provided in Appendix-E in our contribution.

6. Motorola Mobility UK Ltd.

Thank you for the interesting contribution. My question is related to your proposal in the "FDD MIMO enhancement for Multiple TRP" section, which reads "Enhancements on CSI measurement and feedback for FDD Coherent Joint Transmission (CJT) could be in the scope of Rel-18 MIMO enhancements". Can you emphasize on the aspects at which the Rel-17 WI on multi-TRP CSI enhancements would fall short for the proposed use case for CSI framework under coherent joint transmission? Also, can you elaborate on the frequency range(s) that this SI/WI targets?

[Huawei] R17 multi-TRP CSI enhancement mainly for NCJT, and the discussion in Rel-17 till now are also not for coherent joint transmission cases. Actually, in practical scenarios, there are many cases with C-RAN deployment, where coherent joint transmission is feasible and beneficial. So, we propose to investigate coherent joint transmission in Rel-18. The coherent joint transmission can be for both TDD and FDD, but the exact frequency range, we are open now.

7. Qualcomm communications-France

On DL MIMO, regarding proposal 6 related to FDD CJT, what are the shortcomings of existing CSI code-books?

[Huawei] CSI design for coherent joint transmission is expected to enable the benefits of CJT in M-TRP, such as large number of antennas, more MU pairing and high capability on interference mitigation. In CJT, there are much more antennas from multiple TRPs for joint transmission, so, more than 32 ports will be required. Then, the antennas from different TRPs are with different correlations, not only the co-phasing,

but also for beam directions, large scale properties, which also need to be considered in the CSI design for CJT. These just some examples which are not well design in CSI for previous releases. We already show there is a big gap between the current codebook design and the enhanced codebook for CJT in our contribution.

8. Samsung Research America

(p8) Re coherent joint transmission based on multi-TRP for low band, could you elaborate more on the following things?

1. # TRPs per cell for a reasonable cell size (low band)?

[Huawei] We have not discussed number of TRPs in a cell. TRPs in the cooperation can be with same PCI or not. In our preliminary simulation, each UE is linked to up to 3 TRPs for CJT considering the RSRP gap threshold being 10db.

2. # antenna ports per TRP?

[Huawei] In our preliminary simulation, we assume 32 ports for each TRP. We are open for the discussion on how many antennas for each TRP.

3. Measurement of phase difference between two TRPs?

[Huawei] For measurement of phase difference between two TRPs, different CSI-RS ports are used for measuring different channels from different TRP, and the phase difference between CSI-RS ports is the phase difference between TRPs.

9. Beijing Lenovo Software Ltd.

Q1 (proposal 2): For DMRS design, do you envision there is any difference between FDD and TDD?

[Huawei] We prefer a unified DMRS design for FDD and TDD.

Q2 (Proposal 4): Inter-cell interference can be managed by gNB through implementation. What makes it necessary to specify it for SRS?

[Huawei] In current deployment, SRS is most likely interference limited, so the interference on SRS should be investigated in both single TRP and multi-TRP. As discussed in our contribution, if using non-overlapped SRS resources among different cells to avoid the collision, large SRS capacity is required or long periodicity for SRS transmission (which brings new challenges with channel aging problem)

Q3 (Proposal 5): What is the time scale considered for time-domain CSI compression?

[Huawei] In our preliminary simulation, we assume the CSI feedback periodicity is 20ms.

Q4 (Proposal 6): What is the number of TRPs involved in coherent JT? Is it 2 or more than 2?

[Huawei] In our preliminary simulation, each UE is linked to up to 3 TRPs for CJT considering the RSRP gap threshold being 10db.

10. Ericsson LM

Q1: On the increase of number of DMRS ports. Is this for both PDSCH and PUSCH? Also, do you consider increasing the DMRS density, i.e. increasing number of ports per OFDM symbol, e.g. comb=4 in Type 1 DMRS?

[Huawei] We are supportive for increasing the number of DMRS ports for both PDSCH and PUSCH, with considering DMRS resource overhead and backward compatibility. It is an efficient way to achieve it through increasing the number of DMRS ports for the same time and frequency resource. For detailed solutions, we can further discuss.

Q2: Can you elaborate on the sequence design to lower the SRS sequence correlation?

[Huawei] There may be several solutions can lower SRS sequence correlation, as an example, forming a long SRS sequence through concatenating multiple SRS to reduce the cross correlation.

Q3: You mention reducing PRG<2 RB, is the intended use case for this C-JT or have you also observed sTRP channels with such severe frequency selectivity?

[Huawei] PRG<2 is targeting for the highly frequency selective scenario, which could be either CJT or single TRP scenario. For CJT cases, since the channels from different TRPs, the frequency selective will be more severe.

Q4: Does the results in Figure 2 include the SINR loss due to channel estimation using the reduced PRG?

[Huawei] Yes, the real DMRS channel estimation has already been taken into account in our simulation.

11. China Mobile Com. Corporation

Q1: Regarding high resolution precoding for high frequency selective fading, I think there is a trade-off between the channel estimation accuracy and the frequency selective precoding gain, I want to know how to achieve such kind of trade-off in your view.

[Huawei] In the evaluation, we have included the impact of channel estimation, where more than 10% performance gain can be obtained. The channel estimation from 2 RB to 1 RB, even to half RB is with not so much impact on performance. But with high resolution precoding, more MU pairing are enabled and more powerful interference avoidance, especially for multi-TRP cases. So, it is beneficial with finer precoding granularity to 1RB or half RB.

Q2: Regarding SRS enhancement, increasing the SRS capacity without reducing channel estimation performance is always helpful and welcome. I am wondering how to further enhance the capacity without increasing time and frequency resources, and how to maintain backward compatibility.

[Huawei] Thanks for operator's confirming the direction. We strive for SRS capacity enhancement with exploiting the sparsity of multi-path channels, which can minimize SRS resources. Backward compatibility can be enabled through orthogonal resources for new SRS pattern and legacy SRS pattern in frequency domain or time domain

Q3: Regarding DMRS enhancement supporting more than 12 ports, in your evaluation, have you consider to separate the UEs in spatial domain as much as possible when they are using the same antenna port? In our understanding, even only with 12 ports, more than 12 UEs can be multiplexed if they can be separated into e.g., two spatially less correlated groups.

[Huawei] In our simulation, we already separate UEs in spatial domain as much as possible. As shown in Figure-4, even using additionally non-orthogonal DMRS ports, there are still large performance loss. The reason is that interference for each DMRS port accumulates as the MU paring number increases especially when the MU paring exceed 12 layers

12. vivo Communication Technology

1) on finer precoding granularity, have you considered channel estimation gain compared to PRB bundling of 2 or 4 PRBs?

[Huawei] Yes, the real DMRS channel estimation has already been taken into account in our simulation. A12-2: The bottleneck for DL high order MU MIMO is the channel estimation, but not for data decoding. As shown in our simulation Figure 4, link level performance with orthogonal DMRS obviously outperform non-orthogonal DMRS cases. A12-3: On top of Rel-17, we strive for enhancing SRS by exploiting channel sparsity to minimize SRS resources without incurring channel estimation loss

2) more orthogonal DMRS ports is desirable from MU perspective, on the other hand how about demodulation performance?

[Huawei] The bottleneck for DL high order MU MIMO is the channel estimation. As shown in our simulation (Figure 4), link level performance with orthogonal DMRS obviously outperform non-orthogonal DMRS cases.

3) what other SRS capacity enhancement on top of Rel-17 enhancement is envisioned?

[Huawei] On top of Rel-17, we strive for enhancing SRS by exploiting channel sparsity to minimize SRS resources without incurring channel estimation loss.

4) on CSI for FDD coherent JT, new codebook design is required? what is the assumption on antenna structure?

[Huawei] In Rel-18, CSI design for coherent joint transmission is expected to enable the benefits of CJT in M-TRP, such as large number of antennas, more MU pairing and high capability on interference mitigation. But current codebook design cannot well support such CJT cases. For example, in CJT, there are much more antennas from multiple TRPs for joint transmission, so, more than 32 ports will be required. And, the antennas from different TRPs are with different correlations, not only the co-phasing, but also for beam directions, which are not considered in codebook design in previous releases. We already show there is a big gap between the current codebook design and the enhanced CSI codebook for CJT.

In our preliminary simulation, we assume 32 ports for each TRP, and each UE can be linked to maximum 3TRPs for coherent joint transmission.

13. Guangdong OPPO Mobile Telecom

We share the same view that CSI compression via time domain correlation is a promising technology to further improve CSI feedback. Regarding to the proposal, how to deal with the impact of imblanced pathloss on the CSI feedback?

[Huawei] For the multi-TRP cases, large scale channel properties need to be considered in CSI feedback to address the issues on imbalance pathloss.

2.2 RWS-210438 NR FR2 enhancements

Feedback Form 3: Comments and questions to RWS-210438

1 – Rakuten Mobile

We Support Large Array at UE and gNB-assisted local UL beam refinement.

For Power Saving Methods, we propose to include in Power Saving Package.

2 – NEC Corporation

We have one question related to the proposed dynamic gNB panel allocation for FDM, does that mean gNB panel is non-transparent to UE?

3 – ZTE Corporation

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

- On mobility with narrow beam, the traditional beam tracking seems to work well with sufficient beam related DFT oversampling. Is there are specific optimization for this issue?
- Regarding dynamic gNB panel allocation for FDM, we share the similar views with NEC that it may be completed with a spec-transparent manner. It is just relevant to DL RS port/resource virtualization from gNB side.

4 – Intel Corporation (UK) Ltd

<Intel>

Q1. Could you please clarify the meaning of UL mobility in your proposal? Do you envision mobility decision based on UL measurements?

5 – Qualcomm communications-France

Q1: On FR2 enhancements, regarding "gNB-assisted local UL beam refinement", can you elaborate how UE decides in which direction to transmit the narrow UL beam in the absence of corresponding narrow DL beam?

Q2: Regarding "dynamic gNB panel allocation for FDM", the figure implies more than 2 gNB panel / TRP simultaneously can be used for a given UE. If that is the intention, is it first required to extend mTRP schemes to more than 2 TRPs? If not, can the existing Rel. 15/16 as well as NCJT CSI in Rel. 17 address multiple CSI hypotheses for DPS (different panels one at a time) as well as NCJT (multiple pairs each pair consists of two Panels/TRPs)?

6 – Beijing Lenovo Software Ltd.

What is the difference between dynamic gNB panel allocation and DPS?

7 – Nokia Corporation

Q1: The current FR2 requirements are very loose and allow UEs lot of leeway in implementations (and therefore allow for very long delays). If the number of beams is increased, so does also the frequency of beam changes, which can cause UP interruptions. What exactly is the mechanism that allows for faster operation (presumably via tighter requirements) for beam tracking and cell search? Is UE required to do more measurements (and hence consume more power) or is it about something else?

