3GPP TSG-RAN WG2 Meeting #109 electronic R2-20xxxxx

Elbonia, 24th–28th February2020

Source: CATT

Title: Report of [035][IIOT] Deprioritized transmissions

Agenda Item: 6.7.3.1

Document for: Discussion and Decision

# Introduction

This contribution provides the report of the email discussion [035][IIOT] Deprioritized transmissions discussing leftover issues on deprioritized transmissions as summarized in [1] based on the contributions posted in the Agenda Item 6.7.3.1. Following [2], the addressed issues are classified as:

* Expecting easy agreement
* Requiring more inputs from companies

# Discussion

* 1. **Non-contentious issues**

### *Issue #1: Can a UE autonomous transmission use the same HARQ process for a different CG configuration?*

MAC Editor’s Note [3]: UE autonomous retransmission using the same HARQ process for the different CG configuration is FFS

As summarized in [1], 13 companies expressed an opinion on this issue ([6]-[9][11]-[13][17]-[22]).

* Support UE autonomous retransmission on different CG configuration: 3
* Not support: 10

This issue seems not much controversial and a possible agreement could be attempted:

**Proposal 1: UE autonomous transmission uses the same HARQ process and the same CG configuration. No change to the current running CR.**

*Q1: Is Proposal 1 agreeable?*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | Yes |  |
| Nokia | Yes |  |
| MediaTek | Yes |  |
| CATT | Yes |  |
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### *Issue #2: Autonomous transmission for consecutive CG/DG de-prioritization?*

MAC Editor’s Note [3]: In case that retransmission grant for a deprioritized configured grant is deprioritized again and the MAC entity is configured with *autonomousReTx*, whether UE performs the autonomous retransmission in the subsequent configured grant is FFS. This running CR assumes that UE does not perform the autonomous retransmission in this case.

As summarized in [1], 6 companies expressed an opinion on this issue ([6][7][12][18][19][22]).

* Support: 1
* Not support: 5

This issue seems not much controversial and an agreement should be attempted:

**Proposal 2: A PDU from a de-prioritized DG scheduled for a re-transmission of a de-prioritized CG cannot be autonomously transmitted using the subsequent CG with same HARQ process. No change to the current running CR.**

*Q2: Is Proposal 2 agreeable?*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | Yes |  |
| Nokia | Yes | In this case the gNB already knows about the existence of this de-prioritized PDU, so autonomous transmission is no longer needed. |
| MediaTek | Yes | Agree with Nokia |
| CATT | Yes |  |
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### *Issue #3: How many times / for how long a pending PDU subject to autonomous transmission can be consecutively de-prioritized?*

5 companies ([6][7][11][13][16]) raised this issue and propose to address it by means of a counter (with possible bare minimum =only one allowed autonomous transmission) or a timer. There seems to be at least a desire to limit the number of consecutive de-prioritizations of a same PDU.

**Proposal 3: There is a limit on the number of times a MAC PDU is consecutively de-prioritized.**

*Q3: Is Proposal 3 agreeable?*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | Yes |  |
| Nokia | Yes | In this case the gNB already knows about the existence of this de-prioritized PDU, so autonomous transmission is no longer needed. |
| MediaTek | Yes |  |
| CATT | Yes | Similar to HARQ re-transmissions, we need a limit. Beyond the limit the MAC PDU is discarded. |
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*Q4: If the answer to Q3 is Yes, would you support introducing a timer or a counter for addressing this limitation?*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | Yes | Counter sounds like a natural solution given UE can only do autonomous transmissions at discrete points in time. |
| Nokia | Yes | A timer relating to the LCHs mapped to the pending MAC PDU. |
| MediaTek | Yes | This has been resolved in NR-U by re-using the *configuredGrantTimer* from Rel-15. We suggest to stick with the same mechanism for IIoT.In Rel-15, the *configuredGrantTimer* determines the duration for which TB in a HARQ process is considered ‘valid’. It is therefore suitable for this purpose, i.e. retransmissions take place so long as the contents of the HARQ process is considered valid. |
| CATT | Yes | Either a timer or a counter seems the simplest approach. No strong view though between timer or counter. |
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* 1. **Issues requiring more inputs**

