

Electronic Meeting, June 28 - July 2, 2021

Agenda Item: 4.1

Source: AT&T

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

Document for: Discussion

1 Introduction

This document is meant to facilitate the email discussion [RAN-R18-WS-eMBB-ATT] between June 14 and June 24 according to the Chairman's guidance in [1]. To help companies better understand AT&T's proposals, the main purpose of email discussion [RAN-R18-WS-eMBB-ATT] is to ask questions that AT&T can then answer. To this end, to allow for follow-up questions, there will be two rounds.

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

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

A summary will be provided by the moderator before June 25, 18:00 UTC.

AT&T submitted four contributions to the Rel. 18 workshop in [2][3][4][5]. The scope of this email discussion is the second contribution in [3] focusing on the eMBB-driven functional evolution for Rel. 18. The summaries for all contributions can be found in [6][7][8].

2 Round 1 comments, questions, and answers

2.1 Comments regarding AT&T's views on the eMBB-driven functional evolution for Rel. 18

Companies are invited to comment on AT&T's views on the eMBB-driven functional evolution for Rel. 18 in the table below. The moderator of email discussion [RAN-R18-WS-eMBB-ATT] will provide answers, as applicable, in Section 4 to these comments.

Feedback Form 1:

1 – China Telecommunications

We share the similar view that UL coverage enhancement should be considered in Rel-18. In your contribution (P3), it is mentioned that “focus on power domain enhancements”. During the Rel-17 SI phase on NR coverage enhancement, power domain solutions includes: waveform design to optimize MPR/A-MPR, FDD high power UE. So do you mean to focus on the above two solutions? In our view, PUSCH, PUCCH and PRACH may all needs further enhancement, we are also interested in other solutions which are beneficial for the uplink coverage.

For UL MIMO enhancement, we share the similar view that higher order SU-MIMO for UL should be supported.

2.2 Questions regarding AT&T’s views on the eMBB-driven functional evolution for Rel. 18

Companies are invited to ask questions for clarification regarding AT&T’s views on the eMBB-driven functional evolution for Rel. 18 in the table below. The moderator of email discussion [RAN-R18-WS-eMBB-ATT] will provide answers, as applicable, in Section 4 to these comments.

Feedback Form 2:

1 – Samsung Research America

- (p4) Regarding low FR1 band enhancements, what enhancements are considered for

- 1) CSI (e.g., multi-panel codebook or something else)
- 2) mTRP (e.g., coherent/non-coherent joint transmission enh. and/or distributed deployment scenario, the number of considered TRPs, or something else),
- 3) Misc (e.g., measurement of phase difference among TRPs or each antenna of each TRP).

2 – Intel Corporation (UK) Ltd

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

1. What kind of UE devices can support more than 4 MIMO layers UL transmission and what is importance of this enhancement considering lack of support of 4 Tx from RAN4 perspective?
2. What is importance of enhancing MIMO <1GHz considering limited spectrum available at such frequency bands
3. Can you please provide more details on the ”Increase parity between UL and DL in capabilities and features”?
4. 4096QAM: The operating SNR for the recently defined FR1 DL 1024QAM is very high. Is it expected that in practical networks higher order modulation will give any meaningful improvement over 1024QAM? Is it expected that a large enough population of UEs will have SNR exceeding 30dB or more?

3 – Qualcomm communications-France

For MIMO enhancements: Q1: Regarding “low FR1 band enhancements” particularly related to mTRP part, what is the scenario / enhancement in mind compared to Rel. 16/17? Q2: Regarding “Multi-panel enhancements to consider self and cross-link interference”, is this related to enabling full duplex operation

or enhancing dynamic TDD? Q3: Regarding “Further CSI enhancements for DL MIMO, MU-MIMO and UL MIMO”, can you please elaborate a bit more on the scenario / enhancement in mind?

4 – Samsung Electronics Co.

