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Variant of RAN-R18-WS-eMBB-Qualcomm Version 0.0.4

RAN

3GPP TSG RAN Rel-18 workshop **RWS-210539**

Electronic Meeting, June 28 – July 2, 2021

Agenda item: 4.1

Source: Moderator (Qualcomm)

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

Document for: Information

1 Introduction

This email discussion summary covers the following documents:

Table 1: Contributions relevant to this discussion

Tdoc#	Title
RWS-210003	eMBB-PHY Enhancements for Rel-18
RWS-210004	eMBB Upper Layer Enhancements for Rel-18

2 1st Round Comments to the Tdocs

2.1 Comments to RWS-21003 eMBB-PHY Enhancements for Rel-18

Feedback Form 1: Comments to RWS-21003 eMBB-PHY Enhancements for Rel-18

1 – vivo Communication Technology For high resolution UL codebook, (WB/SB) high-res precoding , what is the assumption on UE antenna setup/architecture/coherence?
2 – ZTE Corporation Thanks so much for sharing this contribution. Please find our following comment(s) for clarification.

- On P6, DL 6/8Rx: We have supported 6 and 8 layers for DL transmission till Rel-17, including DMRS ports, CSI feedback, SRS etc. 6/8Rx UEs can already be achieved. So what do you have in mind requires enhancement in Rel-18?

- On P3&P14, regarding UL TPMI enhancement, can we assume that this enhancement of higher resolution UL codebook is only relevant to >4 antenna ports and >4 layers?

- On P17, if no PL-RS measurement in UL-only M-TRP operation, could you clarify how to guarantee the UL link adaption well? Also, we can assume that we do not need any enhancement on TA in such case, right?

3 – Nokia Corporation

What is the intended scope of L1/L2 intercell mobility considering the decisions made so far in RAN#92-e?

4 – Xiaomi Communications

We are interested in the IDC topic. We have the following two questions for clarificatison:

Question 1: We wonder whether Qualcomm is also interested in the hardware sharing indication and the IDC indication for MDT/SON as in LTE.

Question 2: Regarding the autonomous deny, it seems that the current RAN4 specification already allows the UE to autonomously suspend the 3GPP uplink transmission via power backoff when there is a transmission via other RAT (e.g. WiFi), as the value of P-MPRc for handling the self desense requirements is up to the UE implementation according to section 6.2.4 of 38.101. However as the network does not know which uplink transmission or how many uplink transmission will be suspended by the UE, there may be issues when many uplink transmissions suspended by the UE are actually undesired by the gNB. As the LTE autonmous deny solution is not well designed, maybe we can discuss whether some network controlled autonomous deny is required.

5 – Xiaomi Communications

It seems the above Xiaomi'comment was posted in the wrong section. The same comments are also posted for the RWS-210004 eMBB upper layer enhancements.

6 – Samsung Electronics Co.

Q1: Could you elaborate more on the improvements related to 6 GHz band? Is it only essential specification change (e.g. sync and channel raster) to support 6 GHz, or general PHY improvement for 6 GHz band only. We didn't see a strong motivation for the second interpretation.

Q2: For FR2x specific enhancements, the listed examples seem applicable to both licensed and unlicensed operations (i.e., the enhancement seems generally applicable to FR2x, instead of unlicensed only). Could you clarify?

7 – Ericsson LM

- What does CSF mean?
- Does the partial spatial sounding consider only fully coherent UEs?

· On Super-QAM, can you elaborate on how you can beat the transmitted EVM by adding more reference symbols? If we assume that most of the EVM stems from the CFR, clipping a narrow peak in time domain with result in a frequency wide noise, and hence even your additional reference symbols will have a limited SNR?

· on SPS for mTRP, why do we need to consider only mDCI? As you know, SPS for mTRP was discussed during Rel-16 mTRP maintenance for both mDCI and sDCI. Neither of these were supported in Rel-16 in the end. Wouldn't it be better to consider both sDCI and mDCI for mTRP SPS?

8 – Sony Europe B.V.

Thank you for the contribution. Here are our questions:

Q1: There is a high level of phase noise in FR2 for 1024QAM and high SINR requirement for 4096QAM. Technical solutions such as non-uniform constellations can reduce the SINR operating point for large constellations. What are your views on considering such techniques?

Q2: CSI enhancements

As well as increasing time resolution of CSI for doppler measurement, for wide bandwidth channels as used in FR2, is there a need to also increase the frequency resolution of CSI measurements?

9 – Beijing Lenovo Software Ltd.

Q1: On UL TPMI

Do you want to introduce new codebooks for 4Tx UE?

Q2: On UL-only M-TRP

Do you want to support this deployment also in FR2? If so, how to support UL beam management without any DL signal?

Q3: On L1/L2 inter-cell mobility

What is your intended objectives of this iterm? More elaborations are appreciated.

Q4: On simultaneous UL

Why start the related design based on CORESETPoolIndex?

2.2 Comments to RWS-21004 eMBB Upper Layer Enhancements for Rel-18

Feedback Form 2: Comments to RWS-21004 eMBB Upper Layer Enhancements for Rel-18

1 – Apple Hungary Kft.

Thank you for triggering this discussion on upper layer enhancements. We definitely are aligned with IDC which is missing several aspects, in the current release. For the DRX group based enhancement, is the intention to also include cross-group control using L2 signaling, or just to limit this to within one CG which has more than 1 DRX group?

2 – Lenovo (Beijing) Ltd

Thanks for your paper.

on MUSIM:

Which node can decide the split RF/baseband resources when both links are active? UE or gNB?

3 – Xiaomi Communications

We are interested in the IDC topic. We have the following two questions for clarificatison:

Question 1: We wonder whether Qualcomm is also interested in the hardware sharing indication and the IDC indication for MDT/SON as in LTE.

Question 2: Regarding the autonomous deny, it seems that the current RAN4 specification already allows the UE to autonomously suspend the 3GPP uplink transmission via power backoff when there is a transmission via other RAT (e.g. WiFi), as the value of P-MPRc for handling the self desense requirements is up to the UE implementation according to section 6.2.4 of 38.101. However as the network does not know which uplink transmission or how many uplink transmission will be suspended by the UE, there may be issues when many uplink transmissions suspended by the UE are actually undesired by the gNB. As the LTE autonmous deny solution is not well designed, maybe we can discuss whether some network controlled autonomous deny is required.

3 1st Round Questions to the Tdocs

3.1 1st Round Questions to RWS-21003 eMBB-PHY Enhancements for Rel-18

Feedback Form 3: Questions to RWS-21003 eMBB-PHY Enhancements for Rel-18

1 – Samsung Research America

- (p3) When we increase the number of layer in UL, is PTRS enhancement proposed? For high rank UL transmission, SINR is likely high and enough with current PTRS design.

- (p10) Re bundled CSI-RS transmission, is it different from TRS (although TRS cannot be configured with reportQuantity)? Re bundled CSI reporting, why is multiple reporting needed?

- p(10) Is it possible to switch between Type II (for stable) CSI and Type I (for varying) CSI based on the proposed bundled CSI framework, e.g. to reduce performance loss of Type II at high speed scenario?

- (p11) is the DMRS-based CSI update limited to CQI or does it also include PMI and RI?

- (p12) Re CPU aspect on the UE initiated CSI feedback, can UE have a separate CPU pool for UE initiated CSI feedback or a common CPU pool for both conventional and UE initiated one?

- (p13-p14) If UL TPMI enhancement is adopted, is it indicated by DCI and how?

- (p13-p14) For UL, UE antenna coherence seems important. Does UL TPMI enhancement consider full coherent case only? Or can partial and no coherent cases be also considered?

- (p17) Re UL PC enhancements, how is PL compensation performed w/o PL-RS measurement?

2 – Sony Corporation

In Page 3, adaptive DMRS and/or SRS is proposed for overhead reduction. That would be great, if proponent could elaborate more on a) under what condition the adaptation will be triggered and b) what mechanism to control it. Thanks a lot.

3 – Guangdong OPPO Mobile Telecom.

Thanks for the contribution. Some questions for MIMO and higher frequence band

MIMO

Q1: For UL only mTRP operation, does beam correspondence become optional for a UE?

High frequence band

Slide 3: What does ”beam squinting for very WB Tx” refer to?

Slide 8:

Q1) can super-QAM modulation/enhance PTRS/enhance DMRS also work for the requency range of 52.6 71GHz?

Q2) can all the cases of RAN4 256QAM requirements apply to the proposed super-QAM?

