3GPP TSG-RAN WG2 Meeting #114-e R2-210xxxx

e-Meeting, 19 May - 27 May 2021

**Agenda item: 6.1.3.1**

**Source: Apple**

**Title: Report of [AT114-e][017][NR16] MAC I - UL Skipping**

**WID/SID: NR\_IIOT-Core**

**Document for: Discussion and Decision**

# Introduction

This document aims to collect and report the results of the following email discussion.

 **[AT114-e][017][NR16] MAC I - UL Skipping (Apple)**

      Scope: Treat R2-2105780, R2-2104896, R2-2105852, R2-2105112, R2-2106442

      determine agreeable parts, for agreeable parts Work on CRs.

      Intended outcome: Report and Agreed CRs.

      Deadline: EOM, can do short post meeting email for CR(s).

UL skipping related

[R2-2105780](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105780.zip) UL Skipping Condition for LCH-basedPrioritization Samsung CR Rel-16 38.321 16.4.0 1109 - F NR\_IIOT-Core

[R2-2104896](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2104896.zip) Correction on UL skipping with lch-basedPrioritization CATT CR Rel-16 38.321 16.4.0 1098 - F NR\_IIOT-Core

[R2-2105852](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105852.zip) Correction to 38.321 on PUSCH Skipping coupled with intra-UE multiplexing ZTE, Sanechips CR Rel-16 38.321 16.4.0 1113 - F NR\_IIOT-Core

[R2-2105112](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105112.zip) UL skipping and intra-UE prioritization Apple discussion Rel-16 NR\_IIOT-Core

[R2-2106442](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2106442.zip) Discussion on whether to ignore an UL grant overlapped with UCI MediaTek Inc. discussion Rel-16

The email discussion is conducted in two phases:

* Phase 1: Collect companies’ comments, by Wednesday 2021-05-26 19:00 UTC
* Phase 2: Summary report and agreeable CR for review: TBD

# Participants

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| Company | Contact: Name (E-mail) |
| LG | SunYoung LEE (ssuyoung.lee@lge.com) |
| Xiaomi | Yumin Wu (wuyumin@xiaomi.com) |
| Apple | Ralf Rossbach (rrossbach@apple.com) |
| Nokia | Ping-Heng Wallace Kuo (Ping-Heng.Kuo@nokia.com) |
| CATT | Pierre Bertrand (pierrebertrand@catt.cn) |
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# Discussion

## UL skipping and intra-UE prioritization

RAN2 discussed enhanced UL skipping during RAN2#113e and agreed on a working assumption [7] when *lch-basedPrioritization* is configured. According to the working assumption, which was confirmed in the RAN2#113bis-e meeting [8], *lch-basedPrioritization* takes precedence over UL skipping in Rel-16.

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| * [019] Working assumption: The MAC entity does not generate a MAC PDU for a deprioritized uplink grant even when its associated PUSCH is overlapping with PUCCH. * Confirm the WA that LCH based prio has higher priority than UL skipping still applies, and we expect that if there are issues, RAN1 will come-back. |

From rapporteur point of view we would like to note that RAN1 is still discussing whether the RAN2 working assumption can be confirmed, and what potential consequences this might imply for the RAN1 design. Assuming that RAN1 confirms the RAN2 working assumption without further changes or concerns, one option for RAN2 is to already prepare a CR. However, there is a possibility that RAN1#105e may postpone the confirmation of the RAN2 working assumption.

**Question 1) Do you agree to capture the RAN2 working assumption in a CR at this point in time?** This could be treated under the assumption that RAN1 confirms the RAN2 WA without additional concerns. Please answer ‘Yes’ if you think that RAN2 can already prepare a CR, and ‘No’ if you think RAN2 should rather wait for RAN1 to confirm the RAN2 working assumption.

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| **Company** | **Q1**  **(Yes/No)** | **Comments** |
| ZTE | No | According to the discussion outcome from RAN1, they postpone the confirmation on whether the LCH based prioritization procedure have a higher priority than the UL skipping check.  For avoiding the possible redundant change for MAC spec, we prefer to postpone the CR discussion until RAN1 have a clear conclusion on this issue. |
| LG | Yes |  |
| Xiaomi | No | It seems ok not to rush to a RAN2 CR in this RAN2 meeting. |
| Apple | Yes (tentative) | The intermediate summary from RAN1 (in [105-e-NR-L1enh-URLLC-04]) seems to say the RAN2 WA is confirmed by a majority at least in general, but it is not finalized yet. We think that we could prepare a CR in this case. However, if there is a different final outcome in RAN1 then RAN2 should not agree a CR at this point. |
| Nokia | No | Although we agree with the intention, procedure-wise it is still better to wait until it is confirmed, so we can avoid potentially redundant work. |
| CATT |  | This question is what we discuss in offline [016]. We don't think it is related to the CRs in 5780, 4896, 5852. See below. |
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***Summary of Question 1:***

