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Elbonia, 24th–28th February2020

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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?*

|  |  |  |
| --- | --- | --- |
| ***Company*** | ***Yes/No*** | ***Comments*** |
| Qualcomm | Yes |  |
| Nokia | Yes |  |
| MediaTek | Yes |  |
| CATT | Yes |  |
| ZTE | Yes |  |
| Huawei, Hisilicon | Yes |  |
| LG | No | In IIoT, as each HARQ process ID periodically is associated with each CG resource, in order to perform UE autonomous transmission, the UE needs to wait for a long time until the next CG resource with the same HARQ process of the same CG configuration comes. In other words, it may lead to unnecessary delay of the de-prioritized MAC PDU.  In IIoT, I think that multiple CG configurations may be configured for single TSN traffic. In other words, these CG configurations have the same MCS/TBS and same LCP restriction.  The approach using the different CG configuration does not require a higher specification effort. This is because the NR-U solution could be reused for the de-prioritized MAC PDU in IIoT.  In order to reduce the unnecessary delay of the de-prioritized MAC PDU, the UE should be allowed to transmit the de-prioritized MAC PDU on the next CG resource with the same HARQ process from not only same CG configuration but also different CG configuration. |
| Samsung | Yes |  |
| SONY | Yes |  |
| Lenovo | Yes |  |
| OPPO | Yes |  |
| Intel | Yes |  |
| Ericsson | Yes |  |
| Docomo | yes |  |
| Sequans | Yes | If we want to solve LG concern, we should allow using different HARQ processes for same CG config instead of different CG config. |
| Sharp | Yes |  |
| Apple | Yes |  |

### *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?*

|  |  |  |
| --- | --- | --- |
| ***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 |  |
| ZTE | Yes |  |
| Huawei, Hisilicon | Yes |  |
| LG | Yes |  |
| Samsung | Yes | Agree with Nokia |
| SONY | Yes |  |
| Lenovo | Yes |  |
| OPPO | Yes | Agree with Nokia |
| Intel | Yes |  |
| Ericsson | Yes |  |
| Docomo | yes | Agree with Nokia |
| Sequans | Yes | Agree with Nokia |
| Sharp | Yes |  |
| Apple | Yes |  |

### *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?*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***Company*** | | ***Yes/No*** | | ***Comments*** | |
| Qualcomm | | Yes | |  | |
| Nokia | | Yes | |  | |
| MediaTek | | Yes | |  | |
| CATT | | Yes | | Similar to HARQ re-transmissions, we need a limit. Beyond the limit the MAC PDU is discarded. | |
| ZTE | | No | | In our understanding, the auto-retransmission is introduced for avoiding the loss of MAC PDU while this timer or counter is introduced for dropping the PDU automatically, the benefit for this timer seems opposed to our basic intention from auto-retransmission. Meanwhile , if MAC PDU is dropped , which means the RLC retransmission will be involved, the benefit from introducing such timer seems not sufficient.  In addition, If NW always schedule a dynamic transmission to override a number of consecutive configured grants with the same HARQ process ID, NW can be aware of to schedule a retransmission for this pending PDU anyway. | |
| Huawei, Hisilicon | No | | Basically we think this is like a corner case that a de-prioritized PDU would be deprioritized several times. If there is really such a case, mostly likely it is a best-effort service which does not require stringent latency requirement. | |
| LG | | Yes, but | | It is up to gNB implementation. | |
| Samsung | | No | | The case that a MAC PDU is deprioritized several consecutive times should not happen frequently. If this case happen frequently so we need the limit, packet error rate will be increased and it give an impact to KPI on reliability. We think NW should control this case by providing retransmission resource. We prefer not to specify the number, leave all control up to NW implementation. | |
| SONY | | No | | Agree with Huawei that this is a corner case. | |
| Lenovo | | No | | Same view as Samsung, Huawei | |
| OPPO | | No | | We think it is a corner case. | |
| Intel | | No | | We also think this is a corner case. | |
| Ericsson | | No | | We agree with Huawei that this is a corner case. | |
| Docomo | | Yes | | Put a limit on the number of consecutive deprioritizing is preferred. | |
| Sequans | | No | | Same view as Huawei and Samsung | |
| Sharp | | Yes | |  | |
| Apple | | No | | This is a very corner case, but consecutive deprioritization for long time should be avoided. We prefer to leave it up to NW implementation. | |