### *Issue #4: Is autonomousReTx configured per CG configuration or per MAC entity?*

Rapporteur of RRC running CR captured the following open issue #9 in [5]:

RAN2 to discuss and agree on one of the following alternatives

a. *autonomousReTx* is only configurable per MAC entity

b. *autonomousReTx* is only configurable per configured grant configuration

As summarized in [1], 4 companies expressed an opinion on this issue ([4][11][17][20]) and none supported the granularity of per MAC entity. However, given the low amount of contributions on this issue, we think it is safer to ask companies their views on it.

*Q5: Which of option a or b (or other, please describe) do you prefer?*

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| ***Company*** | ***a/b/other*** | ***Comments*** |
| Qualcomm | b | It may only be needed for CG configurations carrying low priority traffic (which are susceptible to deprioritization) and not for all CG configurations. |
| Nokia | b/other | It can be configured per CG configuration or per LCH |
| MediaTek | b |  |
| CATT | b | Per configured grant configuration provides more flexibility than per MAC entity. And we don't see the need to go lower (e.g. LCH-based) since it is not always guaranteed that an LCH ends-up in a specific CG. |
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### *Issue #5: Capturing UE processing time limitation for autonomous transmission in MAC.*

MAC Editor’s Note [3]: Whether this MAC CR needs to capture something to reflect a RAN2#108 agreement “The case when the next CG resource cannot be used for a retransmission because of UE processing time limitation can occur (no consensus on whether this is a corner case or a mainstream case). Leave the timeline restriction to UE implementation (we don’t specify a new number, can specify something)” is FFS.

9 companies expressed an opinion on this issue ([6]-[9][12][15][19][21][22]).

* 4 companies think it is fully left to UE implementation and/or already captured in RAN1 specification and nothing needs to be captured in MAC, or just a Note.
* 2 companies think the MAC specification should be updated to reflect that the UE may not be able to select the *next* CG resource due to processing time limitation.
* 2 companies suggest specifying explicit timers/time restrictions by which either the CG or DG can be used.
* 1 company proposes restricting UE autonomous transmissions to configured grant configurations with periodicity greater than Tproc,2 specified in TS 38.214.

Companies’ opinions on the need / how to address the issue is spread, so we list below possible options among the above proposals, aiming at down-scoping the solutions:

* Option 1: No need to capture anything
* Option 2: Update the MAC specification to reflect that the UE may not always be able to select the *next* CG resource due to processing time limitation.
* Option 3: Capture explicit timer(s)
* Option 4: Restricting UE autonomous transmissions to configured grant configurations with periodicity greater than Tproc,2 specified in TS 38.214
* Option 5: Other

*Q6: Which option do you prefer?*

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| ***Company*** | ***Option*** | ***Comments*** |
| Qualcomm | 4 | Option 4 is the simplest. Just needs some text in the RRC specifications. It is likely that traffic being carried in CGs that experience deprioritiziation is not URLLC in the first place (if URLLC, they are less likely to be deprioritized) and such a restriction is thus not too limiting.Option 3 is acceptable, though it is effectively same as option 4.Option 2 is not clear about what UE does when UE is unable to select next CG resource (e.g., does the UE skip the resource or use it for new PDU?). This ambiguity could result in more complexity.Option 1 is not aligned with the agreement. |
| Nokia | 1 | We don’t need to specify anything, a proper UE-implementation should know how much time it needs (following RAN1 spec. ) to select a suitable CG resource. |
| MediaTek | 5/1? | We prefer to leave this to UE implementation with a Note in the specs to allow this. Unsure if this is option 1 or a new option. |
| CATT | 2 | We think all that needs to be captured is to relax the wording of “if the previous configured uplink grant for this HARQ process was de-prioritized; and…”. We can instead leave it possible that the de-prioritization occurred in a previous configured uplink grant, and has still not been transmitted:3> else if the MAC entity is configured with *autonomousReTx*; and3> if this uplink grant is a configured grant which is a prioritized uplink grant; and3> if ~~the~~ a previous configured uplink grant for this HARQ process was de-prioritized; and3> if a MAC PDU had already been obtained for ~~this HARQ process~~ the de-prioritized configured uplink grant; and3> if a transmission of the obtained MAC PDU has not been performed:4> consider the MAC PDU has been obtained. |
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### *Issue #6: Should the UE be allowed to use the retransmission grant (sent by the gNB due to a de-prioritization of CG) for a new transmission if the associated HARQ ID buffer is empty?*