*TBD*

**Proposal 1**: TBD

## Solutions for UL skipping with LCH based prioritization

[R2-2105780](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105780.zip) UL Skipping Condition for LCH-basedPrioritization Samsung CR Rel-16 38.321 16.4.0 1109 - F NR\_IIOT-Core

[R2-2104896](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2104896.zip) Correction on UL skipping with lch-basedPrioritization CATT CR Rel-16 38.321 16.4.0 1098 - F NR\_IIOT-Core

[R2-2105852](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105852.zip) Correction to 38.321 on PUSCH Skipping coupled with intra-UE multiplexing ZTE, Sanechips CR Rel-16 38.321 16.4.0 1113 - F NR\_IIOT-Core

[R2-2105112](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105112.zip) UL skipping and intra-UE prioritization Apple discussion Rel-16 NR\_IIOT-Core

The contributions in [2][3] [4] propose a change to the MAC specification to enable the RAN2 working assumption on enhanced UL skipping with lch-basedPrioritization in the specification.

**Option 1 (1A: R2-2105780/Samsung [2], 1B: R2-2104896/CATT [3]): It is proposed to remove the restriction when lch-basedPrioritization is not configured from the set of conditions for Rel-16 UL skipping.**

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| The MAC entity shall:  1> if the MAC entity is configured with *enhancedSkipUplinkTxDynamic* with value *true* and the grant indicated to the HARQ entity was addressed to a C-RNTI, or if the MAC entity is configured with *enhancedSkipUplinkTxConfigured* with value *true* and the grant indicated to the HARQ entity is a configured uplink grant; and  1> if there is no UCI to be multiplexed on this PUSCH transmission as specified in TS 38.213 [6]; and  1> if there is no aperiodic CSI requested for this PUSCH transmission as specified in TS 38.212 [9]; and  1> if the MAC PDU includes zero MAC SDUs; and  1> if the MAC PDU includes only the periodic BSR and there is no data available for any LCG, or the MAC PDU includes only the padding BSR:  2> not generate a MAC PDU for the HARQ entity.  1> else if the MAC entity is configured with *skipUplinkTxDynamic* with value *true* and the grant indicated to the HARQ entity was addressed to a C-RNTI, or the grant indicated to the HARQ entity is a configured uplink grant; and  1> if there is no aperiodic CSI requested for this PUSCH transmission as specified in TS 38.212 [9]; and  1> if the MAC PDU includes zero MAC SDUs; and  1> if the MAC PDU includes only the periodic BSR and there is no data available for any LCG, or the MAC PDU includes only the padding BSR:  2> not generate a MAC PDU for the HARQ entity. |

**Option 2 (R2-2105852, ZTE): The CR intends to capture the RAN2 WA for the case when MAC is configured with lch-basedPrioritization while Rel-16 PUSCH skipping is configured in the following way.**

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| The MAC entity shall:  1> if the MAC entity is configured with *enhancedSkipUplinkTxDynamic* with value *true* and the grant indicated to the HARQ entity was addressed to a C-RNTI, or if the MAC entity is configured with *enhancedSkipUplinkTxConfigured* with value *true* and the grant indicated to the HARQ entity is a configured uplink grant; and  1> if the MAC entity is not configured with *lch-basedPrioritization*, or if the MAC entity is configured with *lch-basedPrioritization* and the UL grant is prioritized; and  1> if there is no UCI to be multiplexed on this PUSCH transmission as specified in TS 38.213 [6]; and  1> if there is no aperiodic CSI requested for this PUSCH transmission as specified in TS 38.212 [9]; and  1> if the MAC PDU includes zero MAC SDUs; and  1> if the MAC PDU includes only the periodic BSR and there is no data available for any LCG, or the MAC PDU includes only the padding BSR:  2> not generate a MAC PDU for the HARQ entity.  1> else if the MAC entity is configured with *skipUplinkTxDynamic* with value *true* and the grant indicated to the HARQ entity was addressed to a C-RNTI, or the grant indicated to the HARQ entity is a configured uplink grant; and  1> if there is no aperiodic CSI requested for this PUSCH transmission as specified in TS 38.212 [9]; and  1> if the MAC PDU includes zero MAC SDUs; and  1> if the MAC PDU includes only the periodic BSR and there is no data available for any LCG, or the MAC PDU includes only the padding BSR:  2> not generate a MAC PDU for the HARQ entity. |

**Question 2: If the answer to Q1 is ‘Yes’, which of the options do companies agree/prefer to specify?** For Option 1, please also indicate whether you prefer the CR in R2-2105780 (option 1A) or the CR in R2-2104896 (option 1B) as a baseline.Note that the exact CR can be further discussed after we agree the direction of change.