8 – Guangdong OPPO Mobile Telecom.

Thanks for the contribution.

1. For FR2, we also support to further enhance mobility since the coverage of FR2 cell is usually limited and there may be frequent handover for UE.

2. Regarding dynamic gNB panel allocation for FDM, is it possible to implement in a transparent way from UE perspective?

2.2.1 Answers

Feedback Form 4: Answers from Huawei to questions and comments on RWS-210438

1 – HuaWei Technologies Co.

1. Rakuten

We Support Large Array at UE and gNB-assisted local UL beam refinement. For Power Saving Methods, we propose to include in Power Saving Package.

[Huawei] Thanks for the support on large array at FR2 UE. We are open to discuss where to include the energy saving mechanisms discussed in this paper – the important thing is to reduce energy consumption in FR2.

2. NEC

We have one question related to the proposed dynamic gNB panel allocation for FDM, does that mean gNB panel is non-transparent to UE?

[Huawei] Thanks for the question. Here 'gNB panel' is used for discussion purpose. As discussed in our paper, our intention is to virtualize gNB panels into different CSI-RS ports within one CSI-RS resource, with which the exact gNB antenna architecture is still transparent to UE.

3. ZTE

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

- On mobility with narrow beam, the traditional beam tracking seems to work well with sufficient beam related DFT oversampling. Is there are specific optimization for this issue?

- Regarding dynamic gNB panel allocation for FDM, we share the similar views with NEC that it may be completed with a spec-transparent manner. It is just relevant to DL RS port/resource virtualization from gNB side.

[Huawei] Thanks for the question/comment.

1. In our estimate, with large array at gNB and/or UE, simply going with "beam-related DFT oversampling" would incur higher resource overhead and measurement complexity. How to address such overhead and complexity is worth investigating in R18, especially with large array. As discussed in our paper, one possible direction is to introduce additional reporting from UE to facilitate gNB narrow beamforming.

2. As mentioned in the reply to NEC, gNB panel will be virtualized into DL RS resource/port. To enable dynamic gNB panel allocation, it would be more efficient if the specification can enable gNB to ask the UE to report CSI for different port combinations based on one CSI-RS resource and within one reporting instance.

4. Intel

Q1. Could you please clarify the meaning of UL mobility in your proposal? Do you envision mobility decision based on UL measurements?

[Huawei] Thanks for the question. By "UL mobility" in this paper, we were primarily referring to UL beam training and tracking**.**

5. Qualcomm

Q1: On FR2 enhancements, regarding "gNB-assisted local UL beam refinement", can you elaborate how UE decides in which direction to transmit the narrow UL beam in the absence of corresponding narrow DL beam?

Q2: Regarding "dynamic gNB panel allocation for FDM", the figure implies more than 2 gNB panel / TRP simultaneously can be used for a given UE. If that is the intention, is it first required to extend mTRP schemes to more than 2 TRPs? If not, can the existing Rel. 15/16 as well as NCJT CSI in Rel. 17 address multiple CSI hypotheses for DPS (different panels one at a time) as well as NCJT (multiple pairs each pair consists of two Panels/TRPs)?

[Huawei] Thanks for the questions.

Q1: Our intention is to provide gNB assistance so that UE knows which DL wide Rx beam should be used as starting point for UL narrow beam training. To be specific, the UE is expected to refine UL Tx beam (via UL beam sweeping) within the angular range of the DL wide Rx beam.

Q2: In general, there can be more than 2 panels (e.g., 4) at one FR2 gNB, which can be used for simultaneous transmission. For multi-TRP-related aspects, we also think using more than 2 TRPs for joint transmission is worth investigating in R18, which is discussed in RWS-210437.

6. Lenovo

What is the difference between dynamic gNB panel allocation and DPS?

[Huawei] Thanks for the question. In our view, dynamic gNB panel allocation supports allocating {1, 2, 3, 4} panels for transmitting towards one UE, while DPS supports selecting only one TRP/panel for transmitting towards one UE. Note the gNB panels discussed here are installed on the same TRP, and can be used to transmit towards one UE simultaneously and coherently.

7. Nokia

Q1: The current FR2 requirements are very loose and allow UEs lot of leeway in implementations (and therefore allow for very long delays). If the number of beams is increased, so does also the frequency of beam changes, which can cause UP interruptions. What exactly is the mechanism that allows for faster operation (presumably via tighter requirements) for beam tracking and cell search? Is UE required to do more measurements (and hence consume more power) or is it about something else?

[Huawei] Thanks for the comment/question. Our proposals on FR2 RRM requirements are discussed in RWS-210457. This paper is about new mechanisms that can help speed up beam acquisition and refinement. One direction is to adopt advanced beam porting (e.g. phase difference between analog beams) to facilitate faster gNB beam refinement without actual narrow beam measurements. So the UE is required to measure/report phase difference among adjacent beams, but the number of measurements does not increase directly. As discussed in Section 4.3.3, another direction is to provide spatial assistance from gNB (e.g. spatial relation between different gNB Tx beams) to help making beam measurement at UE side more purposeful and faster.

8. OPPO

Thanks for the contribution.

1. For FR2, we also support to further enhance mobility since the coverage of FR2 cell is usually limited and there may be frequent handover for UE.

2. Regarding dynamic gNB panel allocation for FDM, is it possible to implement in a transparent way from UE perspective?

[Huawei] Thanks for the support/comment/question.

1. Compared with dense deployment of FR2 gNBs with small array and coverage, where frequent handover may be required, by adopting large array at FR2 gNB, the cell coverage would be expanded and less cells would be required (even reusing existing macro site locations), with which the inter-cell handover can be less frequent. On the other hand, with large array at FR2 gNB, narrow beamforming would be applied to serve remote UEs, with which intra-cell beam management needs to be enhanced.

2. As mentioned in the reply to NEC/ZTE, to enable dynamic gNB panel allocation, it would be more efficient if the specification can enable gNB to ask the UE to report CSI for different port combinations based on one CSI-RS resource and within one reporting instance.

2.3 RWS-210440 5G-Advanced Fixed Wireless Access

Feedback Form 5: Comments and questions to RWS-210440

1 – Xiaomi Communications

This is an interesting topic. We have the following questions for clarification:

Question 1: Should the UL spectrum efficiency be considered as well?

Question 2: What are the assistance information to enable low complexity UE receivers with interference cancellation?

2 – CATT

Could you please elaborate on the assistance information that is foreseen for this enhancement?

3 – Qualcomm Incorporated

On DMRS overhead reduction for stationary devices, In figure 3: any clarification why the red curves (2DMRS/slot) have worse BLER performance compared to other scenarios with reduced DMRS overhead?

2.3.1 Answers

Feedback Form 6: Answers from Huawei to questions and comments on RWS-210440

1 – Huawei Tech.(UK) Co.. Ltd

1 – Answers to Xiaomi

Thanks for your comments.

For Q1: Yes. We are open for UL spectrum efficiency enhancement and some details can be found in our companion contribution RWS-210436 where most of the mentioned techniques are common for both eMBB and FWA. We are also willing to study other techniques for UL spectrum efficiency enhancement that is specific to FWA scenario.

For Q2: The assistance information that needs to be used can be further studied under FWA scenario, and some examples can be the existence of interference, DMRS port(s) and modulation of interference. For CPE using E-MMSE-IRC receiver, the assistance information can be only the DMRS port(s) of interference. While for CPE using R-ML receiver, modulation of interference seems to be required for signaling from network.

2 – Answers to CATT

Thanks for your comments. The assistance information that needs to be used can be further studied under FWA scenario, and some examples for the assistance information can be the existence of interference, DMRS ports and modulation of interference. For CPE using E-MMSE-IRC receiver, the assistance information can be only the DMRS port(s) of interference. While for CPE using R-ML receiver, modulation of interference seems to be required for signaling from network.

3 – Answers to Qualcomm

Thank you for your question. In the simulation, for a given coding rate, the TB size for red curve (2DMRS/slot) is smaller than that for other curves where fewer DMRS are used and more REs are available for PDSCH. For a given coding rate, the BLER performance with a smaller TB size is worse than that with a larger TB size (as observed in R1-1610580). Due to this reason, the BLER performance for red curves will be slightly worse than other curves with the same coding rate.

2.4 RWS-210441 NR Multi-Band Serving Cell

Feedback Form 7: Comments and questions to RWS-210441

1 – Rakuten Mobile

This is interesting topic and we would like to potentially support it for Rel-18.

We have two questions.

Huawei's Comment
"Note: The frequency distance between the non-contiguous carriers in the serving cell may be within a limit such that simplified network and/or UE behavior can be exploited, e.g. the time-frequency synchronization, QCL, etc. from one carrier can be used for another carrier of the serving cell."

Rakuten: If such is the case then why PRACH to each carrier is required as mentioned on page 4.

Q2: We don't understand why there is such a huge improvement in DAPS HO.

2 – vivo Communication Technology

Thanks Huawei for proposing the new ways of utilizing low frequency band for NR deployment. As the proposal may potentially introduce UE hardware impact, we would like to clarify the following

1) Is the proposal applicable to FDD bands only?

2) It would be necessary to understand the targeting frequency bands, and what would be the maximum separation between non-consecutive carriers that consists a single serving cell?

3) Can you confirm that the current RAN4 UE RF requirement based on carriers are kept unchanged in general, and what would be the RAN4 impact do you have in mind?

4) Can you confirm that the current RAN4 band combinations for carrier aggregation are still applicable for the case of multi-band serving cell. furthermore, should the design principle be such that we allow UE supporting less bands/smaller BW than the NW aggregated bands/BW to be able to work in the NW?

5) How to consider the performance degradation when the estimation results based on SSB/RS in one band be applied to another band?

6) The proposal would mean UE stays active for multiple bands, how do you consider the UE power consumption increase and what kind of power saving scheme could be used instead of Scell deactivation? And does such power saving scheme also introduce additional delay?

3 – China Telecom Corporation Ltd.

We support this Topic and also show our interest for the scenario of 700/800/900MHz in our document of RWS-210147.

A question for the potential objectives:

In Page 6 of the slides, saying Support multiple active DL&UL BWPs in the serving cell for a UE where each BWP is mapped within a carrier of contiguous bandwidth

Does it means for one carrier only one BWP is allowed to be activated or multiple BWPs are allowed to be activated?

4 – Lenovo (Beijing) Ltd

Thanks for the nice contribution. Several comments from my side for clarification:

(1) Is FR2 carrier included for this proposal?

(2) From a UE's perspective, the aggregated multiple carriers are regarded as multiple active BWPs of one serving cell. In that sense, in order to support this feature, a UE has to be equipped with multiple independent RF units for simultaneously receiving/transmitting the PDSCH/PUSCH on multiple carriers?

