

RAN-R18-WS-non-eMBB-vivo - Version 0.0.2

RAN

3GPP TSG RAN Rel-18 workshop RWS-210602

Electronic Meeting, June 28 - July 2, 2021

Agenda Item: 4.2

Source: vivo

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

1 Introduction

This NWM document is used to capture the Q&A about the following vivo contributions for Rel-18 non-eMBB enhancements.

Table 1:

RWS-210167	Further URLLC/IIOT enhancements in Rel-18	vivo
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2 Questions and comments

2.1 General questions and comments

Feedback Form 1: 1st round of general questions and comments to vivo non-eMBB submissions

1 – Sony Europe B.V.

On carrier switching enhancement (Slide 3), it is proposed to have retransmission in a different CC. What is the expected gain on reTx in different CC when using frequency selective scheduling in a CC with large bandwidth?

2 – ZTE Corporation

I assume the proposed enhancements are related to carrier switching which extends to PDSCH/PUSCH in Rel-18 while we already have PUCCH carrier switching in Rel-17.

Questions: which case should be studied first between the inter-band CCs switching and intra-band CCs switching. What is main difference between the two cases if carrier switching is applied, and how about the potential specification impact?

3 – Huawei Tech.(UK) Co.. Ltd

On 168:

On page 1, regarding the 'average current @IDLE', is it an average value across deep sleep, RRM measurement and paging reception, or a value only for deep sleep?

The coverage of the AZP-WUS seems to be smaller than that of normal paging message. How the network knows whether a UE to be paged is utilizing AZP-WUR for power saving, or utilizing the main receiver in IDLE mode?

In page 4, is the RF sensitivity of -20dBm for "zero power" valid for all kinds of energy harvesting? Or may it only derive from harvesting energy from received RF signals?

4 – Huawei Tech.(UK) Co.. Ltd

One more question on 168:

The pages on use cases emphasized wearable devices. Do you think smart phones can also use the AZP-WUR for further power saving?

Feedback Form 2: 2nd round of general questions and comments

2.2 Further URLLC/IIOT enhancements (RWS-210167)

In this contribution, it is proposed to study/specify the following enhancements in Rel-18

Specify PDSCH/PUSCH initial transmissions and re-transmissions on different CCs. [RAN1, RAN2]

Study and if agreed, specify PDSCH/PUSCH/PUCCH repetitions over multiple CCs. [RAN1, RAN2]

Study and if agreed, specify early termination for PDSCH repetitions. [RAN1]

2.2.1 1st Round-Questions

Feedback Form 3: 1st round of questions and comments to RWS-210167

1 – NTT DOCOMO INC.

Thanks for sharing interesting proposals!

Q1: Do you have any specific motivated new use case for the proposed enhancements?

Q2: For the third bullet about early termination for PDSCH repetitions, is there any special consideration that early termination for only PDSCH repetition rather than for PDSCH/PUSCH repetition is proposed?

2 – Nokia Germany

Objective 1 – PDSCH / PUSCH re-tx carrier switching: There is a motivation, but this had been discussed in RAN1 before (e.g. during the Rel-16 SI phase) - so do you expect this has changed now? Impacts to HARQ-ACK feedback operation (e.g. for Type 1 / Type 3 CB – CC playing a role there)

as well as gNB and UE implementation would need to be considered. Do you think the rather large complexity justifies

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Objective 2 – repetitions across CCs: For same numerology of all the involved CCs and FDD this seems still somehow easy to pull off. But how about the handling of different numerologies (SCS) as well as TDD carriers with different UL/DL switching points? gNB and UE implementation would need to be considered

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Objective 3 – early PDSCH repetition termination: Had been discussed as part of the Rel-16 URLLC SI before. Would this increase the UL control load dramatically (as basically HARQ-ACK would not just be sent based on the timing of the last repetition, but for each repetition – in worst case 8x HARQ-ACK is to be sent compared to once based on Rel-16)? So is this a potential DL capacity enhancement that would lead to increased UL traffic (at least PUCCH) and increase UE power consumption for the needed HARQ-ACK retransmissions?

3 – Apple Italia S.R.L.

For cross-CC HARQ retransmission, is there any evaluation that shows how much gain can be achieved? What is the expected specification impact?

For repetitions over multiple CCs, is there any evaluation that shows how much gain this provides comparing to sending smaller TBs on multiple CCs? The associated complexity is not trivial.

Early termination for PDSCH repetitions was discussed in R16 URLLC and not agreed. A very large number of repetitions was not considered as a typical use case for URLLC.