Q1: Thanks for your view on intra-node full duplex. We agree the benefits AT&T pointed out in the slides 6 and both XDD (subband operation) and FD can enjoy this benefit. Both can avoid self-interference by implementation but what is AT&T’s view on how to handle inter-operator cross-link interference in FD? We think that XDD (subband operation) has room to avoid this by placing UL subband in the middle, but FD is not possible. Also, can you share your view on scope and priority in Rel-18?

Q2: Is it a correct understanding that AT&T prefers a dedicated WI for unlicensed enhancement, including RX-assistant LBT for FR1/FR2x, as well as unlicensed sidelink and unlicensed IAB? What do you think of having unlicensed operation discussion be part of corresponding verticals?

5 – Qualcomm Incorporated

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On page 3 for FWA enhancement, we have couple of questions for clarification:

Q4: what are some examples for further enhancement for rel-17 coverage enhancement for CPE?

Q5: For power domain enhancement, do you mean 29+ dBm ?

6 – Sony Europe B.V.

Thank you for the contribution.

We are supportive of higher order modulation.

Non-uniform 4096QAM constellation will bring SINR benefits. What are your views on studying non-uniform 4096QAM?

2.3 Answers provided by the moderator of email discussion [RAN-R18-WS-eMBB-ATT]

In response to the question by China Telecommunications, AT&T’s response is:

Q: In your contribution (P3), it is mentioned that “focus on power domain enhancements”. During the Rel-17 SI phase on NR coverage enhancement, power domain solutions includes: waveform design to optimize MPR/A-MPR, FDD high power UE. So do you mean to focus on the above two solutions?

A: These could be potential candidate solutions but as commented in our response to Qualcomm below power domain solutions could also incorporate Qualcomm’s proposals in [9], p. 4, “uplink dynamic power aggregation”, and [10], p. 5, “Tx ON mode optimizations” both of which can potentially increase coverage.

In response to the question by Samsung, AT&T’s response is:

Q: Regarding low FR1 band enhancements, what enhancements are considered for

1) CSI (e.g., multi-panel codebook or something else)

2) mTRP (e.g., coherent/non-coherent joint transmission enh. and/or distributed deployment scenario, the number of considered TRPs, or something else),

3) Misc (e.g., measurement of phase difference among TRPs or each antenna of each TRP).

A: For low FR1 band enhancements. Enhancements are needed to improve the performance, considering the form factor constraints at low frequencies.

- 1) CSI enhancements can be considered for SU-MIMO and MU-MIMO, building on the enhancements in Rel. 17, and taking into account potential transmission from multiple (possibly uncalibrated) panels.
- 2) Joint transmission from multiple TRPs/multiple panels, mTRP enhancements might be needed to enable such a scenario.
- 3) This needs to be considered if transmission from multiple panels/multiple TRPs is to be used.

Q: Thanks for your view on intra-node full duplex. We agree the benefits AT&T pointed out in the slides 6 and both XDD (subband operation) and FD can enjoy this benefit. Both can avoid self-interference by implementation but what is AT&T's view on how to handle inter-operator cross-link interference in FD? We think that XDD (subband operation) has room to avoid this by placing UL subband in the middle, but FD is not possible. Also, can you share your view on scope and priority in Rel-18?

A: We also anticipate that frequency guard bands may be critical to enable FD operation and avoid inter-operator interference similar to dynamic TDD. In addition we think the initial focus should be on intra-node full duplex (e.g. on the network side) and on interference avoidance/suppression techniques (e.g. not self-interference IC) as a starting point.

Q: Is it a correct understanding that AT&T prefers a dedicated WI for unlicensed enhancement, including RX-assistant LBT for FR1/FR2x, as well as unlicensed sidelink and unlicensed IAB? What do you think of having unlicensed operation discussion be part of corresponding verticals?