(3) Regarding using a single DCI scheduling PDSCH/PUSCH across multiple carriers, we share same view and would like to extend the scope to FR2/licensed and unlicensed spectrum/two-stage DCI. The detailed address can be checked in https://nwm-trial.etsi.org/#/documents/4609

(5) Since one intention of this proposal is to reduce the overhead like SSB/SIB1 in each carrier, I am afraid there is coexistence issue for legacy UE as some carriers may not have SSBs/SIB1 for initial access. So how can legacy UE access these carriers?

5 – MediaTek Inc.

Thanks for the quality contribution. This is an interesting direction and also related to general CA/DC enhancements, e.g., 1-DCI scheduling multiple carriers. Below please find our comments/questions:

- It is understood the target is to reduce the per-carrier overhead for increased CA capacity. On the other hand, we are wondering **whether the limitation of legacy UEs (R15/R16/R17) will reduce the expected capacity benefit**. For example, if legacy UEs are blocked out of this super cell, there may be less UEs accommodated.
- Regarding the impact to UE complexity, is there any expected range on the maximum number of active BWPs? Also any BW range limit for sharing time-freq. synchronization, and QCL?

6 – CATT

We support the motivation and we have similar proposal in RWS- 210402. We think single cell over multi-band is an efficient approach to aggregate the non-contiguous frequency spectrum. For the details, we think we can further discuss, e.g. whether to support multiple active BWPs or to support a BWP with non-contiguous frequency spectrum.

7 – Intel Corporation (UK) Ltd

<Intel>

Q1. How many TBs are transmitted on the multiple active BWPs?

8 – Spreadtrum Communications

Thanks for the contribution. We have one question for clarification:

- How to consider performance loss if T/F tracking information, QCL, etc., is achieved from only one carrier of the cell consisting of multiple non-continuous carriers each corresponding to one band.

9 – Qualcomm Incorporated

Regarding "common signalling (SSB/OSI/paging) in one band for idle/inactive state", the carrier(s)/band(s) that does not have the common signalling would be inaccessible by legacy NR UEs. Is it intended to enable this for narrowband carrier(s)/band(s) that cannot accommodate SSB/OSI/paging? If so, what bandwidth is such narrowband carrier(s) supposed to have? If not, does not this cause "unbalanced cell load" across carrier(s)/band(s), which may result in performance loss?

10 – Nokia Corporation

Q1: Would this require UE to have multiple active BWPs per cell and aggregate its Tx/Rx over all of those? Or would those be switched dynamically so the operation looks similar to current BWP?

Q2: How would this impact UE CA capabilities?

Q3: Is this proposal for both IDLE and CONNECTED, or only for CONNECTED?

Q4: Is this for both FR1 and FR2?

11 – China Mobile Com. Corporation

Thank you for the contribution. We share the same view for flexible using of multi-band carriers, and a similar study is proposed in RWS-210335. You also mention that aggregating multiple non-contiguous intra-band and inter-band carriers into one serving cell, do you mean when the multiple carriers are in neighbour bands, BWP like operation can be adopted, and when multiple carriers are far away, what's your consideration for the multi-carrier operation?

12 – Beijing Xiaomi Mobile Software

Thanks for the good contribution and the motivation sounds reasonable, we are interested in the proposals.

Also, we have some questions for clarification.

1 What's the considered impact on UE RF cost and complexity, would it increasing?

2 What's the impact on the UE power consumption?

In addition, we suggest reuse the current BWP operation as much as possible and study the flexible resource mapping mechanism.

2.4.1 Answers

Feedback Form 8: Answers from Huawei to questions and comments on RWS-210441

1 – Huawei Tech.(UK) Co.. Ltd

1. **Rakuten Mobile**

Q1: Why PRACH to each carrier is required as mentioned on page 4.

[Huawei] PRACH is not mandatory on each carrier. But PRACH could also be flexibly allocated on multiple carriers which could lead to better offloading to avoid congestion or large access delay, more frequency diversity, better adaption to different UE capabilities.

Q2: We don't understand why there is such a huge improvement in DAPS HO.

[Huawei] In Rel-17, DAPS with CA is not supported. If we treat these non-contiguous carriers as multiple serving cells, under DAPS framework, we should release all the SCells and just keep one PCell before DAPS, and after DAPS, all the SCells are added back. The delay for SCells releasing and addition is large and during which it leads to the throughput loss due to narrow bandwidth.

2. vivo

Q1: Is the proposal applicable to FDD bands only?

[Huawei] It can be applicable to any neighboring bands. But FDD bands are typically scattered in small chunks, i.e., the contiguous bandwidth of each band is small and the non-contiguous bands are not far from each other.

Q2: It would be necessary to understand the targeting frequency bands, and what would be the maximum separation between non-consecutive carriers that consists a single serving cell?

[Huawei] The frequency distance between the non-contiguous carriers in the serving cell should be within a limit, ensuring that simplified network and/or UE behavior can be exploited, e.g. the time-frequency synchronization from one carrier can be used for another carrier of the serving cell. The concrete value can be decided by future RAN4 discussion.

Q3: Can you confirm that the current RAN4 UE RF requirement based on carriers are kept unchanged in general, and what would be the RAN4 impact do you have in mind?

[Huawei] Most of current RAN4 UE RF requirements defined based on carriers are independent of features (except for UL-MIMO). Those requirements should be kept unchanged. For definitions of band and band combinations we have no intention to change them. Regarding RAN4 UE RF impacts, we would like to consider necessary additional requirements which are required to support the new feature.

Q4: Can you confirm that the current RAN4 band combinations for carrier aggregation are still applicable for the case of multi-band serving cell.

[Huawei] We think current RAN4 requirements for CA band combinations can be reused for the case of multi-band serving cell. We try to reuse the existing requirements as much as possible to ensure the backward compatibility and save efforts for implementation. Some additional BS RF requirements would be needed to enable better cooperation between CCs and to save power for UE. Multi-band serving cell is a new feature and we are not sure that we should keep reusing CA/DC band combinations but anyway the multi-band serving cell feature will be compatible with CA/DC.

Q5: Furthermore, should the design principle be such that we allow UE supporting less bands/smaller BW than the NW aggregated bands/BW to be able to work in the NW?

[Huawei] Yes.

Q6: How to consider the performance degradation when the estimation results based on SSB/RS in one band be applied to another band?

[Huawei] We are not quite sure about what the estimation results you refer to. In our understanding, they could be time-frequency synchronization, for example. If so, BS would ensure that there is no difference of estimation results between multiple co-located CCs, which is in the other word BS RF requirements between multiple co-located CCs are the same with those for single serving cell, e.g., time-frequency synchronization, thus there is no performance loss.

Q7: The proposal would mean UE stays active for multiple bands, how do you consider the UE power consumption increase and what kind of power saving scheme could be used instead of Scell deactivation? And does such power saving scheme also introduce additional delay?

[Huawei]

- UE does not always stay active for multiple bands, and BWPs/RFs can be dynamically switched on/off according to the traffic load. If there is no traffic, only one BWP or carrier needs to be active, i.e., switching off other BWPs/carriers for power saving. When burst traffic arrives, we can switch on the other BWPs/carriers to achieve instantaneous wideband transmission and achieve high data rate.
- Since the time-frequency synchronization, etc, from one carrier can be used for another carrier of the serving cell, BWP-like operation can be used, which does not introduce additional delay.

3. <u>China Telecom</u>

Q1: Does it means for one carrier only one BWP is allowed to be activated or multiple BWPs are allowed to be activated?

[Huawei] At most one active BWP per carrier.

4. <u>Lenovo</u>

Q1: Is FR2 carrier included for this proposal?

[Huawei] The proposal at least applies FR1 and to the intra-band scenarios for FR2. Besides, we don't target to aggregate FR1 and FR2 carriers/bands into one multi-band serving cell.

Q2: From a UE's perspective, the aggregated multiple carriers are regarded as multiple active BWPs of one serving cell. In that sense, in order to support this feature, a UE has to be equipped with multiple independent RF units for simultaneously receiving/transmitting the PDSCH/PUSCH on multiple carriers?

[Huawei]

- UE needs be capable of supporting reception/transmission of PDSCH/PUSCH on multiple carriers/bands, but it is not necessary to require UE to support simultaneous reception/transmission of PDSCH/-PUSCH on multiple carriers/bands.
- UE needs multiple independent RF units, which is nothing new since the existing UE can support multiple bands which may requires multiple independent RF units if the bands are separate or shared some RF units if the bands are close to each other. The proposed technique would not require more RF units than CA given a certain band combination.

Q3: Regarding using a single DCI scheduling PDSCH/PUSCH across multiple carriers, we share same view and would like to extend the scope to FR2/licensed and unlicensed spectrum/two-stage DCI. The detailed address can be checked in https://nwm-trial.etsi.org/#/documents/4609

[Huawei] Thanks for support and suggestion. We are open for the technical details.

Q4: Since one intention of this proposal is to reduce the overhead like SSB/SIB1 in each carrier, I am afraid there is coexistence issue for legacy UE as some carriers may not have SSBs/SIB1 for initial access. So how can legacy UE access these carriers?

[Huawei] It depends on the deployment. If there are legacy UEs which need to access the other band, operators can also decide to send common signaling in that band. However, how to support legacy UE is not a new problem, and currently many operators choose one SSB/SIB1 deployment using one low-frequency band for network power saving. In addition, MBSC could provide flexibility for deployment, e.g., for spectrum re-farmed from LTE, there may be no need to send common signaling as no legacy NR UEs may support this spectrum for NR.

5. MediaTek

Q1: It is understood the target is to reduce the per-carrier overhead for increased CA capacity. On the other hand, we are wondering whether the limitation of legacy UEs (R15/R16/R17) will reduce the expected capacity benefit. For example, if legacy UEs are blocked out of this super cell, there may be less UEs accommodated.

[Huawei] It depends on the deployment. If there are legacy UEs which need to access the other band, operators can also decide to send common signaling in that band. However, how to support legacy UE is not a new problem, and currently many operators choose one SSB/SIB1 deployment using one low-frequency band for network power saving. In addition, MBSC could provide flexibility for deployment, e.g., for spectrums re-farmed from LTE, there may beno need to send common signaling as no legacy NR UEs may support this spectrum for NR.

Q2: Regarding the impact to UE complexity, is there any expected range on the maximum number of active BWPs?

[Huawei] There should be at most one active BWP per carrier. The maximum number of active BWPs should be a UE capability.

Q3: Also any BW range limit for sharing time-freq. synchronization, and QCL?

[Huawei] The frequency bands within the serving cell should ensure that simplified network and/or UE behavior can be exploited, e.g. the time-frequency synchronization, QCL, etc. from one carrier can be used for another carrier of the serving cell. The concrete value can be decided by future RAN4 discussion.

6. CATT.

[Huawei] Thanks for support. Agree that we can further discuss the details.