This issue was originally raised before the agreement on autonomous transmission was made e.g. in [25] and is further discussed in three contributions to this meeting [12][14][23], with mixed views.

*Q7: Should the UE be allowed to use the retransmission grant (sent by the gNB due to a de-prioritization of CG) for a new transmission if the associated HARQ ID buffer is empty?*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | Yes | The rationale for this is the following:* To recover the related data, gNB has to schedule a new transmission for the case when PDU was not generated and a retransmission when PDU was generated.
* gNB does not know whether a PDU for deprioritized CG was generated to or not because this depends on PDU generation timeline internal to UE.

A simple solution would be to allow to always allow recovering the PDU using a retransmission grant. This would require that * deprioritization empties HARQ buffer if PDU is not generated.
* Retransmission grant is used for a new transmission of HARQ buffer is empty.

Note that this behavior is already used for dynamic grants in Rel-15. |
| Nokia | No | Considering that we are approaching the end of Rel-16, we prefer to defer such optimization. |
| MediaTek | No | Agree with Nokia that this is an unnecessary optimization. |
| CATT | No | This option was discussed altogether with the autonomous transmission. Having agreed to support autonomous transmissions should result in much less waste of retransmission grants (since gNB can rely on autonomous transmissions) hence the issue #6 is no more an issue in our view. |
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### *Issue #7: The configuredGrantTimer blocks potential CG resources for autonomous transmission which increases latency.*

- Company: OPPO [9].

- Issue description: The latency of the deprioritized MAC PDU transmission will not be alleviated since the configured grant is blocked by *configuredGrantTimer*.

- Solution: To support UE autonomous transmission, modify the condition of CG timer start, i.e. start /restart CG timer in the first symbol after the end of the corresponding PUSCH transmission.

*Q8: Should the issue of the latency induced by the configuredGrantTimer for a next available CG for autonomous transmission be addressed in Rel-16? If Yes, do you agree with the proposed solutions (otherwise please suggest an alternate way)?*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | No | The *configuredGrantTimer* would still be useful in allowing gNB enough time to recover deprioritized PDU via dynamically scheduled retransmission grants (dynamically scheduled retransmission grants should be the primary method for recovering deprioritized PDU and other enhancements should not impact this). |
| Nokia | No | In principle we agree with the intention. However, RAN2 may need more time to evaluate any possible “side effects” of such change that may affect other topics. Therefore for Rel-16 we think we can focus on cases where initial transmission of the pending MAC PDUs has not even started (i.e. CG timer has not started). Further optimization for other cases could studied in future releases.  |
| MediaTek | No | Disagree with the described behaviour. We ought to follow the same principles as agreed for autonomous retransmission in NR-U (that is captured in the running MAC CR).* The *configuredGrantTimer* should start at the first transmission occasion of the TB.
* Thereafter, the retransmission attempts take place so long the timer is running (i.e. so long as the TB in the HARQ buffer is considered valid).
* Once the timer expires, the UE stops autonomous retransmission attempts.
* If a dynamic grant is received from the gNB, autonomous retransmission attempts are stopped.
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| CATT | No | We don't think this issue is severe enough to be solved in Rel-16. We expect the latency is less an issue for the de-prioritized PDU than for the prioritized one. We view this proposal more like an optimization. |
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### *Issue #8: Conditions of autonomous transmission.*

- Company: Nokia [13].