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| **Company** | **Option**  **(1A / 1B / 2)**  **Agree as is; Agree with changes; Disagree** | **Comments** |
| ZTE | (Proponent of Option 1B) | Just a short comment, in our understanding, the main difference between option 1A and option 1B is that option 1A does not reflect the WA in RAN2 (i.e LCH based prioritization procedure have a higher priority than the UL skipping check) while the Option 1B reflect this WA.  Anyway, since the WA confirmation is postponed in RAN1, we think the CR discussion can be pending until there is outcome from RAN1.  [Apple] I guess Option 1B is a mixup/typo and it should read Option 2? |
| LG | Option 1 | Failed to find any difference between option 1A and 1B. Thus, either one is fine to be used as a baseline.  In option 2, it further states in the condition whether the uplink grant is prioritized one, which seesm not necessary because as in S5.4.2.1, the MAC will tray to obtain the MAC PDU from M&A entity only for the prioritized uplink grant. |
| Apple | Option 1A | We would like to confirm the RAN2 WA as a baseline. In our understanding, LCH-based prioritization (in 5.4.1) happens before LCP (5.4.3.1.3), therefore, removing the line as proposed in both 1A and 1B essentially has the effect that LCH-based prioritization takes precedence over Rel-16 enhanced UL skipping. The same behavior actually applies for Rel-15 UL skipping already. |
| Nokia | Option 1A/1B | Not sure what is the difference between 1A and 1B.  Agree with LG, this part of specification is written under the clause 5.4.3, which deals with MAC’s behavior when a MAC PDU is to be generated by M&A, so it has to be a priortiized grant anyway (when LCH-based prioritization is configured). Therefore Option 2 is not needed. |
| CATT (option 1/B proponent) | Agree 1A or 1B | This CR is independent of the WA and should be agreed.  It is clear that when *lch-basedPrioritization* is configured, an UL grant not overlapping with any other grant or SR will be de-facto prioritized by the lch-based prioritization procedure, but it could be empty and then the R16 PUSCH skipping procedure should apply equally as when when *lch-basedPrioritization* is not configured. And so, if there would be UCI to be multiplexed on the associated PUSCH the “MAC-delivering-an-empty-PDU” behavior should also apply.  1/A/1B are identical so we are fine with either CR. |
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***Summary of Question 2:***

*TBD*

**Proposal 2**: TBD

The contribution in [5] proposes a few additional options to enable lch-basedPrioritization with enhanced UL skipping in Rel-16. Alternative 1 is similar to Option 1A and 1B proposed by [2][3][4] in question 2 above, alternatives 2 and 3 can be considered as additional enhancements (presumably even on top).

* **Alternative 1:** LCH-based prioritization takes precedence over UL skipping (similar to [2][3][4]).
* **Alternative 2:** The UL grant mapped to a PUSCH-with-UCI for which LCH data is available is selected as prioritized grant.
* **Alternative 3:** Adopt a scheme to increase the LCH priority of UL grants for PUSCH with multiplexed UCI according to pre-defined rules, so that a PUSCH-with-UCI gets a higher probability to become the prioritized grant.

**Question 3: Do companies wish to consolidate additional changes?** If yes, please indicate which of the alternatives you prefer. Note that the exact solution can be further discussed after we agree the direction of change.