7. Intel

Q1: How many TBs are transmitted on the multiple active BWPs?

[Huawei] Whether one TB or multiple TBs is technical detail, and at this stage we are open on this.

8. Spreadtrum Communications

Q1: How to consider performance loss if T/F tracking information, QCL, etc., is achieved from only one carrier of the cell consisting of multiple non-continuous carriers each corresponding to one band.

[Huawei] BS would ensure that there is no difference of estimation results between multiple co-located CCs, which means BS RF requirements between multiple co-located CCs are the same with those for single serving cell, e.g., time-frequency synchronization, QCL, thus there is no performance loss.

9. Qualcomm

Q1: Is it intended to enable this for narrowband carrier(s)/band(s) that cannot accommodate SSB/OSI/paging? If so, what bandwidth is such narrowband carrier(s) supposed to have?

[Huawei] Our primary goal is for FDD carrier(s)/band(s) which can accommodate SSB/OSI/paging, e.g., 10MHz, 20MHz, 40MHz, etc., but the solution would also work for narrowband carrier(s)/band(s) that cannot accommodate SSB/OSI/paging if operators have that narrowband carrier/band. Here we assumed that you meant narrowband carrier(s) are carrier(s) with bandwidth smaller than 5MHz.

Q3: If not, does not this cause “unbalanced cell load” across carrier(s)/band(s), which may result in performance loss?

[Huawei] Whether legacy UEs need to access those bands depends on the deployment. If the operator wants that legacy UEs are able to access more than one of those bands, then the operator can decide to

send common signaling in those band. In this case the overhead savings are lower. However, how to support legacy UE is not a new problem, and currently many operators choose one SSB/SIB1 deployment using one low-frequency band for network power saving. In addition, MBSC could provide flexibility for deployment, e.g., for spectrums re-farmed from LTE, there may be no need to send common signaling as no legacy NR UEs may support this spectrum for NR.

10. Nokia

Q1: Would this require UE to have multiple active BWPs per cell and aggregate its Tx/Rx over all of those? Or would those be switched dynamically so the operation looks similar to current BWP?

[Huawei] In our understanding, at most one active BWP per carrier. Total number of active BWPs should be a UE capability.

- If UE can just support 1 active BWP , then dynamically switching BWP/carrier would be used.
- If UE can support multiple active BWPs, no switching is needed.

Q2: How would this impact UE CA capabilities?

[Huawei] If you are talking about the requirements for UE RF for a certain band combination, then most CA RF requirements can be reused. Multi-band serving cell would have its own new features which need new UE capability.

Q3: Is this proposal for both IDLE and CONNECTED, or only for CONNECTED?

[Huawei] For both IDLE and CONNECTED.

Q4: Is this for both FR1 and FR2?

[Huawei] It can be applied for any neighboring bands within FR1, and at least for intra-band FR2. Besides, we don't target to aggregate FR1 and FR2 carriers/bands into one multi-band serving cell.

11. China Mobile

Q1: Do you mean when the multiple carriers are in neighbor bands, BWP like operation can be adopted, and when multiple carriers are far away, what's your consideration for the multi-carrier operation?

[Huawei] The frequency bands within one serving cell should ensure that simplified network and/or UE behavior can be exploited, e.g. the time-frequency synchronization from one carrier can be used for another carrier of the serving cell. When multiple carriers are far away, this condition is more difficult to satisfy, which makes BWP-like operation challenging, and CA may be a more proper solution.

12. Xiaomi

Q1: What's the considered impact on UE RF cost and complexity, would it increasing?

[Huawei] UE RF cost and complexity is very important. MBSC would seek to minimize impact on UE RF cost and complexity. Most existing UE RF requirements can be reused. We do not see too much impact on UE RF cost and complexity compared to CA. Because BS ensure common properties between CCs, thus UE may have chance to save power.

Q2: What's the impact on the UE power consumption?

[Huawei] UE does not always stay active for multiple bands, and BWPs/RFs can be dynamically switched on/off according to the traffic load. If there is no traffic, only one BWP or carrier needs to be active, i.e., switching off other BWPs/carriers for power saving. When burst traffic arrives, we can switch on the other BWPs/carriers to achieve instantaneous wideband transmission and achieve high data rate. Even if multiple BWPs are kept active, we expect that since UE only needs to perform some measurements in a single band,

that the UE is able to save power on the other bands compared to CA where multiple carriers are kept active.

2.5 RWS-210449 Further mobility enhancements

Feedback Form 9: Comments and questions to RWS-210449

1 – KDDI Corporation

.Regarding Figure3, it is mentioned that ”the serving cell configurations of Cell 3 and Cell 4 can be configured by RRC in advance”, is it different from the configuration of CHO? Do you expect some enhancement from Rel-17 CHO?

2.Do you expect to have some performance evaluation(latency, throughput .etc)about your dynamic switch mechanism proposal? We think it will easily convince other companies to progress this study if the performance gain could be confirmed. We will have more concreate motivation to progress the work.

3. Could you please explain the issue why we could not use the current Rel-17 Fast Scell activation/deactivation scheme, e.g we have multiple Scells, but have some of them in deactivation initially, then activate them according to the UE moving, it seems the issue in Figure 4 could be addressed by Rel-17.

2 – Rakuten Mobile

We support following proposal along with DAPS support for FR2.

Proposal 3: to consider leftovers of mobility, e.g. combination of DAPS and CHO, and 0ms interruption for MN change etc.

3 – China Telecommunications

We are interested in mobility enhancements and have similar views on P1 and P3.

Regarding to P2, does the dual N3 tunnel approach means to support dual N3 tunnel between single UPF and two different gNBs (source gNB and target gNB)? If yes, it is different with the dual N3 tunnel in URLLC, which is introduced to support redundant transmission and the dual N3 tunnel towards one gNB. The proposed approach may have impact on the core network and need SA2 confirmation.

4 – Lenovo (Beijing) Ltd

Thanks for the interesting paper. We also have the paper to discuss the enhancement of mobility. please see RWS-210283.

You have the following observation 2: Existing DAPS solution cannot be applied to CA/DC, and thus CA/MR-DC operation with L3 mobility still have data rate degradation. I am not sure if you want to support DAPS with DCCA.

I have a question for stage 3 (L3 handover) in Figures. How to ensure the 0 interruption at the stage 3 if the DAPS is not used.

5 – Beijing Xiaomi Mobile Software

Seems the dynamic switch mechanism only apply to SN change? The data rate would still be degraded during handover?

6 – China Unicom

Thanks for this contibution.

L1/L2 centric solution will bring benefits in intra-DU scenario. What is the scope of L1/L2 centric mobility solution in R18, and whether the inter-DU or inter-cell are considered in the scope?

7 – MediaTek Inc.

Q1. Dynamic switch mechanism: Do you consider this for SN change only, or also for PCell change? Also, inter-frequency measurement may involve measurement gap, would the dynamic switch rely on L1 measurement or L3 measurement?

Q2. 0ms interruption for MN change: If dynamic switching can be applied to MN change, we may not need DAPS? Then can we focus on CHO optimizations (e.g. RACH-less CHO execution)?

8 – CATT

In general we support the motivations/directions in this paper. Thanks for brining them up. For P3, besides what have been listed, would it be useful to consider also DAPS+CA, as that may be useful for the case when both data rate and continuatity are needed.

9 – LG Electronics France

Q1) Regarding proposal 1, Regarding proposal 1, do you consider not only multi-SN but also multi-MN, or only multi-SN?

10 – Sony Europe B.V.

Question for clarification: is P2 applicable for DAPS or normal HO?

11 – Intel Corporation (UK) Ltd

<Intel>

Q1. Regarding dual N3 tunnels during mobility towards both gNBs, how we can make sure duplicate packets are not delivered to the UE in DL?

12 – InterDigital Germany GmbH

Do you see a single WID for mobility and DCCA enhancements in R18 or separate ones?

13 – Apple (UK) Limited

Regarding proposal 1, I am wondering what's the difference from fast CA activation, conditional HO, conditional PSCell addition/change?

14 – Samsung Electronics Co.

We are supportive on further mobility enhancements. Please see our questions below:

Q1: The proposal 1 intends to HO/SCG change +DC/CA?

Q2: The combination of DAPS HO and CHO could mean two different intentions as follows:

Intention 1 - DAPS HO is triggered upon a certain condition is met, or

Intention 2 - DAPS HO can be commanded (unconditionally) to the UE with CHO configuration

Thus, we wonder the exact intention on DAPS HO + CHO, i.e. intention 1, intention 2 or both.

Q3: We wonder what expected gain is with DAPS HO + CHO.

15 – Nokia Corporation

We share your view that mobility enhancements are important area for Rel-18 enhancements.

Could you please share further details for your mobility enhancements proposals related to P1?

2.5.1 Answers

Feedback Form 10: Answers from Huawei to questions and comments on RWS-210449

1 – HuaWei Technologies Co.

1 **KDDI Corporation**

[HW] Regarding Q1: our intention is to have pre-configurations of multiple cells like CHO, but consider a dynamic switch approach among multiple (>=2) carriers/cell(s) or cell group(s). This solution does not require increasing the UE capability to support more RF chains for simultaneous transmission/reception, and can be applied to various scenarios where multiple carriers are deployed, including change of serving cell for standalone case, change of PCell and/or SCell for CA case, change of MCG and/or SCG for MR-DC case. Note that it is triggered by the network via L1/L2 signaling under NW control, which is different from CHO where UE autonomously triggered RRC connection to the target gNB. In general we understand mobility management needs to consider radio condition, UE requirement and network load and thus to let network control the mobility is a better approach compared with UE autonomous switch.

Regarding Q2, we have provided some performance analysis for both CA and MR-DC case in subsection 2.2 (assuming UE supports two UL simultaneous transmissions). For SCell change case, legacy SCell change would cause around 15ms latency, while our proposal of dynamic switch can be used to be close to 0ms, where more cells are pre-configured and SCell can be changed dynamically via L1/L2 signaling.

Regarding Q3. Rel-17 fast SCell activation/deactivation has the configuration restriction of serving cells to comply with capabilities derived from the UE capability for simultaneous Tx. And activation of a serving cell still requires several milliseconds to take effect, which brings the interruption larger than L1/L2 dynamic switch. In addition, current SCell activation/deactivation framework cannot address the PCell change as shown in Stage 3 in our contribution, where Cell 2 (former SCell) is prompted to become the PCell for coverage.

2 **Rakuten Mobile, Inc**

[HW] Thanks for the support and we can have further discussion on solution details.

3 **China Telecommunications**

[HW] We would like to clarify that dual N3 tunnel is towards the source and target gNBs respectively. Given that dual N3 tunnel has been introduced at a single gNB, and duplication functionality at UPF has been supported, we don't see much additional impacts to SA2, and the main impact would be PDCP SN/COUNT

assignment at gNB. So we can start discussion in RAN3 and coordinate with SA2 regarding the signaling and procedures.