4 – Samsung Electronics Co.

NR-U

Q1: Page 3. Could you elaborate more on the improvements related to 6 GHz band? Is it only essential specification change (e.g. sync and channel raster) to support 6 GHz, or general PHY improvement for 6 GHz band only. We didn't see a strong motivation for the second interpretation.

Q2: Page 3. For FR2x specific enhancements, the listed examples seem applicable to both licensed and unlicensed operations (i.e., the enhancement seems generally applicable to FR2x, instead of unlicensed only). Could you clarify?

5 – MediaTek Inc.

1) UL-only mTRP: Please could you explain what value you see for this compared to a TRP containing Tx and Rx towards UE?

2) High mobility:

a) For the CSI report selection/recommendation (slide 11) does the UE report both CSI reports to gNB with a recommendation? or does it just select one and report that?

b) Medium mobility (slide 11) - which CSI reporting type is bundled (1 or 2 or both)?

6 – Motorola Mobility UK Ltd.

Thank you for the interesting contribution. My question is related to your proposal in the ***"High Mobility Enhancements"*** section, which reads *"Network configures multiple CSI types in one CSI report config" and "UE provides CSI type recommendation"*. In our understanding, a UE configured with Rel-16 eType-II codebook can select non-zero coefficients corresponding to one spatial beam only, which falls back to Rel-15 eType-I codebook. In light of that, can you please clarify the need for UE providing CSI type recommendation?

7 – Intel Corporation (UK) Ltd

Thank you for the contribution. Please see our questions below:

1. Presentation contains large number of proposals in different areas, which is not feasible to complete in one release. What are priorities from Qualcomm perspective for these enhancements in Rel-18?

2. Evaluation results suggest 8Tx in the UL for study on SRS grouping. Is it not more logical to at least first start some work on 4Tx UE in RAN4 before discussing issue for SRS for 8Tx UE?

3. UL dynamic power aggregation: How does dynamic power aggregation affect UL peak data rate? Does this proposal have any RAN1 impact or can be handled in RAN4? Is it a generic proposal or focused on some specific band combinations?

4. 6/8RX: What are the benefits/reasons to consider simplified demodulation architectures for high-end NR CPE devices with 6/8 RX antennas? What is the expected performance difference between ”LLS-combining” and regular full ”8RX” receiver?

5. NR-U: What are the specific ”Improvements related to 6GHz band regulations”?

6. Higher order modulation: The recent work in RAN4 has shown that 1024QAM use case is quite limited in practical conditions. What are the target SNR conditions to enable 4096QAM and ensure performance improvement over 1024QAM? Also, is it planned to use 4096QAM jointly with 6/8RX?

8 – Spreadtrum Communications

For **Uplink power aggregation**, we have two questions for the scope:

Q1: Can UL power aggregation apply to CA case only, or both DC case? If used in DC deployment, what is the impact to the current dynamic power control between MCG and SCG.

Q2: Regarding the short term power boosting, those only up to UE implementation or also under the control of gNB? Does it have RAN1 impacts?

9 – LG Electronics Inc.

Q) Regarding NR-U, could you clarify what improvements related to 6GHz band regulations (FCC & ETSI) require additional specification work for NR-U?

10 – CATT

Q1: What is the use case and scenario for 4096QAM?
Q2: On UL only mTRP operation, what is the benefit comparing to a full functionality mTRP? What is the expected cost reduction?
Q3: On uplink dynamic power aggregation, it can be simply achieved by defining a new PC class. Is this the expected work?
Q4: On page 7, what is the correlation information between antennas? Is it a correlation matrix? Is it wideband reported or subband reported?
Q5: On page 10, it seems the bundled CSI report are reported in different reporting instances. Then what is the difference between bundled CSI report and multiple individual CSI report triggered by gNB? Is there any change to CSI reporting content?
Q6: On page 11, does UE provide CSI for multiple CSI types in addition to the recommended CSI type? If not, this would limit gNB scheduling flexibility.
Q7: On page 12, gNB will not simply rely on HARQ-ACK feedback to decide whether to trigger a new CSI report. Because there are multiple reasons for decoding errors, for example, bursty interference. gNB would make the decision depending on many factors such as estimated moving speed, periodic CSI reporting, DL traffic etc. The gain is expected to be marginal.
Q8: On UL TPMI enhancement, would the SB precoding based on FD compress impose restrictions on UL scheduling, e.g., contiguous resource allocation?
Q9: Page 20, for extending sequence based PUCCH beyond 2 bits UCI(up to 11 bits), the motivation is not clear. Qualcomm considers existing PUCCH channel code is not optimized, but it is not clear how to choose the sequence and how much gain can be achieved, more simulation result is needed to show the benefit.
Q10: On Page 6, “Null DMRS for better Rnn estimation”. Can this be implemented with ZP-IMR?
Q11: On Page 7, It is unclear 2nd order statistics between antenna (correlation) is used for uplink instant channel extrapolation. Would help to clarify.
Q12: On page 8: would be helpful to clarify spec impact.
Q13: On page 10, bundled CSI report: helpful to clarify details. What are the contents of different parts of CSI in the bundled report?

11 – Fraunhofer IIS

On page 10, a bundled CSI report comprises multiple CSIs? Have you also foreseen some time-domain compression of the multiple CSIs to save feedback overhead?

3.2 1st Round Questions to RWS-21004 eMBB Upper Layer Enhancements for Rel-18

Feedback Form 4: Questions to RWS-21004 eMBB Upper Layer Enhancements for Rel-18

1 – ZTE Corporation

We want to clarify the relationship between Multi-SIM and eIDC. In LTE, the main intention of IDC is to enable the coexistence of LTE and GPS/ ISM radio within the same device. For Multi-SIM, it seems Multi-SIM with two active USIM can be considered as a special case of IDC with two NR radio within the same device. Therefore, to minimize the complexity on both standardization and implementation, we are wondering whether a common framework&solution can be considered for IDC and Multi-SIM to enable the capability coordination&update in NR.

2 – HuaWei Technologies Co.

for MR-DC enhancements, we have similar view that L3 handover for CG change can be improved. Do you think the similar issue could be also valid in general, i.e. not only for MR-DC case, as long as there are multiple carriers deployed and the UE may have mobility among these cells, similar principle can also be applicable?

For MUSIM, we share the similar views that UE capability coordination/update is useful for Dual TX/-Dual RX UE. Which capabilities need to be updated when both links are active? For the intra-PLMN optimizations, what's the extra benefit compared with UE implementation for RRC*IDLE/Inactive and RRC*Connected case respectively.

3 – Intel Corporation (UK) Ltd

Thank you for the contribution. Please see our questions below:

1. Power saving: Are you considering the proposed DRX enhancements as part of separate PS WI, with potentially including RAN1 impact? Rel 15 to Rel 17 provide decent set of tools for power saving, and further additional considerations/enhancements to DRX groups which may result in incremental PS gain with large spec impact may not justify need for a separate WI

2. MUSIM: What is the use case when both sim have to work in Connected mode simultaneously? TDM seems more preferable. Does extension of multi cell group require UE to implement more RF chains than the basic assumption of two? Can you please elaborate more on the practical use case for this?

4 – Nokia Corporation

Rel-18 MUSIM: Coordination of UE capabilities

Could you please share further details of benefits (beyond UE complexity) and what kind of standardization impacts you see necessary for solutions like signaling for the UE to request reduction of number of CCs, BW and MIMO layers, which would mean that in inter-PLMN case UE would prioritize other PLMN with reduced capability request to another PLMN?

Rel-18 MUSIM: Intra-PLMN optimizations:

Could you please share what kind of standardization impacts you see necessary for Intra-PLMN MUSIM?

Rel-18 Further UE Power Savings:

On your slide your propose network assistance to UE to indicate total size of DL buffered data, to assist UE to better allocate its radio resources (e.g. number of Rx antennas). Could you please share further details how UE would utilize this type of assistance as the network will anyway configure if multi-layer or single layer transmission, number carriers and BWPs are to be used in transmission and UE requirements define the minimum number of Rx branches etc? Are you considering UE relaxations for RAN4 requirements for power saving purposes?

Rel-18 MR-DC enhancements:

We share your view that there is need to enhance CA/DC and Mobility further in Rel-18 .

It is not clear to us if there is need to improve the current CHO or CPC solutions in this scenario where we have one MCG and more than one SCG. Could you please share further details like what kind of mobility enhancement needs and solutions you have in mind or are you mainly considering CA/DC enhancements?