- Issue description: Limit the cases where UE uses autonomous transmissions.

- Solution: The UE may choose to rely on gNB scheduling of re-transmission grant or autonomous transmission to handle a de-prioritized MAC PDU, based on whether at least some DM-RS symbols associating to its PUSCH have been transmitted.

*Q9: Should the autonomous transmission be conditional to some specific aspects of the de-prioritized grant e.g. whether some DM-RS symbols associating to its PUSCH have been transmitted?*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | No | Over-optimization and too complex to specify.  |
| Nokia | Yes | This helps the gNB to determine if a re-TX grant should be issued. |
| MediaTek | No | Agree with Qualcomm. The only condition should be the RRC configuration for autonomous retransmissions. |
| CATT | No | We don't think it is worth adding further complexity in filtering the use of autonomous transmissions also provided that the proposed condition is not 100% reliable. |
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### *Issue #9: Prioritization of dynamic ReTx over autonomous transmission of the same PDU.*

- Company: Lenovo, Motorola Mobility [15].

- Issue description: Collision of the CG PUSCH used for autonomous transmission with the DG PUSCH used for re-transmission of the de-prioritized PDU.

- Solution: UE prioritizes a dynamically scheduled retransmission over an autonomous retransmission on a configured uplink grant, for cases when the PUSCH duration(s) of both grants are overlapping.

*Rapporteur: This depends on the outcome of following Editor’s Note: It is FFS whether an uplink grant addressed to CS-RNTI with NDI=1 (i.e. retransmission of a configured grant) is considered as a configured grant or not. In this version of running CR, it is assumed that an uplink grant addressed to CS-RNTI with NDI=1 is considered as a dynamic grant.*

If the running CR is confirmed then the above issue reduces to a CG/DG prioritization of equal-priority grants resulting in prioritizing the DG. Thus we think we can postpone this issue for now.

### *Issue #10: Case of a CG PUSCH for an autonomous transmission occurring after the DG for the re-transmission but before the PUSCH for the re-transmission*

- Company: Lenovo, Motorola Mobility [15].

- Issue description: A dynamic grant for a retransmission of a de-prioritized PDU is received before the next CG resource for autonomous transmissions, but the associated PUSCH is after that CG resource. In such case, with current CR, even though the dynamic grant was received before the resource for autonomous transmission, the latter is not cancelled and the DG resource is wasted.



- Solution: no specific solution suggested.

*Q10: Should the issue of a PDCCH scheduling a dynamic retransmission of the deprioritized TB received before the PUSCH used for the autonomous transmission whereas the PUSCH corresponding to the PDCCH occurs after the PUSCH resource for the autonomous transmission be addressed in Rel-16?*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | No | Such scenarios can be avoided by the scheduler which can either avoid scheduling DGs for a CG configured with auto retranmission or schedule it before end of CG PUSCH. |
| Nokia | No | In RAN2 #108 we have already agreed that:* **UE shall not perform autonomous transmission of the PDU if network has scheduled a retransmission grant for the PDU.**

In our understanding this agreement already cover the raised issue. |
| MediaTek | No |  |
| CATT | No | This looks to us like a corner case gNB should be able to avoid. Addressing this looks to us like an optimization. |
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### *Issue #11: Autonomous transmission when CG’s configuration changes.*

- Company: Qualcomm [19].

- Issue description: If the CG’s configuration (e.g., MCS/TBS) changes (e.g., due to reception of reactivation DCI), the deprioritized grant’s PDU may no longer fit in the new CG PUSCH or may need additional processing.

- Solution: UE autonomous retransmission for the same CG is not performed if the CG’s configuration changes.