4 **Lenovo (Beijing) Ltd**

[HW] DAPS with DCCA would add significant complexity and requires much higher UE capability to support at least 4 legs. Our proposal of dynamic switch approach is targeted for a solution without increasing the UE capability. Dynamic switch among pre-configured serving cells can be close to 0ms interruption, similar to UL TX switch introduced in Rel-16.

5 **Beijing Xiaomi Mobile Software**

[HW] Our intention can be seen in the response to KDDI Q1. With the dynamic switch approach, the CA/DC connectivity can be maintained during handover and the interruption time can be close to 0ms so that the data rate would not be degraded.

6 **China Unicom**

[HW] For the detailed scope, please see our response to KDDI Q1. In addition we think both inter-frequency and inter-DU cases can be considered.

7 **MediaTek Inc.**

[HW] Regarding Q1, please see our response to KDDI Q1. The dynamic switch approach is not relevant to the measurement gap. Assuming UE has two RL chains, we don't see a problem to perform inter-frequency measurement while maintaining the connectivity. Furthermore, L1 measurement can be considered to support such mobility, which has advantages of speeding up the handover procedure, especially in FR2.

Regarding Q2, we understand it is possible to apply dynamic switch also for MN change, and this requires the additional pre-configuration of MR-DC sets. For DAPS enhancements for MN change, we understand this has extra complexity on the UE side for RF chains and if dynamic switch can be used for MN change, we think DAPS with MN change is less important then.

8 **CATT**

[HW] As we described in observation 2, DAPS+CA would add more UE complexity, do you agree?

9 **LG Electronics France**

[HW] First we would like to understand what "multi-MN" means. Our intention is explained in response to KDDI Q1. If what you mean is dynamic switch among multiple MN configurations, we think yes the principle can apply to multi-MN. In addition we think dynamic role change between serving MCG and SCG is also applicable by using similar principle.

10 **Sony Europe B.V.**

[HW] P2 can be applicable to both DAPS and normal HO.

11 **Intel Corporation (UK) Ltd**

[HW] We think duplicate packets can be delivered to the UE from both source gNB and target gNB so that the E2E latency of the packets can be minimized. In addition, we don't see a problem for duplicating packets delivery since the PDCP entity will perform duplication detection as long as the PDCP COUNT is continuously assigned at the target gNB.

12 **InterDigital Germany GmbH**

[HW] We understand we need to first figure out the potential issues and enhancements for DCCA and mobility, then to discuss whether to have a separate item or not.

13 **Apple (UK) Limited**

[HW] Please see our response to KDDI.

14 **Samsung Electronics Co., Ltd**

[HW] Regarding Q1, HO/SCG change + DC/CA can be covered as well as MCG change + DC/CA. The detailed information can also be seen in the response to KDDI Q1.

Regarding Q2, Both of them can be considered. But we think the intention 1 is more important.

Regarding Q3, the motivation is to obtain both the high reliability and 0ms interruption for the handover.

15 **Nokia Corporation**

[HW] Please see our response to KDDI Q1 and we understand there is similarity with fast cell selection proposed by Nokia?

2.6 RWS-210450 Consideration on PDCP concatenation

Feedback Form 11: Comments and questions to RWS-210450

1 – Rakuten Mobile

We support this proposal.

Q1) Can you clarify how it support the User data integrity protection as mentioned in paper?

2 – Sony Europe B.V.

We agree with the problem regarding L2 header size and concatenation may solve the problem for small packet sizes.

3 – Lenovo Information Technology

It is an interesting topic. We have the following questions for clarifications:

Q1: how the AS layer is aware of it is TCP ACKs PDCP SDUs?

Q2: We are wondering whether it can work in case of CU-DU split. In order to support PDCP SDU concatenation, the gNB-DU may need to provide real-time scheduling resource info to the gNB-CU? In general, PDCP is a non real-time layer.

2.6.1 Answers

Feedback Form 12: Answers from Huawei to questions and comments on RWS-210450

1 – HuaWei Technologies Co.

1 **Rakuten Mobile, Inc**

We support this proposal. Q1) Can you clarify how it support the User data integrity protection as mentioned in paper?

[HW] Thanks for the question. The UP IP has already been adopted to NR, but without concatenation it is quite inefficient in processing PDCP SDU (See details in Processing efficiency of UP IP and ciphering in our paper). By concatenating multiple small PDCP SDUs into one packet first, then the UP IP process can be only applied once concatenated packet is ready, which would significantly improve the processing efficiency, and reduce the L2 protocol header overhead. Note that PDCP concatenation reuses the legacy UP IP processing, but UP IP is operated only once where multiple small PDCP SDUs are concatenated, instead of processing each small individual PDCP SDUs.

2 **Sony Europe B.V.**

We agree with the problem regarding L2 header size and concatenation may solve the problem for small packet sizes.

[HW] Thanks for the comment and we are happy to continue discussing solution details.

3 **Lenovo Information Technology**:

It is an interesting topic. We have the following questions for clarifications:

Q1: how the AS layer is aware of it is TCP ACKs PDCP SDUs?

Q2: We are wondering whether it can work in case of CU-DU split. In order to support PDCP SDU concatenation, the gNB-DU may need to provide real-time scheduling resource info to the gNB-CU? In general, PDCP is a non real-time layer.

[HW] Regarding Q1. TCP ACK is one of typical scenarios we have identified so far. We just use TCP ACK as an example to show the benefits. However, this add-on functionality doesn't require AS layer to be aware of TCP ACKs.

Regarding Q2. We think it can be applied to CU-DU split. Our understanding PDCP concatenation doesn't need to be coupled with lower layers, e.g. RLC, and doesn't break L2 protocol stack hierarchy. It can be up to NW implementation to adapt to the PDCP concatenation for improving the system performance.

2.7 RWS-210456 mmWave multi-band BS

Feedback Form 13: Comments and questions to RWS-210456

1 – Intel Corporation (UK) Ltd

<Intel>

Q1. Could you explain any specific requirements that Huawei aims to introduce for BS?

2 – Samsung Electronics Co.

Q1□For UE spporting multi-band serving cell, is UE required to report capability of which bands can be grouped as serving cell or UE has to support all the bands designed for this feature, e.g., all the lower bands

Q2: Whether will the Multi-band serving cell be restricted to lower band, e.g., 800/900MHz, with smaller bandwidth, or it can also invovle other bands depends on operator deployment?

2.7.1 Answers

Feedback Form 14: Answers from Huawei to questions and comments on RWS-210456

1 – Huawei Technologies France

1- Answers to Intel:

Thanks for your comments. The requirements for multi-band BS are different from that of single band BS. FR1, there are additional requirements for BS capable of multi-band operation, e.g. for spurious emission, exclusion regions need to be considered for MB-BS, and out-of-band blocking are should be considered differently for MB operation. For mmWave, it is expected that similar study as that for FR1 should be carried out for MB BS. And considering all the requirements for FR2 are defined as OTA based, the case could be more complicated. Meanwhile, the conformance test should also be carefully studied for mmWave mult-band BS.

2- Answers to Samsung:

Thanks for your comments. Maybe the questions are not relevant to mmWave MB BS? The study is specific to FR2, which does not include low bands requirements in FR1.

2.8 RWS-210457 FR2 RRM requirements evolution

Feedback Form 15: Comments and questions to RWS-210457

1 – Intel Corporation (UK) Ltd

<Intel>

Q1. Proposals regarding BM enhancement are not clear to us. Is it to configure more BM resources than what is already allowed? Or is it mainly proposing to specify network behaviour in choosing which are the candidate resources to be configured to the UE?

Q2. For support of DAPS in FR2 inter-band CA, could you explain how it is related to IBM whereas we do not think two capabilities do not need to be linked together?

Q3. Regarding unknown cell activation, could we get more clarification from you why it is a case that we should consider?

2.8.1 Answers

Feedback Form 16: Answers from Huawei to questions and comments on RWS-210457

1 – Huawei Technologies France

1- Answers to Intel:

Thanks for your comments.

Answer to Q1: The intention is to allow network to configure more BM resources over UE capability (but not necessarily more than what's already allowed by the signaling), and then specify UE behavior on choosing subset of configured BM resources for measurement. One motivation of the proposal is to avoid the need for network to choose the a subset of resources to be configured to the UE, since it will lead to frequent RRC reconfiguration when UE does not have the capability to support large number of BM resources.

Answer to Q2: In our understanding, in FR2 inter-band scenario the typical case for HO is the source cell and the target cell is non-collocated. As we know CBM UE can only support CA with collocated deployment, so it may be difficult to support DAPS which requires simultaneous Rx/Tx on the two bands. So far we see it may be more feasible for IBM UEs to support DAPS in FR2 inter-band HO, as IBM capable UE can implement on different band with independent RF chain. However we are open to further discuss the linkage between the two capabilities when the work starts.

Answer to Q3: RAN4 has defined the SCell activation requirements for both known and unknown cases, so we see unknown case also important to address. Otherwise network has to make sure the SCell is known if it wants fast activation, which may impose restrictions on the network side. It is also noted that currently the FR2 the unknown SCell activation delay is particularly long due to Rx beam sweeping (over 500ms).

2.9 RWS-210458 UE advanced receiver for Rel-18

Feedback Form 17: Comments and questions to RWS-210458

1 – Intel Corporation (UK) Ltd

<Intel>

Q1. For MU-MIMO receivers, is it considered that additional network assistance on modulation shall be

provided for R-ML and SLIC receivers?

Q2. For ”Enhanced MMSE-IRC under uneven interference”, is it planned to consider any network assistance? Which MMSE ”enhancements” is considered?

2 – Samsung Electronics Co.

For MU-MIMO and MMSE-IRC receiver, what is the assumption of network assistance singlling

2.9.1 Answers

Feedback Form 18: Answers from Huawei to questions and comments on RWS-210458

1 – Huawei Technologies France

1 – Answers to Intel Corporation (UK) Ltd

Thanks for your comments.

For Q1: Yes. Modulation is an effective information to assist UE/CPE reduce computational complexity when applying R-ML and SLIC receivers, but the resultant signaling overhead cannot be neglected. For instance, considering signaling overhead on network assistance, it seems the enhancement is more suitable for more stationary scenarios, such as FWA due to the stability of traffic (and thus scheduling). But the mechanism can be common for both eMBB and FWA.

For Q2: Yes. We also consider to introduce some network signaling here to enhance the performance of MMSE-IRC receiver under uneven interference. For instance, when the interference is not fully aligned with desired signal in time domain resource allocation (TDRA), the assistance information may include the TDRA of interference. We are willing to study and identify more assistance information that are efficient.

2 –Answers to Samsung Electronics Co.

Thanks for your comments.