4 1st Round Answers by moderator

4.1 Answers to RWS-21003 eMBB-PHY Enhancements for Rel-18

The following is a list of **comments received** during the first round of discussions along with our replies:

vivo Communication Technology # 1

For high resolution UL codebook, (WB/SB) high-res precoding, what is the assumption on UE antenna setup/architecture/coherence?

[Answer] The design does not have any restriction on the UE antenna structure. We consider new codebook at least for full coherent UL. Partial coherent UL is not precluded for now.

ZTE Corporation # 2

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

On P6, DL 6/8Rx: We have supported 6 and 8 layers for DL transmission till Rel-17, including DMRS ports, CSI feedback, SRS etc. 6/8Rx UEs can already be achieved. So what do you have in mind requires enhancement in Rel-18?

[Answer] There are few enhancements that can improve UE devices equipped with 6/8Rx antennas. The UE may deploy specific receiver architecture such as LLR combining or SDM-based demod. gNB knowledge of such architecture can help improving DL performance by deriving proper DL precoder from sounded UL channel. The results in page 6 shows the DL performance improvement if gNB is aware of the demod architecture, in this simulation LLR combining. Some other enhancement listed in page 6 such as DMRS overhead reduction and improve RNN estimation through null REs. On page 7, couple of examples for DMRS reduction and corresponding simulation results are provided.

On P3&P14, regarding UL TPMI enhancement, can we assume that this enhancement of higher resolution UL codebook is only relevant to >4 antenna ports and >4 layers?

[Answer] The enhancement is for >=4 antenna ports. No restrictions on the number of layers.

On P17, if no PL-RS measurement in UL-only M-TRP operation, could you clarify how to guarantee the UL link adaption well? Also, we can assume that we do not need any enhancement on TA in such case, right?

[Answer**]:** Proper power control and link adaptation w/o PL-RS becomes a challenging problem. One way is to purely rely on closed loop PC (TPC commands), but some enhancements may be needed such as early power adjustment after initial access to ensure that UL interference is well-controlled in the system given the UL densification. Another way is to make open loop PC more dynamic and flexible from signaling perspective given that PL measurements are available at the Rx nodes. Regarding TA enhancements, we do not see that as high priority so far, but it depends if initial access needs to be also considered (i.e., be optimized) for this type of deployment or not. Even in that case, TA command (TA accumulation/adjustment) may not require enhancements, but TA indication in RAR depends on whether initial access enhancements are considered or not.

Nokia Corporation # 3

What is the intended scope of L1/L2 intercell mobility considering the decisions made so far in RAN#92-e?

As agreed in RAN#92e, the Rel-17 scope will be limited to the so-called RAN2 Scenario 1 (mTRP framework). In Rel-18 we would like RAN2 to focus on Scenario 2.

[Answer] As agreed in RAN#92e, the Rel-17 scope will be limited to the so-called RAN2 Scenario 1 (mTRP framework). In Rel-18 we would like RAN2 to focus on Scenario 2.

Samsung Electronics Co., Ltd # 6

Q1: Could you elaborate more on the improvements related to 6 GHz band? Is it only essential specification change (e.g. sync and channel raster) to support 6 GHz, or general PHY improvement for 6 GHz band only. We didn't see a strong motivation for the second interpretation.

[Answer] The regulation in different regions on 6GHz unlicensed usage are gradually stabilizing. For the 6GHz enhancement, other than sync raster or channel raster, we expect some RAN4 work may be needed to

reflect the regulation requirement. Additionally, some optimization might be possible to improve NR-U in the band, such as very low PSD limitation cases, such as LPI mode and VLP mode

Q2: For FR2x specific enhancements, the listed examples seem applicable to both licensed and unlicensed operations (i.e., the enhancement seems generally applicable to FR2x, instead of unlicensed only). Could you clarify?

[Answer] Yes the listed areas for potential enhancements for FR2x apply to both licensed and unlicensed. We are hoping the channel access aspects of FR2x should stabilize during the Rel.17 time frame.

Ericsson LM # 7

What does CSF mean?

[Answer] CSI feedback.

Does the partial spatial sounding consider only fully coherent UEs?

[Answer] At least for fully coherent and partial coherent UEs.

On Super-QAM, can you elaborate on how you can beat the transmitted EVM by adding more reference symbols? If we assume that most of the EVM stems from the CFR, clipping a narrow peak in time domain with result in a frequency wide noise, and hence even your additional reference symbols will have a limited SNR?

[Answer] In-band clipping due to CFR and PA non-linearity can be handled by advanced receiver.

On SPS for mTRP, why do we need to consider only mDCI? As you know, SPS for mTRP was discussed during Rel-16 mTRP maintenance for both mDCI and sDCI. Neither of these were supported in Rel-16 in the end. Wouldn't it be better to consider both sDCI and mDCI for mTRP SPS?

[Answer] SPS is useful for both sDCI and mDCI, but there may be different understandings on what is supported in Rel. 16. In Rel. 16 maintenance, the following was concluded: "No consensus to change the spec for the issue of DL SPS transmission in multi-TRP system". For sDCI, the only clarification required was to assume first RV=0 for repetition schemes, but irrespective of that clarification, RV is always 0 in activation DCI for the purpose of activation validation. In our view, it would have been nice to have that clarification only because such spec language is already there for single-TRP. However, there was no consensus to change the spec. This should not mean that SPS for sDCI is not supported in Rel. 16.

Sony Europe B.V. # 8

Thank you for the contribution. Here are our questions:

Q1: There is a high level of phase noise in FR2 for 1024QAM and high SINR requirement for 4096QAM. Technical solutions such as non-uniform constellations can reduce the SINR operating point for large constellations. What are your views on considering such techniques?

[Answer] Using such techniques can definitely work well in augmentation with our proposal.

Q2: CSI enhancements

As well as increasing time resolution of CSI for doppler measurement, for wide bandwidth channels as used in FR2, is there a need to also increase the frequency resolution of CSI measurements?

[Answer] For higher band, antenna spacing may impact very wider bandwidth operation, e.g., beam squinting issue . Further study is needed on the frequency resolution of CSI measurements.

Beijing Lenovo Software Ltd. # 9

Q1: On UL TPMI

Do you want to introduce new codebooks for 4Tx UE?

[Answer] We are open for discussion. But we do see benefit of introducing a new codebook at least for 4 Tx frequency-selective precoding.

Q2: On UL-only M-TRP

Do you want to support this deployment also in FR2? If so, how to support UL beam management without any DL signal?

[Answer] We are open to study this.

Q3: On L1/L2 inter-cell mobility

What is your intended objectives of this iterm? More elaborations are appreciated.

[Answer] As agreed in RAN#92e, the Rel-17 scope will be limited to the so-called RAN2 Scenario 1 (mTRP framework). In Rel-18 we would like RAN2 to focus on Scenario 2.

Q4: On simultaneous UL

Why start the related design based on CORESETPoolIndex?

[Answer] For the case that simultaneous UL is for two different PUSCH's, we think that would be the natural starting point. This is similar to DL where two different PDSCH's can be simultaneously received only with multi-DCI based framework. For the repetition case, single-DCI is a more natural starting point (extend the Rel. 17 TDMed based solutions to FDM/SDM).

The following is a list of **questions received** during the first round of discussions along with our replies:

Samsung Research America # 1

- (p3) When we increase the number of layer in UL, is PTRS enhancement proposed? For high rank UL transmission, SINR is likely high and enough with current PTRS design.

[Answer] This something we need to study. Need to take into account UE capability and practical impairment, e.g., antenna correlation/imbalance/coherency, etc.

- (p10) Re bundled CSI-RS transmission, is it different from TRS (although TRS cannot be configured with reportQuantity)? Re bundled CSI reporting, why is multiple reporting needed?

[Answer] Bundled CSI-RS transmission is used for "Doppler-CSI" measurement (e.g., the Doppler spectrum measurement per sample in spatial-frequency domain). TRS is insufficient as it only has one port.

- p(10) Is it possible to switch between Type II (for stable) CSI and Type I (for varying) CSI based on the proposed bundled CSI framework, e.g. to reduce performance loss of Type II at high speed scenario?

[Answer] No, "bundled CSI" can be thought as "FeType II". The switching would happen among Type I, Type II, eType II, "FeType II", and semi-open loop, depending on the channel variation and network configuration.

- (p11) is the DMRS-based CSI update limited to CQI or does it also include PMI and RI?