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| **Company** | **Alternative**  **(A1/A2/A3)** | **Comments** |
| ZTE | No additional enhancement | We are not willing to introduce additional enhancement for this issue at this very late stage of Rel-16 since the current priority handling procedure is pretty much complex.... |
| LG | No additional enhancement | We see no big motivation of having some flexibility to promote or not promote the UCI-multiplexed PUSCH, hence, A3 is not preferred.  Alternative 2 may bring undesirable/complex issue to URLLC data. For example, higher priority logical channel data may be delayed due to UCI-multiplexed PUSCH. In our view, it is sufficient not to skip UCI-multiplexed PUSCH if it has change to be transmitted and too late to have another enhancement for it.  Alternative 1 is really not clear what alterantive it refers to and how it works. |
| Apple | A3 | The case where UCI is to be multiplexed in a PUSCH requires a balance between a) ‘always generating a MAC PDU’ (i.e., no skipping, no matter what’s the LCH priority and regardless of whether or not there is data available) and b) ‘always giving precedence to LCH-based prioritization’ (which implies that the PUSCH-with-UCI can get deprioritized). Therefore A3 is our preference, followed by A2. Both changes are relatively straight-forward, however, if companies think this is too much for Rel-16 we are also fine to accept A1, which we understand is the current RAN2 WA (dealt with in question 2). |
| Nokia | No additional enhancement | If our understanding is correct, A1 is already what we have agreed as the working assumption.  A2 and A3 look like enhancements that dilute the purpose of LCH-based prioritization, which has not been thoroughly discussed and hence not acceptable. In particular, PHY should do UCI multiplexing based on which grant is prioritized in MAC, but A2 sounds like the other way around. A3 is complicated without clear motivation, LCH priority is set to reflect QoS requirement, why it should be affected by UCI ? |
| CATT | No additional enhancement | We agreed at this meeting that “MAC does not use knowledge of UCI multiplexing when MAC executes LCH based prioritization and deciding when to transmit SR (i.e. in the context of the cases listed in R2-2105781)”.  So only A1 is possible, which is discussed in offline [016]. |
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***Summary of Question 3:***

*TBD*

**Proposal 3**: TBD

## Discussion on whether to ignore an UL grant overlapped with UCI

The contribution in [6] raises the question whether RAN2 should revisit the principle to flush the HARQ buffer if the UE skips an UL transmission given the recent changes in RAN1 for R16 UL skipping.

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| 5.4.2 HARQ operation  5.4.2.1 HARQ Entity  For each uplink grant, the HARQ entity shall:  1> identify the HARQ process associated with this grant, and for each identified HARQ process:  2> if the received grant was not addressed to a Temporary C-RNTI on PDCCH, and the NDI provided in the associated HARQ information has been toggled compared to the value in the previous transmission of this TB of this HARQ process; or  …  2> if the uplink grant is part of a bundle of the configured uplink grant, and may be used for initial transmission according to clause 6.1.2.3 of TS 38.214 [7], and if no MAC PDU has been obtained for this bundle:  …  3> if a MAC PDU to transmit has been obtained:  4> …  3> else:  4> flush the HARQ buffer of the identified HARQ process.  2> else (i.e. retransmission):  3> if the uplink grant received on PDCCH was addressed to CS-RNTI and if the HARQ buffer of the identified process is empty; or  3> if the uplink grant is part of a bundle and if no MAC PDU has been obtained for this bundle; or  3> if the uplink grant is part of a bundle of the configured uplink grant, and the PUSCH duration of the uplink grant overlaps with a PUSCH duration of another uplink grant received on the PDCCH or an uplink grant received in a Random Access Response (i.e. MAC RAR or fallbackRAR) or an uplink grant determined as specified in clause 5.1.2a for MSGA payload for this Serving Cell; or:  3> if the MAC entity is configured with *lch-basedPrioritization* and this uplink grant is not a prioritized uplink grant:  4> ignore the uplink grant. // whether UE should skip this uplink grant in case the PUSCH for retransmissin is overlapped with UCI?  3> else:  4> … |

The scenario would typically happen if, for example, the UE did not have data available at initial transmission while there was also no overlapping UCI. As a result, the initial transmission gets skipped as part of the normal UL skipping procedure and MAC does not create a MAC PDU for the UL grant. Per the current procedure, MAC flushes the HARQ buffer in this case.

Now if the UE would receive a DCI requesting a retransmission for such earlier HARQ process (or more generally any retransmission grant where MAC did not create a MAC PDU at InitialTx), MAC basically ignores the retransmission grant per the current procedure.

Then the question is, if PHY had a UCI to transmit at the time of such a ReTx, is MAC supposed to create an empty MAC PDU (just for the sake of UCI) in response to the retransmission grant? If the scenario is valid then the rapporteur thinks that RAN2 may end up with change somewhat similar to what might be required for TB repetition as well, where, depending on the solution that RAN1 will select, MAC could be required to adjust the creation time of a MAC PDU (currently at InitialTx only).

**Question 4: Do you think the scenario is valid in the sense that MAC should create a MAC PDU when a retransmission grant overlaps with UCI and the initial transmission was skipped earlier?** If you think the scenario is valid, please indicate the expected UE behavior to handle a retransmission uplink grant overlapping with UCI.