For MU-MIMO case, the assistance information depends on the utilized receiver at UE side. For UE/CPE using E-MMSE-IRC receiver, the assistance information can be only the DMRS port(s) of interference. While for UE/CPE using R-ML receiver, modulation of interference seems to be additionally required for signaling from network. For UE/CPE using MMSE-IRC receiver, when the interference is not fully aligned with desired signal in time domain resource allocation (TDRA), the assistance information may include the TDRA of interference. The assistance information is not limited to aforementioned ones which can be further studied.

3 [Second round] Q&A

3.1 RWS-210437 NR enhancements for DL MIMO

Feedback Form 19: Further questions on RWS-210437

1 – Beijing Xiaomi Mobile Software

Thanks for your answers. We have further questions on the number of TRPs, if it is more than 2, do you want to support the dynamically switching between 2 TRPs coherent joint transmission and 3 TRPs coherent joint transmission? In this case the overhead of CSI feedback will be very large.

2 – Guangdong OPPO Mobile Telecom.

Thanks for your reply. Some additional questions:

1) For finer precoding granularity for DL precoding, what is the expected granularity in mind?

2) For Coherent Joint Transmission, how to aviod repeated discussion as that in LTE? What is the additional gain for NR compared to LTE?

3 – Qualcomm CDMA Technologies

Regarding proposal 6 related to FDD CJT, we have the following follow-up questions:

Q1: Is the time alignment error (TAE) across TRPs envisioned to be the same as existing RAN4 requirements for MIMO (i.e., 65ns)? How this can be achieved?

Q2: Are you envisioning that the distributed TRPs share the same clock / PLL? If not, what are the phase drift requirements for CJT to work in practice?

4 – Intel Corporation (UK) Ltd

Thank you for the responses. We have additional questions below:

Q1. Could you please explain why there is residual interference after MU-MIMO precoding even for TDD-based precoding? Is it because of inaccurate channel measurement on SRS or rough granularity of the DL precoder in the frequency domain? If CSI is accurate, ZF should efficiently suppress interference irrespective of the number of co-scheduled UEs.

Q2. For distributed MIMO with coherent JT, we assume that SLNR-like precoder should be used across RRHs to reduce interference. Could you please clarify how power normalization per each RRH is implemented to avoid RRH transmit beyond the maximum power?

5 – NTT DOCOMO INC.

For finer precoding granularity for DL MIMO, did you intent to improve CSI-RS for finer measurement, and enhance Type II CSI feedback for finer PMI feedback?

3.1.1 Answers

Feedback Form 20: Answers from Huawei to questions and comments on RWS-210437

1 – HuaWei Technologies Co.

1. **Beijing Xiaomi Mobile Software**

Thanks for your answers. We have further questions on the number of TRPs, if it is more than 2, do you want to support the dynamically switching between 2 TRPs coherent joint transmission and 3 TRPs coherent joint transmission? In this case the overhead of CSI feedback will be very large.

[Huawei]: In practical cases, it is possible with dynamically schedule 2 or 3 TRPs for coherent joint

transmission. With multiple CSI reporting setting configurations (such as one setting for 2-TRP, another setting for 3-TRP), dynamic switching between 2 or 3 TRPs can be already enabled in current specs with DCI triggering. For the CSI overhead, since only one CSI reporting will be triggered for a gNB schedule (no need CSI feedback for both CSI reporting settings), so it seems not a big issue.

2. Guangdong OPPO Mobile Telecom

Thanks for your reply. Some additional questions: For finer precoding granularity for DL precoding, what is the expected granularity in mind?

For Coherent Joint Transmission, how to avoid repeated discussion as that in LTE? What is the additional gain for NR compared to LTE?

[Huawei]: From the previous evaluation, we can see that granularity with 1RB or 6REs brings obvious performance gain, where channel estimation error are already included. So, 1 RB and 6REs can be taken as the starting point.

In LTE, actually, the coherent joint transmission was not well investigated, there was no specific high resolution CSI measurement in my memory. However, in NR, we have massive MIMO and C-RAN structure in the real deployment. So, the enhancements on coherent joint transmission are worthy to be investigated. As we clarified in our Tdoc, performance gain can be from interference mitigation, codebook enhancement for CJT, and supporting high order MU pairing, etc.

3. Qualcomm CDMA Technologies

Regarding proposal 6 related to FDD CJT, we have the following follow-up questions:

Q1: Is the time alignment error (TAE) across TRPs envisioned to be the same as existing RAN4 requirements for MIMO (i.e., 65ns)? How this can be achieved?

Q2: Are you envisioning that the distributed TRPs share the same clock / PLL? If not, what are the phase drift requirements for CJT to work in practice?

[Huawei] For Q1: In our preliminary evaluation in our Tdoc, the TAE is not included. The impact can be further investigated in the following meetings. Anyways, as discussed in LTE stage, TAE=65ns, is with small impact on the system performance, while we already have frequency-selective precoding.

For Q2: In the CJT case, the RRHs can be connected to the shared BBUs, so it is possible that the distributed TRPs are with the same clock/PLL. In our preliminary evaluation, the same clock / PLL are assumed to the distributed TRPs.

4. Intel Corporation (UK) Ltd

Thank you for the responses. We have additional questions below:

Q1. Could you please explain why there is residual interference after MU-MIMO precoding even for TDD-based precoding? Is it because of inaccurate channel measurement on SRS or rough granularity of the DL precoder in the frequency domain? If CSI is accurate, ZF should efficiently suppress interference irrespective of the number of co-scheduled UEs.

Q2. For distributed MIMO with coherent JT, we assume that SLNR-like precoder should be used across RRHs to reduce interference. Could you please clarify how power normalization per each RRH is implemented to avoid RRH transmit beyond the maximum power?

[Huawei]For Q1: In practical system, the orthogonality after ZF cannot be perfectly achieved due to non-ideal factors. For example, mismatched precoder due to the channel estimation error based on SRS for TDD or quantization error of PMI for FDD will break the orthogonality of ZF. In addition, coarse frequency granularity for the precoding will lead to residual MU interference as well. With more MU pairing, the residual interference on DMRS accumulates to degrade the channel estimation performance obviously.

For Q2: Agree the interference suppression should be considered in the precoding calculation. The restriction on the maximum transmit power for each RRH can be guaranteed with considering power constriction of each RRH during precoding calculation.

5. NTT DOCOMO INC.

For finer precoding granularity for DL MIMO, did you intent to improve CSI-RS for finer measurement, and enhance Type II CSI feedback for finer PMI feedback?

[Huawei] Finer precoding granularity for DL MIMO can be for both TDD and FDD. For the TDD cases, the precoding are mainly calculated from SRS measurement. For FDD cases, the CSI measurement and CSI feedback may need some further enhanced for better supporting finer precoding granularity, especially for coherent joint transmission cases.

3.2 RWS-210438 NR FR2 enhancements

Feedback Form 21: Further questions on RWS-210438

1 – ZTE Corporation

Thank you so much for your replay. Regarding enhancement on facilitating gNB narrow beamforming, can we assume that it is relevant to linear combination in port-selection CSI. Some further clarification is highly appreciated.

Then, regarding spatial relation among gNB beams, we think that this issue can be extended for cross-CC scenarios, e.g., QCL relationship among SSBs from different CCs.

3.2.1 Answers

Feedback Form 22: Answers from Huawei to questions and comments on RWS-210438

1 – HuaWei Technologies Co.

ZTE Corporation

Thank you so much for your replay. Regarding enhancement on facilitating gNB narrow beamforming, can we assume that it is relevant to linear combination in port-selection CSI. Some further clarification is highly appreciated.

Then, regarding spatial relation among gNB beams, we think that this issue can be extended for cross-CC scenarios, e.g., QCL relationship among SSBs from different CCs.

[Huawei]

1. The idea of enhanced beam reporting to facilitate gNB narrow beamforming in FR2 is similar to "linear combination in port-selection CSI" in FR1, but not exactly the same. There are several differences between these two, such as, here we are adjusting analog beam in FR2 instead of digital port in FR1, and the reported quantity is not CSI, but beam based reports (e.g., L1-RSRP/SINR and combination coefficients). With such differences, it appears necessary to revisit existing specification support.

2. We are open on extending the proposed spatial relation among gNB beams to cross-CC case, and perhaps the frequency separation between the involved CCs could be one aspect to investigate.

3.3 RWS-210440 5G-Advanced Fixed Wireless Access

Feedback Form 23: Further questions on RWS-210440

3.3.1 Answers

Feedback Form 24: Answers from Huawei to questions and comments on RWS-210440

3.4 RWS-210441 NR Multi-Band Serving Cell

Feedback Form 25: Further questions on RWS-210441

1 – vivo Communication Technology

Thanks for the reply. According to the reply, if UE can switch off the reception for one or more bands, due to less traffic demand, what is your assumption for the delay and interruption when UE is required to turn on the corresponding RF receiver for higher data rate? It seems to us the such procedure including the delay and interruption (for other carriers) are similar to current Scell activation therefore not clear how much syetem level benefit can be achieved considering the mentioned UE power saving implementations in practice? Could you comment on this, thanks.

2 – Lenovo (Beijing) Ltd

Thank Huawei for the elaboration. Further comments from my side for better understanding your proposal:

(1) Regarding the spectrum, could you elaborate what is technical concern on aggregating FR1 and FR2 carriers into one MBSC? From RAN1's perspective, seems no standard impact if the MBSC includes one FR1 carrier and FR2 carrier. Is it correct?

(2) Regarding the backward compatibility issue, for the new re-farmed LTE spectrum, if it is configured without the SSB/SIBs transmission, does it impact those legacy NR UEs supporting LTE/NR coexistence like DSS on that spectrum? It is anticipated that a legacy CA-capable UE's performance may be degraded when SSB/SIB1 of some of its supported carriers are omitted. Do you see whether the performance degradation of legacy CA-capable UEs is allowed?

(3) For a carrier without SSBs in case of MBSC, how can a UE synchronize to gNB on that carrier and ensure the sufficient time/frequency accuracy?

3 – QUALCOMM JAPAN LLC.

On the carrier(s)/band(s) with sufficient bandwidth for SSB/SIB/paging (e.g., 5MHz, 10MHz), if they are not transmitted, the carrier(s)/band(s) becomes inaccessible by legacy UEs. While the overhead reduction of SSB/SIB/paging could be a potential gain, we are wondering if this could offer actual performance improvement given the load across carrier(s)/band(s) would be unbalanced.

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

4 – China Mobile Com. Corporation

You have mentioned in section 2.2.3 that ”dynamically switching the carrier where UE monitors system information and paging, performs RRM/RLF measurement, or sends control and data” to achieve load balancing, Is this switching cell specific or UE specific? if it is cell specific, how does the idle/inactive UEs know it?