[Answer] If we don't make a mistake, this question is about p12 not p11. For UE initiated CSI, the measurement resource can be discussed, e.g., DMRS, CSI-RS, etc. The reporting quantity can be also further discussed if UE initiated CSI is adopted.

- (p12) Re CPU aspect on the UE initiated CSI feedback, can UE have a separate CPU pool for UE initiated CSI feedback or a common CPU pool for both conventional and UE initiated one?

[Answer] Yes, there could be a separate pool, but it's next-level detail and we can discuss further.

- (p13-p14) If UL TPMI enhancement is adopted, is it indicated by DCI and how?

[Answer] There could be several ways to signal UL TPMI, e.g., 2-level indication via 2-stage DCI, or via MAC CE + DCI, or via some other approaches. We can down-select after study all available alternatives.

- (p13-p14) For UL, UE antenna coherence seems important. Does UL TPMI enhancement consider full coherent case only? Or can partial and no coherent cases be also considered?

[Answer] We consider both full coherent case and partial coherent case.

- (p17) Re UL PC enhancements, how is PL compensation performed w/o PL-RS measurement?

[Answer] PL estimation is available at the Rx nodes, and one way for PL compensation in this scenario is to make open loop PC signaling more flexible. Another way is to enhance closed loop PC to be able to quickly react to PL changes.

Sony Corporation # 2

In Page 3, adaptive DMRS and/or SRS is proposed for overhead reduction. That would be great, if proponent could elaborate more on a) under what condition the adaptation will be triggered and b) what mechanism to control it. Thanks a lot.

[Answer] Thank you for your question. To allow DMRS adaptation, dynamic signalling option for DMRS configuration (or for some of its parameters) should be introduced. Regarding adaptation itself, it depends on several parameters like channel characteristics (Doppler spread, Delay spread), working SNR point, Tx mode (for example in relation to HST-SFN scenario or to different UL transmission modes). To optimize link efficiency, an optimal trade off between DMRS overhead and the involved related to channel estimation error floor should be targeted. So, basically, DMRS selection criteria may be based on an effective spectral efficiency metric maximization. DMRS selection for DL can be UE assisted and DMRS recommendation can be reported by a UE. Other option can be NW driven DMRS adaptation for DL and UL. To guarantee that NW has reliable way to estimate all the required channel parameters we suggest also to introduce Doppler tracking SRS in UL (is promoted by QC for Rel-17). SRS parameters can be also selected adaptively per scenario (link budget, Doppler, Delay spread) or per targeted based on SRS procedure/targeted for estimation parameters to improve the efficiency of SRS usage per scenario.

Guangdong OPPO Mobile Telecom. # 3

Thanks for the contribution. Some questions for MIMO and higher frequency band

MIMO

Q1: For UL only mTRP operation, does beam correspondence become optional for a UE?

[Answer] Not in terms of the capability. The UE is still capable of beam correspondence as UE capabilities

cannot be solely based on this deployment model. Even in this deployment model, depending on UE locations and ratio of DL versus UL densification, some of the UEs communicate with the same DL and UL TRP. As UE moves, UL TRP may change in which case the beam correspondence capability is not used at that instance.

High frequency band

Slide 3: What does ”beam squinting for very WB Tx” refer to?

[Answer] Antenna spacing is typically fixed for a particular carrier frequency. As bandwidth increases like in FR2x with 14GHz (57-71GHz), for the same beam, the measurement can vary across frequency domain. In this case, there is pointing angle variation across frequency in addition to frequency selective variation.

Slide 8:

Q1) can super-QAM modulation/enhance PTRS/enhance DMRS also work for the requency range of 52.6 71GHz?

[Answer] Yes. We need to analyse the achievable spectral efficiency with the PN at that band

Q2) can all the cases of RAN4 256QAM requirements apply to the proposed super-QAM?

[Answer] For FR1 RAN4 256QAM requirements apply and for FR2 RAN4 64QAM requirements apply

Samsung Electronics Co., Ltd # 4

NR-U

Q1: Page 3. Could you elaborate more on the improvements related to 6 GHz band? Is it only essential specification change (e.g. sync and channel raster) to support 6 GHz, or general PHY improvement for 6 GHz band only. We didn’t see a strong motivation for the second interpretation.

[Answer] The regulation in different regions on 6GHz unlicensed usage are gradually stabilizing. For the 6GHz enhancement, other than sync raster or channel raster, we expect some RAN4 work may be needed to reflect the regulation requirement. Additionally, some optimization might be possible to improve NR-U in the band, such as very low PSD limitation cases, such as LPI mode and VLP mode

Q2: Page 3. For FR2x specific enhancements, the listed examples seem applicable to both licensed and unlicensed operations (i.e., the enhancement seems generally applicable to FR2x, instead of unlicensed only). Could you clarify?

[Answer] Yes the listed areas for potential enhancements for FR2x apply to both licensed and unlicensed. We are hoping the channel access aspects of FR2x should stabilize during the Rel.17 time frame.

MediaTek Inc. # 5

1) UL-only mTRP: Please could you explain what value you see for this compared to a TRP containing Tx and Rx towards UE?

[Answer] This feature allows for asymmetric DL and UL densification. Given that UL coverage is typically the bottleneck (and also in scenarios where UL traffic is dominant), this deployment model allows for low-cost UL densification.

2) High mobility:

a) For the CSI report selection/recommendation (slide 11) does the UE report both CSI reports to gNB with a recommendation? or does it just select one and report that?

[Answer] Just report one type of CSI. There could be several alternatives, e.g., UE always report CSI for a type configured by gNB, and in addition would recommend if some other CSI type could be better; or, the UE selects the best CSI type and report the CSI for the selected type.

b) Medium mobility (slide 11) - which CSI reporting type is bundled (1 or 2 or both)?

[Answer] For medium mobility, we consider introducing "bundled CSI" which can be thought as a new CSI type (neither Type I nor Type II). The "bundled CSI" includes some time-domain information which can be exploit by gNB to do time-domain extrapolation to combat CSI aging.

Motorola Mobility UK Ltd. # 6

Thank you for the interesting contribution. My question is related to your proposal in the **"High Mobility Enhancements"** section, which reads "Network configures multiple CSI types in one CSI report config" and "UE provides CSI type recommendation". In our understanding, a UE configured with Rel-16 eType-II codebook can select non-zero coefficients corresponding to one spatial beam only, which falls back to Rel-15 eType-I codebook. In light of that, can you please clarify the need for UE providing CSI type recommendation?

[Answer] In high mobility, semi-open loop maybe more robust, it cannot be indicated via Type II framework.

Intel Corporation (UK) Ltd # 7

Thank you for the contribution. Please see our questions below:

1. Presentation contains large number of proposals in different areas, which is not feasible to complete in one release. What are priorities from Qualcomm perspective for these enhancements in Rel-18?

[Answer] Yes, our list of enhancements is an extensive list and we understand that we cannot work on all of them in Rek-18. We are in the process of identifying the most promising features in terms of commercial

applicability and performance impact so that Rel-18 ends up working on features that will make a difference in actual deployments.

2. Evaluation results suggest 8Tx in the UL for study on SRS grouping. Is it not more logical to at least first start some work on 4Tx UE in RAN4 before discussing issue for SRS for 8Tx UE?

[Answer] We see needs of more than 4 Tx for operators to improve UL throughput and to support non-smartphone devices (e.g., CPE, FWA), etc. RAN plenary can sort out whether 4 Tx UE in RAN4 should start earlier than 8 Tx enhancement in RAN1 or not.

3. UL dynamic power aggregation: How does dynamic power aggregation affect UL peak data rate? Does this proposal have any RAN1 impact or can be handled in RAN4? Is it a generic proposal or focused on some specific band combinations?

[Answer] Peak data rate should experience a boost. Typically, even peak data rate scenarios involve some intermittent scheduling, e.g. due to TDD patterns or gNB scheduling constraints, or the burst lasts shorter than the SAR averaging period. In these cases, the UE can consistently transmit at elevated power levels.

[Answer] This depends on what power management solution is chosen for the case when the UE has to reduce long term aggregate power, e.g. due to SAR limitation. If this is left up to UE implementation, the solution can be handled in RAN4. Although the RAN1 specification would still need to be updated in this case to turn off the power sharing procedure. On the other hand, if the decision is to define a different procedure and scaling rule for these cases, then it is best to have more RAN1 involvement.

[Answer] The intent is to make it applicable to all band combinations, in particular to band combinations consisting of multiple FR1 bands, where such power aggregation is not currently allowed.