A: We indeed prefer a dedicated work item for enhancements in unlicensed spectrum. In regard to your second question, our proposals in [3] are very much eMBB centric. So the discussion should not be whether there is a dedicated work item for unlicensed operation but rather whether potential enhancements for verticals that operate in unlicensed bands are specified in such a dedicated work item or in the respective work item for each vertical.

In response to the question by Intel, AT&T's response is:

Q: Please see our question below:

1) What kind of UE devices can support more than 4 MIMO layers UL transmission and what is importance of this enhancement considering lack of support of 4 Tx from RAN4 perspective?

2) What is importance of enhancing MIMO <1GHz considering limited spectrum available at such frequency bands

3) Can you please provide more details on the "Increase parity between UL and DL in capabilities and features"?

4) 4096QAM: The operating SNR for the recently defined FR1 DL 1024QAM is very high. Is it expected that in practical networks higher order modulation will give any meaningful improvement over 1024QAM? Is it expected that a large enough population of UEs will have SNR exceeding 30dB or more?

A: AT&T's answers are as follows:

- 1) The main use case here is high capability UEs for example in FWA scenarios. Such a device type can have more than 4 MIMO layers UL transmission capability.
- 2) Operators will deploy NR on already available spectrum below 1GHz. It is important to optimize the performance in these bands to get the most out of NR.
- 3) For FWA applications, it is important to improve the UL performance. Since in current systems, UL capabilities are lagging when compared with DL, it becomes beneficial to improve UL through for example increased Rx/Tx capabilities, UL mTRP enhancements, to decrease the gap between DL and UL performance.
- 4) As also mentioned in our response to Sony below, these and any other issues can be addressed as part of this study/work item. More specifically, we are also interested in techniques to reduce the EVM requirements similar to the proposal in [9].

In response to the question by Qualcomm, AT&T's response is:

Q: For MIMO enhancements:

1) Regarding "low FR1 band enhancements" particularly related to mTRP part, what is the scenario / enhancement in mind compared to Rel. 16/17?

2) Regarding "Multi-panel enhancements to consider self and cross-link interference", is this related to enabling full duplex operation or enhancing dynamic TDD?

3) Regarding "Further CSI enhancements for DL MIMO, MU-MIMO and UL MIMO", can you please elaborate a bit more on the scenario / enhancement in mind?

A: AT&T's answers are as follows:

- 1) For low FR1 band enhancements, there might be a need to consider transmission from multiple points/multiple panels to get around the form factor constraints at low frequencies. For such scenarios, with joint transmission, mTRP enhancements might be needed.
- 2) For multi-panel enhancements with self and cross-link interference considerations, this can be related to full duplex operation, or multi-panel transmit/reception in an IAB scenario for example.
- 3) CSI enhancements can be considered to i) further reduce the overhead as for example using DMRS-based CSI, ii) consider the Doppler domain in addition to what was considered in Rel.16/Rel. 17 in the CSI codebook enhancements, exploiting FDD reciprocity, (iii) UL enhancements to further bridge the gap between DL and UL MIMO.

Q: On page 3 for FWA enhancement, we have couple of questions for clarification. What are some examples for further enhancement for rel-17 coverage enhancement for CPE? For power domain enhancement, do you mean 29+ dBm ?

A: Power domain enhancements, for example, could incorporate Qualcomm's proposals in [9], p. 4, "uplink dynamic power aggregation", and [10], p. 5, "Tx ON mode optimizations" both of which can potentially increase coverage in the power domain.

In response to the question by Sony, AT&T's response is:

Q: We are supportive of higher order modulation. Non-uniform 4096QAM constellation will bring SINR

benefits. What are your views on studying non-uniform 4096QAM?

A: As commented to Intel above, we are open to studying the benefits of 4096QAM first and such a study could potentially comprise non-uniform constellations.

3 Round 2 comments, questions, and answers

3.1 Follow-up comments regarding any aspects of Round 1

Companies are invited to comment on any aspects of round 1 and AT&T's answers in Section 2.3 specifically.