3.4.1 Answers

Feedback Form 26: Answers from Huawei to questions and comments on RWS-210441

1 – Huawei Tech.(UK) Co.. Ltd

1. Vivo

Q1: According to the reply, if UE can switch off the reception for one or more bands, due to less traffic demand, what is your assumption for the delay and interruption when UE is required to turn on the corresponding RF receiver for higher data rate? It seems to us the such procedure including the delay and interruption (for other carriers) are similar to current Scell activation therefore not clear how much system level benefit can be achieved considering the mentioned UE power saving implementations in practice?

[Huawei] Thanks for your follow-up. A delay and interruption similar to BWP switching (around or less than 1ms 2ms) is targeted, which is different from SCell activation. We believe it is feasible for a UE at least in case of frequency-neighboring bands where network ensure that the time-frequency synchronization, some QCL, etc. from one carrier can be used for another carrier of the same serving cell.

2. Lenovo

Q1: Regarding the spectrum, could you elaborate what is technical concern on aggregating FR1 and FR2 carriers into one MBSC? From RAN1's perspective, seems no standard impact if the MBSC includes one FR1 carrier and FR2 carrier. Is it correct?

[Huawei]

- If carriers are from far apart multiple bands (e.g., FR1+FR2), it is hard to manage them as a serving cell since almost all the DL related procedures and overhead cannot be simplified. For example, far apart multiple bands have significant coverage or pathloss gap, time/frequency synchronization and RSRP difference, thus RRM, O&M, time/frequency synchronization and RSRP measurement procedure for AGC settling per DL carrier are still needed.

- Additionally, taking into account different SCS and different number of beams between FR1 and FR2 carriers, there would likely be additional standard impact to form bands in these two frequency ranges as a serving cell.

Q2: Regarding the backward compatibility issue, for the new re-farmed LTE spectrum, if it is configured without the SSB/SIBs transmission, does it impact those legacy NR UEs supporting LTE/NR coexistence like DSS on that spectrum?

[Huawei] In our understanding, there is no impact for LTE/NR coexistence. For a new UE capable of MB-SC, it even becomes easier to coexist with LTE CRS signals thanks to no dependence of NR SSB or NR PDCCH on the shared bandwidth. For legacy NR UEs capable of SUL, there is no impact due to no DL sharing. For legacy NR UEs capable of DSS, if the spectrum applied to the multiple carriers of MB-SC are re-farmed from multiple LTE and DSS carriers, at least one carrier should provide SSB for legacy DSS

UEs and we feel the carrier may have sufficient capacity to accommodate all legacy DSS UEs that are reconfigured from other carriers because the capacity that have been occupied by LTE UEs on the carrier are released. Of course, in some extreme case where too many legacy DSS UEs are fully occupying the carriers, SSB is needed for each carrier. But as replied before, whether a SSB is needed on a particular carrier is up to operator's deployment.

It is anticipated that a legacy CA-capable UE's performance may be degraded when SSB/SIB1 of some of its supported carriers are omitted. Do you see whether the performance degradation of legacy CA-capable UEs is allowed?

[Huawei] If some percentage of the legacy UEs are also capable of legacy CA on these carriers, the same solution as replied before can be applied.

Q3: For a carrier without SSBs in case of MBSC, how can a UE synchronize to gNB on that carrier and ensure the sufficient time/frequency accuracy?

[Huawei] BS would ensure the same time/frequency between multiple co-located carriers within a MBSC, so that the time/frequency information for a carrier can be derived from the SSB of the other carrier.

3. QUALCOMM

Q1: On the carrier(s)/band(s) with sufficient bandwidth for SSB/SIB/paging (e.g., 5MHz, 10MHz), if they are not transmitted, the carrier(s)/band(s) becomes inaccessible by legacy UEs. While the overhead reduction of SSB/SIB/paging could be a potential gain, we are wondering if this could offer actual performance improvement given the load across carrier(s)/band(s) would be unbalanced.

[Huawei] On top of all, for multiple frequency-neighboring carriers with 10-20MHz bandwidth each, both Scenario A legacy UEs dominating and Scenario B MB-SC UEs dominating are possible for operator deployment. But we feel Scenario B is the best in term of signaling overhead and multi-carrier access latency , it is expected to be typical in spectrum re-farmed from LTE to NR. Because SSB and SIB1 overheads (20 48 PRBs) are not trivial for a 10-20MHz carrier (52 106 PRBs) and the latency and interruption of SCell activation caused by SCell measurement and synchronization can be typically 12 ms or more, Scenario A with dominating number of legacy UEs on these carriers is not the best way to go for the future. In particular, Scenario B is more reflecting the current state for low-frequency FDD bands like 700/800/900MHz. In case of Scenario B, there is no issue of unbalance because MB-SC UEs will be dominant in number and legacy UEs can be served by the carrier configured with SSB and be additionally carrier-aggregated with other bands like C-band. In case of Scenario A, SSBs are needed for every carrier to have better traffic balance.

Q2: One further essential question is: whether the proposal is to enable initial/random access on a UL carrier based on SSB/SIB/paging reception on a DL carrier that is not paired/linked with the UL carrier in the band definition. For any possible linkage, REFSENS, MSD and other requirements still need to be derived and specified per pairing. Once it is done, how is the pairing really different from simply defining it as an FDD band? Also, in such pairings, the possible DL BW and UL BW combinations and frequency offsets would still need to be defined, which again would make it not much different from simply defining it as an FDD band.

[Huawei] We are open to such initial/random access and see some benefit in some cases. However, we have no intention to change the definitions of band and band combinations. We think current RAN4 requirements for CA/SUL band combinations can be reused for multi-band serving cell. We aim to reuse the existing requirements as much as possible to ensure the backward compatibility and save efforts for implementation.

4. China Mobile

Q1: You have mentioned in section 2.2.3 that "dynamically switching the carrier where UE monitors system information and paging, performs RRM/RLF measurement, or sends control and data" to achieve load balancing, Is this switching cell specific or UE specific? if it is cell specific, how does the idle/inactive UEs know it?

[Huawei] UE specific switching is considered. For example, gNB can switch carrier/BWP to transmit/receive UE-specific data to achieve load balancing.

3.5 RWS-210449 Further mobility enhancements

Feedback Form 27: Further questions on RWS-210449

1 – China Telecommunications

Thanks for the response, we are OK to study the dual N3 tunnel approach during the mobility procedure to minimize the network latency.

Besides, for proposal1, what are the applicable scenarios for dynamic switch mechanism? MN change? SN change? Normal handover? Or others?

2 – ZTE Corporation

For the "dynamic switch mechanism", we are also interested in mechanisms to enable a more efficient and dynamic switching for cell group switch and serving cell switch, including the role change between MCG and SCG and between PCell and SCell. The similar proposal can also be found in our tdoc RWS-210464.

For the dual N3 tunnel approach, we also see some benefits in this. Considering some changes from SA2 may be required, SA2 shall be involved in the discussion as well to confirm the feasibility.

3 – China Unicom

Thanks for your contributions and clarification.

For L1/L2 mobility enhancement solution, what's the potential impacts on RAN1 and RAN2?

4 – CATT

Thanks for your response to our question in 1st round. Just to follow up: we agree if we want to narrow the gap for high data rate + non interuption, it may add more compleixty to UE side. But this could be less of a problem if it mainly targets on some of the terminial types such as TV camera and so on. This depends on the use cases.

5 – MediaTek Inc.

Thanks for your clarifications. We have some further questions.

Q1. Pre-configurations of multiple cells: We share similar view that dynamic switch between pre-configured cells can be considered in Rel-18. From you explanation, the cell change istriggered by the network via L1/L2 signaling under NW control. Besides signaling (e.g. replacing RRC handover command with MAC CE), what are the difference between the proposed method and RRC-based handover? What can we save or gain from the proposed method?

3.5.1 Answers

Feedback Form 28: Answers from Huawei to questions and comments on RWS-210449

1 – HuaWei Technologies Co.

1 **China Telecommunications**

Thanks for the response, we are OK to study the dual N3 tunnel approach during the mobility procedure to minimize the network latency.Besides, for proposal1, what are the applicable scenarios for dynamic switch mechanism? MN change? SN change? Normal handover? Or others?

[HW] Thanks for the further questions. Dynamic switch mechanism is applicable to various scenarios where multiple carriers are deployed, including change of serving cell for standalone case, change of PCell and/or SCell for CA case, change of MCG and/or SCG for MR-DC case.

2 **ZTE Corporation**

For the "dynamic switch mechanism", we are also interested in mechanisms to enable a more efficient and dynamic switching for cell group switch and serving cell switch, including the role change between MCG and SCG and between PCell and SCell. The similar proposal can also be found in our tdoc RWS-210464.

For the dual N3 tunnel approach, we also see some benefits in this. Considering some changes from SA2 may be required, SA2 shall be involved in the discussion as well to confirm the feasibility.

[HW] Thanks for the comments and we have similar consideration on dynamic switch. Regarding dual tunnel, given that dual N3 tunnel has been introduced at a single gNB, and duplication functionality at UPF has been supported, we think feasibility would not be a big issue. In our analysis the main impact would be PDCP SN/COUNT assignment at gNB that can be initially discussed in RAN3. So we can start discussion in RAN3 and coordinate with SA2 regarding the signaling and procedures.

3 **China Unicom**

Thanks for your contributions and clarification. For L1/L2 mobility enhancement solution, what's the potential impacts on RAN1 and RAN2?

[HW] Thanks for the further questions. We think that RAN1/RAN2 may need to specify the mechanisms of pre-configuring multiple cells/cell groups including both source and potential targets, and allowing activating or scheduling all or a subset of multiple cells/cell groups dynamically based on L1/L2 measurement. Specifically, as UL UE capability is often limited to 2 Tx or 3Tx at most, the cell change including UL only switching among more than 2 bands/2 cell groups would also be necessary as we proposed in RWS-210436.

4 **CATT**

Thanks for your response to our question in 1st round. Just to follow up: we agree if we want to narrow the gap for high data rate + non interuption, it may add more compleixty to UE side. But this could be less of a problem if it mainly targets on some of the terminial types such as TV camera and so on. This depends on the use cases.

[HW] Thanks for the follow up and we agree there are various use cases. From our perspective, we understand those terminal types like TV camera usually do not require mobility as they basically have no/low mobility, we think the mobility for smart phones to adapt to FR1/FR2 deployment is more important scenario to be considered at this stage. Thus the UE capability is not expected to be increased very high.

5 **MediaTek Inc.**

Thanks for your clarifications. We have some further questions.

Q1. Pre-configurations of multiple cells: We share similar view that dynamic switch between pre-configured cells can be considered in Rel-18. From you explanation, the cell change istriggered by the network via

L1/L2 signaling under NW control. Besides signaling (e.g. replacing RRC handover command with MAC CE), what are the difference between the proposed method and RRC-based handover? What can we save or gain from the proposed method?