4. 6/8RX: What are the benefits/reasons to consider simplified demodulation architectures for high-end NR CPE devices with 6/8 RX antennas? What is the expected performance difference between ”LLS-combining” and regular full ”8RX” receiver?

[Answer] LLR combining is just one receiver architecture for 8Rx and is not necessarily used for high-end NR CPE. It could be used for a low complexity UE equipped with 8Rx to support maximum of 4 DL layers with increased reliability.

5. NR-U: What are the specific ”Improvements related to 6GHz band regulations”?

[Answer] The regulation in different regions on 6GHz unlicensed usage are gradually stabilizing. For the 6GHz enhancement, other than sync raster or channel raster, we expect some RAN4 work may be needed to reflect the regulation requirement. Additionally, some optimization might be possible to improve NR-U in the band, such as very low PSD limitation cases, such as LPI mode and VLP mode

6. Higher order modulation: The recent work in RAN4 has shown that 1024QAM use case is quite limited in practical conditions. What are the target SNR conditions to enable 4096QAM and ensure performance improvement over 1024QAM? Also, is it planned to use 4096QAM jointly with 6/8RX?

[Answer] We will provide more detailed SNR conditions in upcoming contributions.

Qualcomm has analysis for MU-MIMO showing high power boost possible due to many gNB TX antennas allowing high SNR for 4096QAM.

NR-CPE and IAB may support more than 4 antennas and are a good use case for 4096QAM.

Spreadtrum Communications # 8

For **Uplink power aggregation**, we have two questions for the scope:

Q1: Can UL power aggregation apply to CA case only, or both DC case?

[Answer] The intent is for it to apply to both CA and DC.

If used in DC deployment, what is the impact to the current dynamic power control between MCG and SCG.

[Answer] This depends on what power management solution is chosen for the case when the UE has to reduce long term aggregate power, e.g. due to SAR+MPE limitation. For example, in the case of FR1+FR2 DC today, the power control is fully independent across the frequency ranges today and the management of the total power is left up to UE implementation. It would be possible to choose the same solution for FR1+FR1 DC. In this case, the impact is that the current dynamic power control procedure between MCG and SCG can be completely removed, simplifying UE operation.

Q2: Regarding the short term power boosting, those only up to UE implementation or also under the control of gNB? Does it have RAN1 impacts?

[Answer] We assume that there would be RRC configurability at least to turn the feature On/Off. We don't think that highly granular configurability is necessary.

[Answer] Yes, there would be some RAN1 impact, depending on the chosen power scaling solution.

LG Electronics Inc. # 9

Q) Regarding NR-U, could you clarify what improvements related to 6GHz band regulations (FCC & ETSI) require additional specification work for NR-U?

[Answer] The regulation in different regions on 6GHz unlicensed usage are gradually stabilizing. For the 6GHz enhancement, other than sync raster or channel raster, we expect some RAN4 work may be needed to

reflect the regulation requirement. Additionally, some optimization might be possible to improve NR-U in the band, such as very low PSD limitation cases, such as LPI mode and VLP mode

CATT # 10

Q1: What is the use case and scenario for 4096QAM?

[Answer] The use cases include FR1 high-end UEs, CPE and IAB

Q2: On UL only mTRP operation, what is the benefit comparing to a full functionality mTRP? What is the expected cost reduction?

[Answer] The benefit is that the additional deployed TRPs for UL densification do not need to have Tx functionality, and hence, cost per TRP can be significantly reduced in terms of hardware/RF/power.

Q3: On uplink dynamic power aggregation, it can be simply achieved by defining a new PC class. Is this the expected work?

[Answer] We don't think a new PC would achieve the goal because once the UE declares a given Powe Class (new or old), it must produce the same power irrespective of the number of UL carriers configured. To achieve the goals of the proposal, a concept like a 'per carrier Power Class' would have to be introduced, which doesn't exist in FR1.

Q4: On page 7, what is the correlation information between antennas? Is it a correlation matrix? Is it wideband reported or subband reported?

[Answer] Correlation matrix is one option. We consider both wideband and subband.

Q5: On page 10, it seems the bundled CSI report are reported in different reporting instances. Then what is the difference between bundled CSI report and multiple individual CSI report triggered by gNB? Is there any change to CSI reporting content?

[Answer] Yes, the bundled CSI is not a simple aggregation of multiple individual CSI reports. It should provide sufficient information about the CSI varying across time, such that the gNB could exploit to address CSI aging.

Q6: On page 11, does UE provide CSI for multiple CSI types in addition to the recommended CSI type? If not, this would limit gNB scheduling flexibility.

[Answer] Why would this restrict scheduling flexibility? Could you please elaborate? In current CSI framework, each report has one codebook type.

Q7: On page 12, gNB will not simply rely on HARQ-ACK feedback to decide whether to trigger a new CSI report. Because there are multiple reasons for decoding errors, for example, bursty interference. gNB would make the decision depending on many factors such as estimated moving speed, periodic CSI reporting, DL traffic etc. The gain is expected to be marginal.

[Answer] We are not discussing based on which network determine triggering a CSI report, the point is that if UE sees a need to update CSI, (due to channel aging and/or bursty interference seen by UE which cannot seen

by network), UE can initiate a CSI, no need to wait gNB trigger so as to shorten the latency. This is beneficial for high-mobility and URLLC.

Q8: On UL TPMI enhancement, would the SB precoding based on FD compress impose restrictions on UL scheduling, e.g., contiguous resource allocation?

[Answer] No, it is just a matter of compressing SB TPMI to reduce payload, not impose any restriction to UL scheduling, similar to DL eType II.

Q9: Page 20, for extending sequence based PUCCH beyond 2 bits UCI(up to 11 bits), the motivation is not clear. Qualcomm considers existing PUCCH channel code is not optimized, but it is not clear how to choose the sequence and how much gain can be achieved, more simulation result is needed to show the benefit.

[Answer] The motivation is improving PUCCH link efficiency by removing DMRS overhead, channel estimation error, and inefficient/suboptimal UCI channel coding. In terms of sequence design, inIn general, there are two types of sequences can be used to carry the UCI, one is a set of orthogonal sequences. The other is a set of non-orthogonal sequences. Theoretically, orthogonal sequences have better link level performance than non-orthogonal sequences, while with the cost of requiring more REs to transmit the UCI payload. For NW perspective, whether use orthogonal or non-orthogonal sequences is a trade-off between PUCCH performance and resource utilization. From UE perspective, whether using orthogonal or non-orthogonal sequences depends on number of REs of PUCCH (x) scheduled by gNB vs number of bits in UCI (y). if log2(x) >= y, orthogonal sequences can be used to transmit y bits UCI. If log2(x)<y, non-orthogonal sequences should be used to transmit y bits. There are many ways to construct orthogonal and non-orthogonal sequences set. We are open to discuss the sequence design details, with a high level design principle to keep low PAPR and low corr of the sequences. The simulation result we included in RWS-210003 is just an example of using 1 RB (168 REs) to transmit 4 bits with orthogonal sequences. Please check more simulation results from multiple companies in TR 38.830.

Q10: On Page 6, “Null DMRS for better Rnn estimation”. Can this be implemented with ZP-IMR?

[Answer] The Null DMRS or in general null RE is intended to capture Rnn for PDSCH demod not Rnn for CSF reporting as it is the case for ZP-IMR.

Q11: On Page 7, It is unclear 2nd order statistics between antenna (correlation) is used for uplink instant channel extrapolation. Would help to clarify.

[Answer] One possible approach is to sound less correlated antennas and to do MMSE estimation of the channel from the unsounded antennas. It’s similar to estimate channel on the pilot tones and use MMSE interpolation to get channel on the non-pilot tones.

Q12: On page 8: would be helpful to clarify spec impact.

[Answer] The transmitter sending some properties of its transmission to the receiver would enable it to improve its baseband processing to compensate for the distortion introduced at the transmitter. The necessary granularity of that information will have to be studied to realize the attainable attractive gains.

Q13: On page 10, bundled CSI report: helpful to clarify details. What are the contents of different parts of CSI in the bundled report? [Answer] The bundled CSI provides sufficient information about CSI varying across time, such that the gNB could exploit to address CSI aging. It could be constructed on top of Type II or eType II by projecting the coefficients onto some time-domain basis.

Fraunhofer IIS # 11

On page 10, a bundled CSI report comprises multiple CSIs? Have you also foreseen some time-domain compression of the multiple CSIs to save feedback overhead?