4 – Intel Corporation (UK) Ltd

Q1: Do you think the potential gains from HARQ retransmission on different CC justifies major MAC changes where single HARQ entity is assumed per CC? Do you think PDCP duplication is not sufficient?

Q2: For DL repetitions, usually DL is not power limited and in many cases larger BW can provide similar result as more repetitions. Do you think this still justifies further enhancements to PDSCH repetitions?

Q3: The early termination of PDSCH repetitions could also be realized by dynamic scheduling with relaxed out-of-order restrictions. Do you think those also need to be discussed?

5 – LG Electronics Inc.

Regarding retransmission on different CC, it has been discussed in RAN2 e.g., even in LTE LAA, and considered to increase complexity highly, which has not been justified properly. Now in NR, we have PDCP packet duplication and LCP restriction, which seems somehow achieves the same thing as cross-HARQ retransmission. In this regards, we wonder what we can expect more with cross-HARQ retransmission.

6 – HUAWEI TECHNOLOGIES Co. Ltd.

Thank you very much for the contribution. We have one question for clarification as below:

Q1: We share similar view that PDSCH/PUSCH initial transmissions and re-transmissions on different CCs should be supported. One question for clarification, do you see any need to restrict the feature to inter-band case? In our understanding, from RAN1 perspective, there is no need to do this kind of limitation.

Table 2:

Respond to	Answers
Sony	<p>Thanks a lot for your comments. The main consideration for re-transmission of a TB from a different carrier than initial transmission is not to obtain the frequency diversity gain. Similar as Rel-17 PUCCH carrier switching, cross-carrier retransmission is to reduce the retransmission delay and improve the retransmission reliability in case the channel conditions for the carrier where the initial transmission happens is bad.</p>
ZTE	<p>Thanks a lot for your questions. We think both cases i.e., inter-band CC switching and intra-band CC switching can have equal priority level for discussion. From our understanding, there is no/less technical difference from RAN1/2 on whether the CC for retransmission is inter-band or intra-band.</p> <p>Regarding to the potential specification impact, we think the main impact lies in RAN2 since currently different carriers have independent HARQ entity. So, the HARQ operation needs to be coordinated among the CCs.</p>
NTT DOCOMO	<p>Thanks a lot for your comments.</p> <p>For Q1, the URLLC use cases and techniques developed since Rel-15 target to achieve the very low latency e.g. 1ms Uu latency and 1e-5 or 1e-6 reliability requirements, but the UE density requirement is very relaxed. However, in some use cases e.g. production line and robot control, reliability requirement is 1e-5 or 1e-6, typically the E2E latency requirement is 4ms, but the UE density requirement is high 400UE/5000m² as mentioned in RWS-210350 for automotive industry.</p> <p>For Q2, at least the early termination is already supported for PUSCH with configured grant. For PUSCH repetitions with dynamic grant, we think it is also possible to support the early termination, although compared to PDSCH for which the PUCCH is available, more specification effort may be needed for DG PUSCH. We are open for it.</p>

Nokia Germany

Thanks a lot for your comments.

For Objective 1: We understood that it was discussed before, the main concern is the major impacts in RAN2. In addition, in previous release, URLLC mainly pursue the very tight latency requirement without optimizing the spectrum efficiency much to accommodate for high UE density. But for Rel-18, with more practical deployments and requirements from the verticals especially in terms of capacity, we would expect that RAN2 is positive for some change.

□ About the HARQ-ACK feedback operation, we think there is at least no impact for Type 1 CB; for type 3 CB, if we do not want to optimize the CB size, we think cross-carrier retransmission also have no impact for Type 3 CB.

For Objective 2: Repetition cross CCs with the same SCS may be easier for uplink. While it seems not so difficult to support repetition cross CCs with different numerologies at least for PDSCH. For TDD carriers with different UL/DL switching points, we can still reuse the current collision handling rule that if on one carrier, there is no enough resource for a repetition, the repetition can be dropped.

For Objective 3: If the traffic for a UE is small, implying that the HARQ-ACKs corresponding to one TB with repetitions will not be multiplexed with other HARQ-ACKs for other TBs, the UL overhead increases. But 1/2-bit PUCCH occupying 1 PRB still have less overhead compared to the resource used by one or more PDSCH repetitions. But if the traffic for a UE is NOT small and the HARQ-ACKs corresponding to one TB with repetitions will be multiplexed with other HARQ-ACKs for other TBs, then the UL overhead increase is marginal. Regarding to the UE power consumption, it may depend on the design, if the UE only needs to feedback ACK, skipping the NACK, then it will not increase UE's power consumption.

Apple

Thanks a lot for your comments.