[HW] Thanks for the further questions. We understand here RRC handover command means DAPS HO, and if it is the case we think the main difference between the dynamic switch mechanism and RRC-based solutions is the requirements for the UE. The dynamic switch mechanism is targeted to not increase the UE capability to support more RF chains for simultaneously transmission/reception, but also reach to 0ms interruption time. However, for RRC-based handover, the legacy DAPS is performed without DC/CA will degrade the user throughput during mobility, while DAPS with DC/CA will add significant complexity and requires higher UE capability to support more legs.

3.6 RWS-210450 Consideration on PDCP concatenation

Feedback Form 29: Further questions on RWS-210450

1 – Beijing Xiaomi Mobile Software

Thanks for the interesting topic. We would like to understand the benefit of putting concatenation in PDCP compared to RLC. And, whether the concatenation is done before resource allocation or at allocation. If it is done before resource allocation, how does PDCP decide when to do concatenation to avoid segmentation at RLC.

3.6.1 Answers

Feedback Form 30: Answers from Huawei to questions and comments on RWS-210450

1 – HuaWei Technologies Co.

 # 1 Beijing Xiaomi Mobile Software

Thanks for the interesting topic. We would like to understand the benefit of putting concatenation in PDCP compared to RLC. And, whether the concatenation is done before resource allocation or at allocation. If it is done before resource allocation, how does PDCP decide when to do concatenation to avoid segmentation at RLC.

[HW] Thanks for the questions. Concatenation at PDCP is beneficial for reducing UP IP and ciphering processing burden, as UPIP and ciphering are handled by PDCP layer instead of RLC layer, i.e. RLC layer cannot achieve such gains. Such benefit is independent with resource allocation, and in our understanding concatenation can be done at PDCP layer either before resource allocation or at resource allocation, which is up to the network implementation. Even if it is done before the resource allocation the network can also schedule the resource to minimize RLC segmentation, of course RLC segmentation can also be improved but this is not dependent on PDCP concatenation.

3.7 RWS-210456 mmWave multi-band BS

Feedback Form 31: Further questions on RWS-210456

1 – Intel Corporation (UK) Ltd

Thank you for the responses! We have an additional question.

Q1: Does the proposal consider tightening of TAE for the inter-band CA case for BS supporting multi-band operation? If so, what is your view on feasible TAE values?

3.7.1 Answers

Feedback Form 32: Answers from Huawei to questions and comments on RWS-210456

1 – Huawei Technologies France

To question of Intel:

Thanks for the further question. There is no intention to tighten the TAE requirement for inter-band CA. Even the MB-BS is for co-location scenario, there is no limitation that only CBM UE is supported in this scenario. It's true that MB-MS is relatively easier to realize small TAE, e.g. 260ns, but the main consideration for MB-BS is to define other requirements similar to MB-MSR for low frequency bands to enable multi-band operation.

3.8 RWS-210457 FR2 RRM requirements evolution

Feedback Form 33: Further questions on RWS-210457

3.8.1 Answers

Feedback Form 34: Answers from Huawei to questions and comments on RWS-210457

3.9 RWS-210458 UE advanced receiver for Rel-18

Feedback Form 35: Further questions on RWS-210458

3.9.1 Answers

Feedback Form 36: Answers from Huawei to questions and comments on RWS-210458

4 Summary and Conclusions

RWS-210437 NR enhancements for DL MIMO

There were questions on the targeted number of TRPs (more than 2) and the number of ports (32) at each TRP for CJT, and it was clarified that with ideal backhaul this can be targeted based on a single DCI. There were questions on the required time alignment error (TAE) across TRPs.

It was asked why Rel-17 mTRP CSI/codebook cannot already be used for CJT. One reason is that more than 32 ports will be required, another reason is to better exploit the different beam directions.

There were questions on increasing the number of orthogonal DMRS ports. It was clarified that orthogonal DMRS ports are necessary when the number of paired layers exceeds 12 (e.g. 16 or 24), and this is considered for both DL and UL, especially for mTRP scenarios when MU order can be large.

There were questions on SRS design for higher capacity per OFDM symbol. It was clarified that better exploiting the sparsity of the channel allows reduce the number of SRS symbols per user in one OFDM symbol without sacrificing the quality of channel estimation. Several companies supported investigating SRS enhancements.

There were questions on finer frequency-domain precoding granularity. It was clarified that the gains are observed with real channel estimation using a smaller PRG size (e.g. on RB or half RB), and that gains are observed in both sTRP and mTRP scenarios. In general, CSI feedback does not require enhancements to support smaller PRG size, but CSI enhancement for CJT can take this into account.

RWS-210438 NR FR2 enhancements

There were questions on narrow beam due to large antenna array deployed in FR2. It was clarified that UE feedback on combination coefficients between adjacent analog beams can enable fast beam training and tracking, and help to reduce the resource overhead and measurement complexity, especially for large antenna array cases. It was also clarified that the combination coefficients feedback for adjacent analog beams are not the same as linear combination of CSI feedback, where the feedback for analog beams combination is based on analog beams and beam reporting.

There were questions on dynamic gNB panel allocation for FDM, it was clarified gNB panel is virtualized to DL RS resources/ports, i.e., gNB panel is transparent to UE. And it was clarified that gNB panel allocation for FDM would be more efficient if gNB is enabled to configure the UE to report CSI for different port combinations based on one CSI-RS resource and within one reporting instance. And it was also clarified that, different from DPS, dynamic gNB panel allocation assumes multiple panels installed on the same TRP, and can be used to transmit towards one UE simultaneously and coherently, which can be {1, 2, 3, 4} panels.

There was a question on gNB-assisted local UL beam refinement, it was clarified that, in the proposed solution, UE is expected to refine UL Tx beam (via UL beam sweeping) within the angular range of the DL wide Rx beam.

RWS-210440 5G-Advanced Fixed Wireless Access

There was discussion on whether enhancements are proposed for DL and/or UL. With regards to advanced receivers, most questions revolved around the type of advanced receiver and the corresponding assistance information signaling. Both would deserve further discussions. It was clarified that the required assistance information should consider the property of FWA scenario.

RWS-210441 NR Multi-Band Serving Cell

There were questions about which neighbor bands can be grouped together (maximum frequency separation, frequency range) to form a single serving cell, and questions for clarifications on the expected benefits. It was clarified that RAN4 RF and band combinations would be reused from CA, that the proposal targets both IDLE and CONNECTED modes, and transitions between neighbor bands is expected to be performed by BWP switching while the network ensures common synchronization across the BWPs in the neighbor bands. There were questions related to the benefit or impact on UE power consumption; it was clarified that UE may save power for time/frequency tracking, RRM measurement, and fast carrier (de-)activation. There were questions on the presence of legacy UEs, and it was clarified that the expected overhead reduction may vary with operator's requirements and with the ratio of legacy/new UEs. There were questions on the applicability of the proposal to bands smaller than 5 MHz. Further discussion would be beneficial

RWS-210449 Further mobility enhancements

In general mobility gets interest from multiple companies.

For dynamic switch mechanism of inter-cell mobility, many companies have provided comments, among which quite a few of them showed interest and potential support on this direction.

During the two rounds of Q&A, the following aspects have been raised and clarified:

1. The applicable scenarios for dynamic switch mechanism include change of serving cell for standalone case, change of PCell and/or SCell for CA case, change of MCG and/or SCG for MR-DC case.

2. The achievable performance of dynamic switch mechanism is near 0 ms interruption, without data degradation since DC/CA can be maintained during handover.

3. The main difference between dynamic switch mechanism and fast CA activation/RRC-based solutions. Dynamic switch mechanism doesn't require increasing the UE capability but can still reach 0ms interruption with high data rate.

4. On whether to have separate MR-DC or mobility enhancements WIs , it is clarified to focus on enhancements aspects first, WI scoping is a later stage discussion.

For dual N3 tunnel approach, companies have provided comments and some of them see benefits for this direction.

During the two rounds of Q&A, the following aspects have been raised and clarified:

1. The main standards impact is in RAN3, and the work can be started in RAN3 with SA2 coordination.

2. This direction would have packet duplication at UE side, and requires PDCP layer to detect and remove duplicated packets in DL

3. The approach is applicable for DAPS and normal HO.

For mobility handover leftover, a few comments showed support or sought clarification of motivation for combined CHO+DAPS.

In summary, we think we can consider dynamic switch and dual N3 tunnel for mobility, and for Rel-16/17 leftover, we understand there are various aspects and this part needs further selection based on companies' views.

RWS-210450 Consideration on PDCP concatenation

Companies provided comments and some of them expressed explicit support for our proposal. In addition we observed that there is another company having a similar proposal. So there is some support to consider PDCP concatenation in Rel-18.

The following aspects have been asked and clarified:

1. UP IP processing is applied to the complete concatenated packet instead of individual small packets.

2. PDCP concatenation does not require AS layer to be aware of TCP ACK.

3. PDCP concatenation is independent on resource allocation. It is up to the network implementation to minimize RLC segmentation, and we are open to have further optimization on RLC segmentation, while this can be independent with PDCP concatenation.

RWS-210456 mmWave multi-band BS

Some clarification questions were raised during the discussion, i.e. specific requirements related to mmWave MB-MS and whether TAE for the inter-band CA case for BS supporting multi-band operation needs to be tightened. It is clarified that for BS capable of multi-band operation, some requirements different from those for single band operation need to be defined, e.g. for spurious emission, exclusion regions need to be considered; out-of-band blocking should be considered differently for MB operation, and requirements applicable for inter RF bandwidth gap, etc. Multi-band requirements for low frequency bands can be a reference to derive the requirements for FR2. As for TAE requirement, though it is relatively easier to realize small TAE for MB-BS, but since the BS need to consider all types of UE, there is no intention to tighten the TAE requirement so far.

RWS-210457 FR2 RRM requirements evolution

There were questions about beam management enhancement, the relation of IBM and FR2-FR2 DAPS handover, and unknown cell activation. For BM FR2 enhancement, it is clarified that to allow network to configure more BM resources over UE capability (but not necessarily more than what's already allowed by the signaling), and then specify UE behavior on choosing subset of configured BM resources for measurement. For FR2-FR2 inter-band DAPS handover, we think it is more feasible for IBM UEs to support DAPS in FR2 inter-band HO, as IBM capable UE can implement on different band with independent RF chain. For SCell enhancement in FR2, unknown SCell is also an important case to address, otherwise network has to make sure the SCell is known which may impose restrictions on the network side.

RWS-210458 UE advanced receiver for Rel-18

There were questions about whether and what the assistant signaling should be provided for MU-MIMO receiver, enhanced IRC. It is clarified that in proponent view the assistant signaling would be needed, and some thoughts on information within signaling were shared. The overhead also needed be considered when designing signaling.