[Answer] Yes, we do consider time-domain compression of the bundled CSIs to save feedback overhead.

4.2 Answers to RWS-21004 eMBB Upper Layer Enhancements for Rel-18

The following is a list of **comments received** during the first round of discussions along with our replies:

Apple Hungary Kft. # 1

Thank you for triggering this discussion on upper layer enhancements. We definitely are aligned with IDC which is missing several aspects, in the current release. For the DRX group based enhancement, is the intention to also include cross-group control using L2 signaling, or just to limit this to within one CG which has more than 1 DRX group? [Answer] We are not proposing to study cross cell-group wakeup signaling but will be open to discuss wakeup signaling across DRX groups within a MAC entity.

Lenovo (Beijing) Ltd # 2

Thanks for your paper.

on MUSIM:

Which node can decide the split RF/baseband resources when both links are active? UE or gNB? [Answer] The UE should decide the split and send the corresponding request (or capability update) to the gNB.

Xiaomi Communications # 3

We are interested in the IDC topic. We have the following two questions for clarificatison:

Question 1: We wonder whether Qualcomm is also interested in the hardware sharing indication and the IDC indication for MDT/SON as in LTE. [Answer] MDT/SON usually follows one release after the feature completion, and we can discuss this at that stage.

Question 2: Regarding the autonomous deny, it seems that the current RAN4 specification already allows the UE to autonomously suspend the 3GPP uplink transmission via power backoff when there is a transmission via other RAT (e.g. WiFi), as the value of P-MPRc for handling the self desense requirements is up to the UE implementation according to section 6.2.4 of 38.101. However as the network does not know which uplink transmission or how many uplink transmission will be suspended by the UE, there may be issues when many uplink transmissions suspended by the UE are actually undesired by the gNB. As the LTE autonmous deny solution is not well designed, maybe we can discuss whether some network controlled autonomous deny is required.

[Answer] At this point, we don't see much value in "autonomous denial" option or improving LTE solution.

The following is a list of **comments received** during the first round of discussions along with our replies:

ZTE Corporation # 1

We want to clarify the relationship between Multi-SIM and eIDC. In LTE, the main intention of IDC is to enable the coexistence of LTE and GPS/ ISM radio within the same device. For Multi-SIM, it seems Multi-SIM with two active USIM can be considered as a special case of IDC with two NR radio within the same device. Therefore, to minimize the complexity on both standardization and implementation, we are wondering whether a common framework&solution can be considered for IDC and Multi-SIM to enable the capability coordination&update in NR.

[Answer] We also think a common framework can be used for IDC and MUSIM where the specified solutions can address IDC problems either due to another USIM or another RAT.

HuaWei Technologies Co., Ltd # 2

for MR-DC enhancements, we have similar view that L3 handover for CG change can be improved. Do you think the similar issue could be also valid in general, i.e. not only for MR-DC case, as long as there are multiple carriers deployed and the UE may have mobility among these cells, similar principle can also be applicable?

[Answer] If the questions is related to L1/L2 mobility which was considered in Rel-17 (but scoped out in RAN#92), then the response is "Yes". For MUSIM, we share the similar views that UE capability coordination/update is useful for Dual TX/Dual RX UE. Which capabilities need to be updated when both links are active? For the intra-PLMN optimizations, what's the extra benefit compared with UE implementation for RRCIDLE/Inactive and RRCConnected case respectively.

[Answer] At least the RF and baseband related capabilities need to be partitioned when they are used for both links. Ideally, the solution should be flexible enough to allow updating any UE capability. But depending on the exact signaling to be used (e.g. UAI, UE capability transfer, or new RRC message), some compromises may need to be made at stage-3 level.

Intel Corporation (UK) Ltd # 3

Thank you for the contribution. Please see our questions below:

1. Power saving: Are you considering the proposed DRX enhancements as part of separate PS WI, with potentially including RAN1 impact? Rel 15 to Rel 17 provide decent set of tools for power saving, and further additional considerations/enhancements to DRX groups which may result in incremental PS gain with large spec impact may not justify need for a separate WI

[Answer] The partitioning into separate PS WI can be decided later. For now, we would like to focus on the merit of the proposals. The proposed enhancement to DRX groups can have different design options, which can have different extent of impact on RAN1. For example, there can be RAN2-only solutions for wake-up signaling for DRX groups or solutions with L1 enhancements to the R16 wakeup signal when jointly configured with DRX groups. DRX groups are a simple solution that has good power savings benefits. You may find more detailed justifications in our contribution RP-202407 to RANP#90e.

2. MUSIM: What is the use case when both sim have to work in Connected mode simultaneously? TDM seems more preferable. Does extension of multi cell group require UE to implement more RF chains than the basic assumption of two? Can you please elaborate more on the practical use case for this? [Answer] Dual-active USIM UEs are widely used in many countries where the customers expect simultaneous activity (e.g. uploading on one USIM while gaming on the other one). TDM vs reduced capability on each connection can be discussed during the Work Item where one option can also be better suited to downlink or uplink. But both options will require new signaling as the UE cannot dynamically change its capability or switch to the other USIM by itself in Rel-17. TDM option can build on top of the network switching with gaps, which will be specified in Rel-17 for Idle + Connected scenario.

Multiple SCGs can enable faster switching between SCGs, for example when SNs are FR2 and the channel conditions and coverage change fast. Furthermore, more legs for duplication can be enabled when multiple SCGs are configured

Nokia Corporation # 4

Rel-18 MUSIM: Coordination of UE capabilities

Could you please share further details of benefits (beyond UE complexity) and what kind of standardization impacts you see necessary for solutions like signaling for the UE to request reduction of number of CCs, BW and MIMO layers, which would mean that in inter-PLMN case UE would prioritize other PLMN with reduced capability request to another PLMN? [Answer] At the very least, it would be good to request reduction of CC, BW, and MIMO at per band combination level so that the UE does not need to repeat signaling when its configuration changes. Many other capabilities can also be impacted, e.g. the UE may not support DAPS HO when it is in dual-active mode.

Rel-18 MUSIM: Intra-PLMN optimizations:

Could you please share what kind of standardization impacts you see necessary for Intra-PLMN MUSIM? [Answer] This will depend on what type of optimizations are pursued. For example, if we share PHY and MAC but keep RLC/PDCP/RRC separate for the two USIMs, the handling of SRB and DRBs for each connection will impact MAC LCP. Also, RLM and RRM should be done only for one connection. It would also be good to synchronize RRC states and mobility between the two connections. If we use independent connections (i.e. separate PHY/MAC and above), the only signaling impact would be for the UE to report the co-existence of the other USIM connection (e.g. report C-RNTI of the other USIM). For this case, the rest of the optimizations can be done as NW implementation without any spec impact.

Rel-18 Further UE Power Savings:

On your slide your propose network assistance to UE to indicate total size of DL buffered data, to assist UE to better allocate its radio resources (e.g. number of Rx antennas). Could you please share further details how UE would utilize this type of assistance as the network will anyway configure if multi-layer or single layer transmission, number carriers and BWPs are to be used in transmission and UE requirements define the minimum number of Rx branches etc? Are you considering UE relaxations for RAN4 requirements for power

saving purposes? [Answer] With this information, UE can better adapt its own hardware resources, e.g. when there is a change in its traffic load. The exact details can depend on individual UE implementation and do not need to be captured in the spec.

Rel-18 MR-DC enhancements:

We share your view that there is need to enhance CA/DC and Mobility further in Rel-18 .

It is not clear to us if there is need to improve the current CHO or CPC solutions in this scenario where we have one MCG and more than one SCG. Could you please share further details like what kind of mobility enhancement needs and solutions you have in mind or are you mainly considering CA/DC enhancements?

[Answer] We were considering this mostly as a DC enhancement. However, CPC between different SCGs can be a natural fit and we are open to further CPC enhancements to make the switching between SCGs more efficient.

5 2nd Round Questions to the Tdocs

5.1 2nd Round Questions to RWS-210003 eMBB-PHY Enhancements for Rel-18

Feedback Form 5: Further questions to RWS-210003 eMBB-PHY Enhancements for Rel-18

1 – Motorola Mobility UK Ltd.

In high-mobility enhancements, ca you elaborate more on the semi-open loop scheme for CSI? Also, in light of our questions in the first round (Motorola Mobility UK Ltd. # 6), *"In high mobility, semi-open loop maybe more robust, it cannot be indicated via Type II framework"*, can you explain your preference on semi-open loop over Type-I CB?