*Q11: Should a condition be added/checked to prevent from UE autonomous transmission to occur when the CG configuration has changed between the de-prioritized CG and the new CG resource for autonomous transmission? If Yes, companies are invited to provide their views on how to capture this.*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | Yes | At least specification will have to cover the case when PDU no longer fits new CG PUSCH after reactivation shrinks CG allocation.  |
| Nokia | Yes but… | This sounds reasonable but it may further complicates the specification. |
| MediaTek | Yes | Our view is that like in NR-U, retransmissions are controlled by the *configuredGrantTimer*, which would be reset when the CG configuration changes. |
| CATT | Yes | Clearly, if the TBS of the CG resource changes, the autonomous transmission procedure does not work. However, to be specific, this is not a configuration change (RRC) but rather a type-2 CG allocation update (via DCI). This should be addressed with an additional condition that e.g. the TBS of the CG has not changed since the de-prioritized uplink configuration. |
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### *Issue #12: Can HARQ processes be shared between different CGs?*

- Company: Samsung [22].

- Issue description: The scenario of HARQ process sharing is not suitable for IIOT scenario and raises issues on *ConfiguredGrantTimer*: it operates per HARQ process but it is configured per configured grant by *ConfiguredGrantConfig* in RRC. Those are contradictory and we need to specify something how to resolve it.

- Solution: HARQ processes are not shared between different CGs.

Rapporteur: Even though this issue goes beyond the scope of autonomous transmissions, we suggest discussing it here since it was posted in this AI.

*Q12: Can a HARQ processes be shared between different CGs?*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | no strong views | We have no strong views.It will be good to consider following NR-U agreement also as an option:The multiple configured grants of a BWP can be explicitly configured to share a common pool of HARQ processes.    If HARQ processes are shared the same CG timer value has to be configured.  Sharing will be more complex especially with features like autonomous transmission. |
| Nokia | No |  |
| MediaTek | No | This introduces unnecessary complexity |
| CATT | No | We also had initially in mind that they could not be shared. We are not sure of the benefit. |
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### *Issue #13: Stopping Configured grant timer when HARQ buffer is empty.*

- Company: Huawei [18].

- Issue description: Unnecessary running of *configuredGrantTimer* when the HARQ buffer of the corresponding HARQ process is empty, which may affect URLLC transmission.

- Solution:

Proposal 2: When the HARQ buffer of the identified HARQ process is flushed, the *configuredGrantTimer* for the corresponding HARQ process shall be stopped, if running.

Proposal 3: When a retransmission grant is ignored and the corresponding HARQ buffer is empty, the *configuredGrantTimer* for the corresponding HARQ process shall be stopped, if running.

*Q13: Should the issue of running configuredGrantTimer when the HARQ buffer of the corresponding HARQ process is empty be addressed in Rel-16? If Yes, do you agree with the proposed solutions (otherwise please suggest an alternate way)*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | No | We did not fully understand the rationale for P2. In particular, it is not clear under what circumstances HARQ process is flushed despite corresponding CG timer running.The motivating scenario in [18] for P3 involves gNB mis-detecting a UE transmission which is not going to be common. Hence, we are not convinced that the enhancement in P3 is needed. |
| Nokia | Yes but… | We agree with P2 where the pending MAC PDU could be flushed away when the time it spent the HARQ buffer already exceeds PDB of the data conveyed by the pending MAC PDU (facilitated by the timer we mentioned in Q4), and the CG timer can be stopped. However, P3 seems to contradict with P2. In P2 the CG timer is stopped when the buffer is flushed, then for the case of P3, the CG timer should already be stopped earlier?So capturing Proposal 2 only should be sufficient. |
| MediaTek | No | Agree with Qualcomm. We do not understand the rationale behind the proposal |
| CATT | No | We don’t think this should occur often and view this more like a corner case. |
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### *Issue #14: LCH mapping restrictions mismatch when rescheduling a dropped CG with new transmission DG (as opposed to re-transmission DG).*

- Company: Sequans [23].

- Issue description: In case of rescheduling a dropped CG with new transmission DG (as opposed to re-transmission DG), different LCH mapping restrictions apply.