For cross-CC HARQ retransmission, the retransmission delay due to the TDD UL/DL configuration can be largely reduced if the retransmission can be performed on the carrier that is different from the one where initial transmission happens. The gain is similar as that for supporting Rel-17 PUCCH carrier switching. From improving the spectrum efficiency/cell capacity perspective, Rel-16 URLLC SI studied the gains brought by reducing $N1/N2$ and allowing for more (re-)transmissions within the latency budget.

The expected specification impacts are mainly in RAN2, since currently different carriers have independent HARQ entity. So, the HARQ operation needs to be coordinated among the CCs.

Comparing to sending smaller TBs on multiple CCs, it requires the packet size for URLLC should be large enough so that it can be split to smaller CBs/TBs. In addition, splitting one TB into multiple TBs occupies more HARQ processes and cannot have the different RV combining gain compared to the repetitions over multiple CCs.

In R16 URLLC, the latency requirement is very tight i.e., 1ms Uu latency, hence not many repetitions can be performed given the tight latency bound. But for Rel-18, the latency bound can be relaxed e.g. 4ms, 8 repetitions can be performed for SCS of 30KHz, 16 for SCS of 60KHz, we think it is beneficial to support early termination for PDSCH repetitions for such use cases.

Intel	<p>Thanks a lot for your comments.</p> <p>A1: Compared to PDCP duplication, the proposed scheme can improve the re-transmission latency and more importantly, improve the resource utilization efficiency since only when the initial transmission fails, the retransmission will be conducted. For PDCP duplication mechanism, the independent packets are deemed in MAC layer for a single PDCP packet. Thus, soft combining gain in PHY layer can't be obtained. In addition, it is possible that the transmissions from more than one legs are received correctly, which leads to the redundant transmission. For CA, there is one MAC entity to coordinate multiple CCs. Similarly, we think it is worthy to study the enhancements for HARQ operation so that the frequency resource in different carriers can be more flexibly used for the same TB transmission/retransmission.</p> <p>A2: We share the views that DL is not power limited and larger BW can provide similar result as more repetitions. But with repetitions, finer and lower coding rate can be achieved. And on one carrier, the resource allocation also need to take other served URLLC UEs into account. In fact, our main consideration is that if the cross-carrier retransmission can be supported, then it is also possible to support the PDSCH repetitions cross multiple CCs.</p> <p>A3: Relaxing OoO for early termination per our understating is to allow subsequent scheduling of the PDSCH with the same HARQ process. (If our understating is wrong, please correct us). It seems not work for the 'last' TB with repetitions. But it can be one way to support early termination for the most cases. We are open for discussing it.</p>
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<p>LG Electronics</p>	<p>Thanks a lot for your comments.</p> <p>As we replied to Nokia, we understood that it was discussed before, the main concern is the major impacts in RAN2. In addition, in previous release, URLLC mainly pursue the very tight latency requirement without optimizing the spectrum efficiency much to accommodate for high UE density. But for Rel-18, with more practical deployments and requirements from the verticals especially in terms of capacity, we would expect that RAN2 is positive for some change.</p> <p>□</p> <p>For PDCP duplication, it does not improve the spectrum efficiency and PHY cannot obtain the combining gain, more HARQ processes will be occupied since the data is treated as different TBs in PHY. About LCP restriction, it supports the packet with high priority to be delivered firstly from MAC to PHY, but it does not mean PHY can timely (re)transmit it due to the UL-DL TDD configuration.</p>
<p>HUAWEI</p>	<p>Thanks a lot for your comments and glad to see that we share the similar view on the feature. □</p> <p>Yes, as we also replied to ZTE, at least from RAN1 perspective, we think the solutions should be band-agnostic.</p>

2.2.3 2nd-Round-Questions

Feedback Form 4: 2nd round questions and comments to Further URLLC/IOT enhancements (RWS-210167)

<p>1 – NTT DOCOMO INC.</p> <p>Thank you very much for your reply. As we understand, early termination for CG PUSCH repetition is only supported for unlicensed but not supported for licensed. Is your intention to also support it in licensed first before discussing the further PDSCH early termination and DG PUSCH early termination?</p>
<p>2 – Nokia Germany</p> <p>Thanks to vivo for the detailed answers to our round 1 questions.</p> <p>Quick follow-up still from our side:</p> <p>Objective 1: As also commented by other companies, the impact on MAC complexity (and operation) is clearly increased by supporting this and we have already now also other enhancements in place (e.g. PDCP duplication)</p> <p>Objective 2: Based on the reply to Apple, it seems that if one operates with PUCCH carrier switching (e.g. the semi-static mode) at least for PUCCH (i.e. HARQ-ACK) some of the gains could be achieved with the Rel-17 enhancements already. And for the PUSCH/PDSCH, the same issue of having to coordinate on</p>

MAC level across cells (and PDSCH reception at the UE, i.e. HARQ buffer sharing / combining across different cells) will complicate the operation there similarly as for objective 1. Clearly some complexity gain analysis would be needed, so that only large gain could justify such increased complexity.