2 – Samsung Research America

- (p10) Re bundled CSIRS, is it a semi-persistent CSI-RS? or is it a extended TRS with multiple ports?
- (p10) What is the time-domain granularity of CSI-RSs in bundled CSI-RSs (inter-CSI-RS interval)?
- (p10) What is bundled CSI reporting, is it a single report or multiple CSI reports? If it refers multiple CSI reports, why the multiple CSI reports are needed rather than a single one?
- (p11) the high level idea is to let the UE decide CSI resolution depending on mobility. Perhaps, the same can be achieved by configuring/reporting codebook parameters (such as L, M, parameter for time (Doppler) domain)
- (p12) is UE-initiated CSI for Type I or Type II? If for Type II, the reserved UL resource could be very large.
- (p13) high resolution UL precoding can be transparent, based on TPMI indicating a group of beams/TPMIs, large performance gain can be observed.
- (p13-p14) Could you elaborate more on 2-stage DCI in your answer for enhanced TPMI indication? Is it based on two separate DCIs? If so, what's the difference between multi-stage approach as in Rel-17?

3 – vivo Communication Technology

On Doppler tracking SRS in UL, is it for Doppler compensation in HST scenario? What is your view on CSI prediction at gNB with SRS?

4 – ZTE Corporation

Thank you so much for your reply. Then, regarding UL-only M-TRP, purely relying on closed loop PC may not be stable considering that some additional adaption has to be done before a given data transmission. In our initial views, we are open to consider above case/solution, but some studies on flexible PL RS configuration/calculation (e.g., based on several DL RSs from DL TRP) may need to be considered. Then, for TA, we are fine that, as in the first step, we are fine without enhancement for TA approach.

Besides, we have one more comment: Regarding L1/L2 based inter-cell mobility, after reviewing the discussion between you, Qualcomm, and Nokia, we also share the same views that Scenario-2 should be handled in Rel-18. One related question: what are the RAN1/PHY-related objectives for this Scenarios-2?

5 – Guangdong OPPO Mobile Telecom.

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

1) Can you provide more details about ”demodulation aware precoding”? For SDM based and LLR-combining demodulation, why there can be additional gain when different layers are detected in different Rx groups instaed of all the Rx antennas? Additionaly, in the figure, why does UE use two 4-Rx receivers (Rx#0,#1,#2,#3 for one receiver, Rx#2,#3,#4,#5 for the other one) for the LLR-combining for a UE with 6 Rx? How to deal with the overlapped part of the information regardign the Rx#2,Rx#3?

2) For higher-order MIMO optimization, is the intention to support more than 12 layers?

3) wthat is the benefit of Null-DMRS compared to NZP CSI-RS based interference measurement?

6 – Huawei Tech.(UK) Co.. Ltd

Thank you for the contribution. We have a couple of questions below.

Page 3: ”UE initiated beam switch events” is proposed. We wonder whether the UE requires some assistance from gNB (such as those in Section 4.3.3 of RWS-210438), or the UE can take such initiative by itself?

Page 17: It was proposed to revisit initial access procedure for coverage extension. We wonder why it is needed for this scenario, given that Rx-only TRP has been proposed to fill the coverage hole, is there any special consideration for initial access?

7 – Spreadtrum Communications

For **Uplink power aggregation**, thanks for your answer. For this new introduced ”per carrier power class”, we think power boosting is a practical method, but there would be a big change comparing with the current UL power control, either per cell, per CA, or per DC. Is that correct understanding?

8 – Intel Corporation (UK) Ltd

Thank you for the responses. We have an additional question below:

Q1. In the scenarios with bursty traffic it may be difficult to accurately extrapolate CSI due to time varying interference that may change the CQI and RI report. Could you please explain how CSI reporting with extrapolation works in the scenario with dynamic interference?

5.2 2nd Round Questions to RWS-210004 eMBB Upper Layer Enhancements for Rel-18

Feedback Form 6: Further questions to RWS-210004 eMBB Upper Layer Enhancements for Rel-18

1 – ZTE Corporation For the MR-DC, we support the extension of Multi-connectivity. We also think the complexity should be taken into account to ensure the feature can be implemented and deployed in the market, and we support to limit the number of simultaneously activated CG to two, which is also mentioned as Multi-connectivity with selective activation in our tdoc RWS-210464. We are also supportive of the RLF enhancement, MN-SN role change, fast MN switch and L1/L2 signaling for activating/switching CGs.
2 – HuaWei Technologies Co. Regarding MR-DC, do you consider similar principle of L1/L2 mobility applies to both FR1 and FR2 in Rel-18?
3 – Xiaomi Communications We are just wondering whether a common framework (as proposed and answered above) for IDC and MUSIM is only applicable for TDM solution.

6 2nd Round Answers by moderator

6.1 Answers to RWS-210003 eMBB-PHY Enhancements for Rel-18

The following is a list of **questions received** during the second round of discussions along with our replies:

Motorola Mobility UK Ltd. # 1

In high-mobility enhancements, ca you elaborate more on the semi-open loop scheme for CSI? Also, in light of our questions in the first round (Motorola Mobility UK Ltd. # 6), ”In high mobility, semi-open loop maybe more robust, it cannot be indicated via Type II framework”, can you explain your preference on semi-open loop over Type-I CB?

[Answer]: The semi-open loop refers to the PRG-level precoder cycling. It corresponds to set *reportQuantity* as “cri-RI-i1-CQI”. In high mobility, we need more study to conclude the preference on semi-open loop over Type-I CB, although our simulation results lean to choose Type-I CB. But it’s too early to draw a conclusion that Type-I CB is always the best choice in high mobility. We may observe differently depending on the simulation assumptions, e.g., model spatial consistency or not. This is what we can study in Rel-18.

Samsung Research America # 2

- (p10) Re bundled CSIRS, is it a semi-persistent CSI-RS? or is it a extended TRS with multiple ports?

[Answer]: It can be CSI-RS with any time-domain behavior, either periodic or semi-persistent or even aperiodic, as long as the time instance is known to both gNB and UE. It's not an extended TRS, still the normal CSI-RS for CSI measurement.

- (p10) What is the time-domain granularity of CSI-RSs in bundled CSI-RSs (inter-CSI-RS interval)?

[Answer]: It depends on the Doppler. In the simulation, we assume CSI-RS with periodicity of 4 slots.

- (p10) What is bundled CSI reporting, is it a single report or multiple CSI reports? If it refers multiple CSI reports, why the multiple CSI reports are needed rather than a single one?

[Answer]: it's neither a single report as defined in current spec, nor concatenation of multiple CSI reports. So, it cannot be replaced by multiple individual CSI reports. The bundled CSI reporting can be thought as a new type of CSI, which includes not only the spatial- and frequency-domain information, but also time-domain information. With the time-domain information, the gNB could perform extrapolation to address CSI aging due to feedback delay and channel varying across time. The time-domain correlation is also employed to compress the CSI feedback overhead.

- (p11) the high level idea is to let the UE decide CSI resolution depending on mobility. Perhaps, the same can be achieved by configuring/reporting codebook parameters (such as L, M, parameter for time (Doppler) domain)

[Answer]: Yes, the UE side has better estimation of Doppler and channel knowledge, therefore performance has room for further improvement. The gNB can configure multiple CSI reports each for a different type of codebook. But that would require UE compute full-blown CSI for each report config and requires addition UL resource to carry the report.

- (p12) is UE-initiated CSI for Type I or Type II? If for Type II, the reserved UL resource could be very large.

[Answer]: It depends on the CSI timeline and the reserved UL resource and is up to further study/discussion.

- (p13) high resolution UL precoding can be transparent, based on TPMI indicating a group of beams/TPMIs, large performance gain can be observed.

[Answer]: There might be several approaches to provide high-resolution UL precoding. Some approaches may rely on UL-DL reciprocity which requires additional cost at UE.

- (p13-p14) Could you elaborate more on 2-stage DCI in your answer for enhanced TPMI indication? Is it based on two separate DCIs? If so, what's the difference between multi-stage approach as in Rel-17?

[Answer]: The 2-stage DCI segments the TPMI into multiple DCI blocks if the payload is insufficient for one DCI. It can be based on two DCI with connections (similar as part-1 and part-2 CSI reporting on UCI). In addition to 2-stage DCI, we also consider other 2-level indication approaches. The details are up to further discussion.

vivo Communication Technology # 3

On Doppler tracking SRS in UL, is it for Doppler compensation in HST scenario? What is your view on CSI prediction at gNB with SRS?