- Solution:

Proposal 1: When rescheduling a dropped CG with a DG and new PDU is generated, LCH mapping restrictions of the CG shall apply

Proposal 2: The CG from which LCH mapping restrictions are reused is derived from the HARQ process indicated in the DG

Proposal 3: The LCH mapping restrictions inheritance shall be configured by RRC on a CG or LCH basis, and only apply when TBS size of DG matches the CG one.

*Q14: Should the issue of LCH mapping restrictions mismatch when rescheduling a dropped CG with new transmission DG (as opposed to re-transmission DG be addressed in Rel-16? If Yes, do you agree with the proposed solutions (otherwise please suggest an alternate way).*

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| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | No | It is likely that traffic being carried in CGs that experience deprioritization is not URLLC in the first place. So, it is not critical that data of dropped CG is recovered using just one DG (ie, using multiple DGs may be okay). |
| Nokia | No | Whether to issue a new transmission DG for a dropped CG is a gNB implementation issue, and how is the UE going to know if this new DG is specifically for a dropped CG or for arbitrary purposes? If this DG is for re-TX of the pending MAC PDU, then there are no LCP issues as the MAC PDU is already built. |
| MediaTek | No | Given that the dynamic grant is sent by the gNB, we can rely on gNB implementation to provide an appropriate grant. |
| CATT | No | As discussed for issue #6, we don’t see that dynamic re-transmissions will be used in the case of de-prioritized configured grant if the UE supports autonomous transmissions, therefore we see even less the need to address the case where NW delivers a dynamic grant for a new transmission for that purpose instead of a re-transmission grant.  |
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# Conclusion

This contribution summarized the contributions posted in the Agenda Item 6.7.3.1 Handling of deprioritized transmissions, at this e-meeting, and suggested some possible agreements / way forward as follows:

# Reference

1. R2-2000485 Summary on deprioritized transmissions; CATT
2. R2-2002046 RAN2 109-e Methods and Guidance RAN2 chairman, RAN2 vice chairmen, session chairs
3. R2-2001487 MAC Running CR for NR IIOT; Samsung
4. R2-2000783RRC running CR for NR IIoT; Ericsson
5. R2-2000785Remaining minor issues in [108#32][IIoT] Running CR 38.331; Ericsson
6. R2-2000114 Remaining Issues on Autonomous Transmission; CATT
7. R2-2000495 Discussion on the MAC PDU recovery procedure; vivo
8. R2-2000593 Open Issues on TSC Scheduling Enhancement; Apple
9. R2-2000698 Left issues on autonomous transmission; OPPO
10. R2-2000703 Consideration on CG timer for the deprioritized MAC PDU; OPPO
11. R2-2000755 Deprioritized transmissions on configured grants; III
12. R2-2000794 Handling of de-prioritized MAC PDUs; Ericsson
13. R2-2000813 Remaining Issues on Autonomous Transmission of Pending MAC PDUs;Nokia, Nokia Shanghai Bell
14. R2-2000825 HARQ retransmissions for deprioritized PDU with empty HARQ buffer; Sony
15. R2-2000839 Remaining details for autonomous retransmission functionality;Lenovo, Motorola Mobility
16. R2-2000845 On UL intra-UE prioritisation ;MediaTek Inc.
17. R2-2001028 Consideration on the de-prioritized PDU transmission;Lenovo, Motorola Mobility
18. R2-2001033 Remaining issues on Configured Grant; Huawei, HiSilicon
19. R2-2001291 Open issues in autonomous retransmission; Qualcomm Incorporated
20. R2-2001420 Autonomous transmission on different CG configuration; LG Electronics Polska
21. R2-2001477 Remaining Issues for Handling of deprioritized transmission; CMCC
22. R2-2001490 Autonomous Retransmissions of Different CG Configurations and Timeline Restriction; Samsung
23. R2-2001495 Transmission of Deprioritized Data by Retransmission Grant; Samsung
24. R2-2001628 Rescheduling dropped CG when PDU was not generated; Sequans Communications
25. R2-1913641, Views on handling of PDUs and data of deprioritized grants, Qualcomm Incorporated, RAN2#107bis, Chongqing, China, 14 – 18 October 2019