Feedback Form 3:

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3.2 Follow-up questions regarding any aspects of Round 1

Companies are invited to ask follow-up questions on any aspects of round 1 and AT&T's answers in Section 2.3 specifically.

Feedback Form 4:

<p>1 – Samsung Research America</p> <p>(p4) - Regarding phase difference among RRHs, if this aspect is considered, do you have any methods/schemes for compensating (measuring/reporting) the phase difference in mind?</p> <p>- Could you please elaborate more on beam indication/measurement enhancements and the overhead/latency reduction enhancements you envision for Rel-18?</p>
<p>2 – Huawei Tech.(UK) Co.. Ltd</p> <p>Thank you for the contribution. On Page 4, does "devices with large number of antennas" include using larger array at FR2 UE for analog beamforming but without increasing the number of digital TXRUs (see Figure 3 of RWS-210438 as an example)?</p>

3.3 Answers provided by the moderator of email discussion [RAN-R18-WS-eMBB-ATT]

In response to the question by Samsung, AT&T's response is:

Q: Regarding phase difference among RRHs, if this aspect is considered, do you have any methods/schemes for compensating (measuring/reporting) the phase difference in mind?

A: In general, enhancements for MIMO operation in below 1GHz should target MU-MIMO performance improvements in urban/sub-urban environments. Such enhancements can include CSI enhancements, and D-MIMO/m-TRP enhancements. If multiple RRHs are considered, phase difference between RRHs needs to be aligned, this can be done with feedback enhancements from UE to assist with the alignment.

Q: Could you please elaborate more on beam indication/measurement enhancements and the overhead/latency reduction enhancements you envision for Rel-18?

A: Multi-beam enhancements targeting further overhead and latency reduction can include BM refinements in initial access, UE-initiated beam refinement, beam failure recovery enhancements. Other beam indication/measurement enhancements that are needed include multi-panel Tx/Rx enhancements that span multiple applications and use cases and L1/L2 inter-cell mobility enhancements.

In response to the question by Huawei, AT&T's response is:

Q: Thank you for the contribution. On Page 4, does "devices with large number of antennas" include using larger array at FR2 UE for analog beamforming but without increasing the number of digital TXRUs (see Figure 3 of RWS-210438 as an example)?

A: The main target of this proposal is operation in mid-band for devices such as CPE and FWA applications.

4 Conclusion

This contribution summarized email discussion [RAN-R18-WS-eMBB-ATT] between June 14 and June 24 in preparation of the 3GPP TSG RAN Rel-18 workshop. Specifically, Section 2 summarizes all comments and questions with the corresponding answers received in round 1 between June 14 – June 17 and Section 3 those of round 2 between June 21 – June 23. The corresponding contribution for email discussion [RAN-R18-WS-eMBB-ATT] can be found in [3]. [2][4][5] reference the other AT&T contributions to the 3GPP TSG RAN Rel-18 workshop and the corresponding email discussion summaries can be found in [7][8].

5 References

- [1] RWS-210002, Some details for RAN Rel-18 Workshop, RAN Chair
- [2] RWS-210211, Views on 5G Enhancements for Release 18 and Beyond, AT&T
- [3] RWS-210212, Views on eMBB-driven Functional Evolution for Rel-18, AT&T
- [4] RWS-210213, Views on Non-eMBB-driven Functional Evolution for Rel-18, AT&T
- [5] RWS-210214, Views on Machine Learning & Artificial Intelligence in RAN, AT&T
- [6] RWS-210513, Email discussion summary for [RAN-R18-WS-eMBB-ATT], AT&T
- [7] RWS-210553, Email discussion summary for [RAN-R18-WS-non-eMBB-ATT], AT&T
- [8] RWS-210607, Email discussion summary for [RAN-R18-WS-crossFunc-ATT], AT&T
- [9] RWS 210003, eMBB PHY Enhancements for Rel 18, Qualcomm
- [10] RWS-210025, 5G Green Networks, Qualcomm