[Answer]: Doppler tracking SRS may be beneficial not only in relation to Doppler shift pre-compensation in HST-SFN scenario (where SRS based Doppler shift estimation is required). Doppler tracking SRS can be used also for Doppler spread/time coherency estimation in UL to assist PUSCH channel estimation, DL and UL RS adaptation (DMRS for example) and to assist other PHY related procedures including gNB driven CSI prediction as you suggested. Additional usage may be also for FO tracking in UL in some specific scenarios where this may be relevant.

ZTE Corporation # 4

Thank you so much for your reply. Then, regarding UL-only M-TRP, purely relying on closed loop PC may not be stable considering that some additional adaption has to be done before a given data transmission. In our initial views, we are open to consider above case/solution, but some studies on flexible PL RS configuration/calculation (e.g., based on several DL RSs from DL TRP) may need to be considered. Then, for TA, we are fine that, as in the first step, we are fine without enhancement for TA approach.

[Answer]: Thanks for your comments. Yes, we think proper study on the required enhancements for power control, beam management, and other adaptations are needed for this deployment model.

Besides, we have one more comment: Regarding L1/L2 based inter-cell mobility, after reviewing the discussion between you, Qualcomm, and Nokia, we also share the same views that Scenario-2 should be handled in Rel-18. One related question: what are the RAN1/PHY-related objectives for this Scenarios-2?

[Answer]: To our understanding, the RAN1 objectives for Scenario 2 could be L1/L2 signalling for updating serving cell as well as corresponding operating parameters, including beam, timing, etc.

Guangdong OPPO Mobile Telecom. # 5

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

1) Can you provide more details about ”demodulation aware precoding”? For SDM based and LLR-combining demodulation, why there can be additional gain when different layers are detected in different Rx groups instaed of all the Rx antennas? Additionaly, in the figure, why does UE use two 4-Rx receivers

(Rx#0,#1,#2,#3 for one receiver, Rx#2,#3,#4,#5 for the other one) for the LLR-combining for a UE with 6 Rx? How to deal with the overlapped part of the information regardign the Rx#2,Rx#3?

[Answer]: We just showed one example of the design. For a more flexible design, UE may switch off one Rx group for other proposes. In this case, there will be misunderstanding between gNB and UE on the channels, which may reduce the performance. Enhancements are needed for such cases. It can also provide a trade-off between performance and complexity. Regarding 6Rx LLR combining, the figure is one example to show how to support up to 4 layers. One Rx group needs to have at least 4 ports to support 4 layers. The overlapped part can be processed in the combining unit. One combining example is to use weighted factor to combine the results of two Rx groups.

2) For higher-order MIMO optimization, is the intention to support more than 12 layers?

[Answer]: No. Although in current spec, it already supports up to 8 layers. The design is not optimal for 8 layers, such as codebook, interference measurement. The main intention is to optimize the design for high layers.

3) wthat is the benefit of Null-DMRS compared to NZP CSI-RS based interference measurement?

[Answer]: Null-DMRS is always together with data transmission which can give a better measurement performance. It also reduces the measurement complexity compared to NZP-CSI-RS. Additionally, when null resources included within the scheduled DMRS symbols, there is no need to do rate matching or puncturing of PDSCH symbols.

Huawei Tech.(UK) Co.. Ltd # 6

Thank you for the contribution. We have a couple of questions below.

Page 3: ”UE initiated beam switch events” is proposed. We wonder whether the UE requires some assistance from gNB (such as those in Section 4.3.3 of RWS-210438), or the UE can take such initiative by itself?

[Answer]: To our understanding, at the 1st stage, the event triggering condition can be provided by gNB, e.g. L1 metric above/below a certain threshold. The gNB beam correlation info in RWS-210438 is also an interesting direction to explore. Considering the complexity, perhaps we can start with gNB indicating QCL relation between SSBs on different CCs, which is already proposed in R17 but likely deferred to later release.

Page 17: It was proposed to revisit initial access procedure for coverage extension. We wonder why it is needed for this scenario, given that Rx-only TRP has been proposed to fill the coverage hole, is there any special consideration for initial access?

[Answer]: The intention is not extending the coverage of channels, as coverage extension is enabled by the deployment model itself. Instead, the intention is to make it possible to communicate with UL-only node even during initial access. In our view, there can be two approaches: Approach 1: Assuming that initial access is targeted toward the DL node, which is more suitable for UL capacity enhancements, but may not help the UL

coverage as UL channels during initial access still need to be received by the DL node and cannot enjoy the UL densification. Approach 2: Even initial access can be targeted toward an UL-only node, which is suitable for coverage in addition to capacity. In approach 2, UL channels during initial access can also benefit from UL densification, but it has more spec impact. We are open to study both approaches.

Spreadtrum Communications # 7

For **Uplink power aggregation**, thanks for your answer. For this new introduced ”per carrier power class”, we think power boosting is a practical method, but there would be a big change comparing with the current UL power control, either per cell, per CA, or per DC. Is that correct understanding?

[Answer]: Indeed, it all depends how we look into the issue and the proposed solution. One could even think that UL power control would get simplified as there would not necessarily be the need for power scaling to maintain the sum power across all transmitted CCs confined within a certain absolute limit as we do today. Instead and similar to the single CC UL transmission case, the transmit power per CC could use the corresponding available PA power. In the long run (time-basis in accordance with SAR limits) the transmit power would have to satisfy regulatory limits which for TDD configurations with DL heavy configuration (inherently with low transmit duty cycle) may not even require power scaling. The scenarios and applicability could be further assessed but we believe that this type of proposal could increase the value of UL CA in actual deployments.

Intel Corporation (UK) Ltd # 8

Thank you for the responses. We have an additional question below:

Q1. In the scenarios with bursty traffic it may be difficult to accurately extrapolate CSI due to time varying interference that may change the CQI and RI report. Could you please explain how CSI reporting with extrapolation works in the scenario with dynamic interference?

[Answer]: Indeed, the time varying interference will reduce the time-domain correlation in CSI. In fact, not only for time-domain, the subband interference variation would also make Rel-16 frequency-domain compression less effective. But eventually, it depends on how rapidly the interference would change in each domain. Apparently, we are not trying to address the scenarios with rapid interference varying. To this scenario, we have other proposals like UE initiated CSI feedback, or DMRS aided CQI estimation and reporting.

6.2 Answers to RWS-210004 eMBB Upper Layer Enhancements for Rel-18

The following is a list of **questions received** during the second round of discussions along with our replies:

ZTE Corporation # 1

For the MR-DC, we support the extension of Multi-connectivity. We also think the complexity should be taken into account to ensure the feature can be implemented and deployed in the market, and we support to limit the number of simultaneously activated CG to two, which is also mentioned as Multi-connectivity with selective activation in our tdoc RWS-210464.

We are also supportive of the RLF enhancement, MN-SN role change, fast MN switch and L1/L2 signaling for activating/switching CGs.

[Answer]: Agree that these can be beneficial optimizations for MR-DC.

HuaWei Technologies Co., Ltd # 2

Regarding MR-DC, do you consider similar principle of L1/L2 mobility applies to both FR1 and FR2 in Rel-18?

[Answer]: Yes, it should be applicable to both FR1 and FR2

Xiaomi Communications # 3

We are just wondering whether a common framework (as proposed and answered above) for IDC and MUSIM is only applicable for TDM solution.

[Answer]: If IDC work includes MUSIM as one of the objectives, all potential solutions should be discussed and different options (TDM or FDM) can be more suitable for different bands (TDD or FDD).

7 Summary of discussions

We appreciate the questions received during the two rounds of discussions. We are open for further offline discussions and clarifications.

We believe that it is important to improve NR support for eMBB use cases in Rel-18.

We understand that the proposals we discussed in this thread relate to multiple areas: improved spectral efficiency (DL and UL MIMO enhancements (including high Doppler scenarios and mTRP operation, multi-beam operation), higher order modulation,...), UL performance (including improved support of CA via power aggregation, improved PUCCH performance, improved support of multi-panel/multi-Tx UEs...), mobility enhancements (incl. L1/L2 mobility, FR2...), RS enhancements to improve adaptability to varying channel, improved unlicensed support (sub7 and FR2-2), UE power savings, MRDC, IDC, MUSIM, etc.

It is, therefore, important to use the rest of the year to better understand the areas of improvement for a balanced support of Rel-18 projects which could make a noticeable impact to eMBB deployments.