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| **Company** | **Q4**  **(Yes/No)** | **Comments** |
| ZTE | No, but | We think the current spec is clear that the UL grant for retransmission would be ignored.  With the below reason, we think MAC should not create a MAC PDU for retransmission:  1: The case is much rare case, if NW does not receive one UL transmission and the UL skipping is configured before hand, NW won’t schedule any retransmission for this HARQ process ID since the power and front loaded DMRS is not detected.  2: Assuming that the MAC PDU is generated(i.e may include only padding) for the retransmission grant, it may cause the logic confusion on the retransmission or new transmission, does it really belong to retransmission when a new MAC PDU is generated for a retransmission？ |
| LG | No | We tend to agree with ZTE that generation of MAC PDU for the retransmission grant of which the initial transmission is skipped may confuse the general logic of initial/re-tx. For example, the MAC needs to obtain a new MAC PDU for retransmission grant or the MAC needs to treat a grant as a new transmission grant even when NDI is not togged if UCI is to be transmitted.  In addition, it may come with another question why we don’t use that UL grant for transmitting any other data rather than ignoring it. For instance, why don’t we use it for transmitting higher priority data?  Considering above, we prefer to keep the current principle as it is, i.e., to ignore retransmission grant if it is for the skipped HARQ transmission. |
| Xiaomi | No | We think that the case that the gNB sends a retransmission DCI for an skipped uplink grant is rare in reality, as the gNB is able to detect the grant skipped by the UE, e.g. via the power detection of PUSCH. |
| Apple | No | We think RAN1 considered the existing MAC PDU generation sequence as a baseline for UL skipping so far. Agree with ZTE that the scenario seems a corner case – if the InitialTx did not happen the gNB should detect that nothing was received in uplink for the PUSCH and typically not generate a retransmission grant. |
| Nokia | No | From gNB perspective, if the earlier initial transmission is already skipped, the gNB can already know that nothing else will be transmitted in this bundle (because obviously the initial transmission happens earlier than retransmission). Hence there is no extra burden of blind decoding. |
| CATT | No | First, it is our understanding that [5] actually discusses the case of a repetition grant within a bundle rather than a gNB-scheduled dynamic retransmission grant for this bundle. Indeed, it would not make sense for NW to schedule a retransmission grant before it has received the whole bundle for DTX detection.  That being clarified, we agree with MediaTek that the current MAC behaviour is to not provide a PDU for a repetition in a CG bundle if the initial grant was skipped. But given this behaviour is clear and known by the NW, we think there is no ambiguity and NW either avoids this corner case, or it performs the blind detection on the repetition grant overlapping with UCI as part of its DTX detection algorithm. In other words, no change is needed. |
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***Summary of Question 4:***

*TBD*

**Proposal 4**: TBD

From rapporteur point of view RAN2 may as well consider discussing a potential solution after RAN1 concluded their current discussion of TB repetitions with Rel-16 UL skipping, because the options RAN1 has in mind may create a requirement for RAN2 to change the specification for the HARQ retransmission case anyway.

**Question 5: Do companies agree to wait until RAN1 concludes on Rel-16 UL skipping with TB repetitions?**

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| **Company** | **Q5**  **(Yes/No)** | **Comments** |
| ZTE | Maybe.. | We cannot consider about the solution until the LS related this issue is received. |
| LG | Yes |  |
| Xiaomi | Yes |  |
| Apple | Yes | A potential change to the sequence of MAC PDU generation, if needed at all, could be discussed after RAN1 concludes on TB repetitions with enhanced UL skipping in R16. |
| Nokia | Yes |  |
| CATT | Yes | We can wait for RAN1 |
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***Summary of Question 5:***

*TBD*

**Proposal 5**: TBD

# Conclusions

TBD

# References

[1] RAN2#114e, Chairman’s Notes

[2] [R2-2105780](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105780.zip), UL Skipping Condition for LCH-basedPrioritization, Samsung

[3] [R2-2104896](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2104896.zip), Correction on UL skipping with lch-basedPrioritization, CATT

[4] [R2-2105852](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105852.zip), Correction to 38.321 on PUSCH Skipping coupled with intra-UE multiplexing, ZTE, Sanechips

[5] [R2-2105112](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2105112.zip), UL skipping and intra-UE prioritization, Apple

[6] [R2-2106442](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_114-e\Docs\R2-2106442.zip), Discussion on whether to ignore an UL grant overlapped with UCI, MediaTek Inc.

[7] Draft\_R2-113-e\_Meeting\_Report\_v1

[8] Draft\_R2-113bis-e\_Meeting\_Report\_v2