Objective 3: Thanks for the answers. Having ACK only transmission could be clearly an option, but of course the DTX to ACK reliability is less compared to NACKàACK. So could there be some reliability issues of actually terminating early? Any thoughts on that?

3 – China Unicom

Thanks for your contribution. Our concern is about the complexity introduced by retransmissions on different CCs. Would you please clarify your consideration on the basis of complexity? Does gNB need to reserve or pre-configure some UL resources for UE to retransmission on different CCs?

2.2.4 2nd Round-Answers

Table 3:

Respond to	Answers
NTT DOCOMO	Thanks a lot DOCOMO for your questions. Our consideration is the early termination for PDSCH repetition and PUSCH repetitions can be discussed in parallel.

NOKIA

Many thanks to Nokia for the follow-up.

For objective 1, compared to cross-carrier retransmission, current PDCP duplication has following drawbacks:

Low efficiency for the resource usage. Even if the transmission from one leg is correctly received, the duplicated transmission still needs to be performed in another leg(s).

Coarse granularity. Current PDCP duplication is based on DRB level, all the packets in the DRB need duplication.

The legs for duplication cannot be dynamically changed. So as the activation and deactivation of the PDCP duplication.

No soft combining gain at PHY. Occupy more HARQ process and buffer.

The PDCP duplication mechanism can be surely enhanced further to resolve above mentioned drawbacks, e.g. NACK to activate the PDCP duplication, PDCP duplication is based on packet level etc., but it also brings many impacts and complexity at both PHY and MAC layer. So, it would be good to investigate the schemes of cross-carrier HARQ retransmission and further enhancements on PDCP duplication, to decide which one is more preferred from performance, complexity and spec impacts perspective.

For objective 2 of supporting repetitions cross multiple CCs, our main consideration is that if the cross-carrier retransmission can be supported, then it is also possible to support the PDSCH repetitions cross multiple CCs. But we agree with you that further study is needed on the impacts/complexity on gNB/UE implementation.

For objective 3, we think DTX to ACK reliability can be ensured to some extent by gNB's implementation. For example, configure proper PUCCH format/length/transmission power and/or configure PCCH repetition to improve the DTX to ACK reliability.

<p>China Unicom</p>	<p>Thanks a lot China Unicom for the comment. For your question, No, gNB does not need to reserve or pre-configure the resource to “schedule” the re-transmission. One benefit for cross-carrier re-transmission is to provide network the flexibility on the resource usage. Depending on the resource availability, traffic load, interference level on different carriers, the retransmission carrier/resource can be flexibly indicated by the gNB. There are other benefits like reduce the retransmission latency, improve the resource usage efficiency. We are open for any solutions to reduce the complexity for the HARQ re-transmission on different CCs.</p>
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3 Summary

The discussions can be summarized as following:

Further URLLC/IOT enhancements (RWS-210167):

Comments/questions received from 8 companies in 1st round of email discussion, the questions raised on the following points.

-For PDSCH / PUSCH re-tx carrier switching:

- Any restriction or prioritization for the feature to be applied to in terms of inter-band and intra-band CCs
- Performance gain and the specification impacts/complexity
- Advantages compared to PDCP duplication

-For repetitions across CCs:

- Performance gain and the specification impacts/complexity
- Different CCs with different numerologies and/or different TDD UL-DL configs.
- Power limitation for PUSCH repetitions over multiple CCs
- Advantages compared to sending smaller TBs on multiple CCs or larger BW

-For early termination of PDSCH repetitions

- Motivation for URLLC
- Views on supporting the early termination for DG PUSCH
- Trade-off between the DL capacity and UL control overhead/UE power consumption

-Views on whether it can be realized by dynamic scheduling with relaxed out-of-order restrictions

Further comments/questions from 3 companies received in 2nd round of email discussion in response to 1st round email discussion

-For PDSCH / PUSCH re-tx carrier switching and repetitions across CCs

-further explanation on the complexity and advantages compared to PDCP duplication

-For early termination

-Views on discussion order between PDSCH repetitions and DG PUSCH repetitions e.g. extend the early termination by CG-DFI in unlicensed band to licensed band

-Any consideration on DTX to ACK reliability in case UE only needs to feedback ACK, e.g. skipping the NACK to reduce the power consumption