*Q4: If the answer to Q3 is Yes, would you support introducing a timer or a counter for addressing this limitation?*

|  |  |  |
| --- | --- | --- |
| ***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. |
| ZTE |  | If the retransmission times shall be limited, we slightly prefer using timer to control it.Considering the transmission in IIOT may have delay requirements, there is no need for UE to send a MAC PDU which is over due. Timer can provide more precise control to it. |
| LG | No | Nothing needs to be changed in running MAC CR. The UE performs the autonomous transmission until the UE receives the dynamic grant with same HARQ process.  Even if de-prioritized MAC PDU is to be stuck in a HARQ buffer for too long, it does not affect the next higher priority traffic. This is because the UE is allowed to transmit the prioritized MAC PDU on the CG when the CG is prioritized.  Besides, for the same HARQ PID associated with the de-prioritized MAC PDU, if the gNB schedules a dynamic grant for a new transmission, the UE no longer performs autonomous transmission. |
| Samsung | Yes | If we have to introduce a limit, counter sounds natural. We agree with Qualcomm. |
| SONY |  | If something is to be specified, a counter is reasonable. |
| OPPO |  | If we need to specify something, a timer way can be used for this limitation. For example, configruedGrantTimer can be reused. The deprioritized PDU can be autonomously transmitted when configruedGrantTimer is running. |
| Docomo | Yes | Either a counter or a timer is fine. Introducing a counter is a bit more reasonable. |
| Sharp | Yes | We think a counter is better. |
| Apple | Yes | If we have to specify something, counter is better than timer. |

* 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?*

|  |  |  |
| --- | --- | --- |
| ***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. |
| ZTE | b |  |
| Huawei, Hisilicon | a | In the current CR, it is configured per MAC entity. We don’t see a big need to configure it per CG configuration. If the network doesn’t want to apply autonomous retransmission to some CG configuration, it can just schedule DG for retransmission for them. |
| LG | a | From the ignaling overhead point of view, per MAC entity configuration is better than per CG configuration. |
| Samsung | b | No strong opinion. We can accept a. |
| SONY | b |  |
| Lenovo | a |  |
| OPPO | b | No strong opinion on this issue, both options can work well. |
| Intel | b | As whether to configure autonomous retransmission is related to QoS, we prefer that it is configurable per CG. |
| Ericsson | b |  |
| docomo | b |  |
| Sequans | b/other | It can be configured per CG configuration or per LCH (same view as Nokia) |
| Sharp | b | Per CG configuration is more flexible. |
| Apple | b | Per CG configuration offers finer granularity and higher flexibility |

### *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?*

|  |  |  |
| --- | --- | --- |
| ***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*; and  3> if this uplink grant is a configured grant which is a prioritized uplink grant; and  3> if ~~the~~ a previous configured uplink grant for this HARQ process was de-prioritized; and  3> if a MAC PDU had already been obtained for ~~this HARQ process~~ the de-prioritized configured uplink grant; and  3> if a transmission of the obtained MAC PDU has not been performed:  4> consider the MAC PDU has been obtained. |
| ZTE | 1 | We think the auto-retransmission of MAC PDU is a special kind LCP , there is no need to specify the processing time in MAC specification. |
| Huawei, Hisilicon | 1 | Don’t see a need to specify anything in MAC. If something should be specified, it should be done in RAN1 as RAN1 may better understand the processing time limitation. |
| LG | Option1 | Nothing needs to be changed in running MAC CR. Legacy PUSCH preparation time, such as N2 can be used for the UE processing time for autonomous transmission. Legacy overlapping between CG and DG will require the UE processing time. This can be used for autonomous transmission as well. |
| Samsung | 1 | We should not mandate a processing restriction to a certain UE implementation. If the UE does not have the sufficient processing time for this autonomous transmission, then the UE cannot perform it. But we think we do not need to specify it in the spec. MAC specification has not had such timeline requirement so far.  Different UE implementation could have slightly different timeline. But we think the timeline of UE implementation will be similar with each other and it does not affect the URLLC performance severely. |
| SONY | 1 | Nothing to be specified. |
| Lenovo | 2 | In principle we think that we can leave it to UE implementation. However problem with the current MAC CR is that one criteria for triggering an autonomous retransmission is to check whether the immediately previously CG was deprioritized  3> if the previous configured uplink grant for this HARQ process was de-prioritized;  Therefore for cases when UE implementation is not able – due to processing timing issues - to perform an autonomous retransmission on the immediate next CG PUSCH following a deprioritized CG , UE is not allowed to trigger an autonomous retransmission on the a subsequent CG PUSCH according to MAC specification, since the criteria is not fulfilled here. So essentially current MAC CR doesn’t allow UE implementations to consider its processing timing limitations. Simple fix would be:  3> if the previous configured uplink grant for this HARQ process for which the last transmission attempt of the MAC PDU was made was de-prioritized; and |
| OPPO | 1 | For this issue, we think a proper UE implementation is sufficient and there is no need to specify anything more.  In addition, as we described in our paper[9], for the agreement in the following:   * UE shall not perform autonomous transmission of the PDU if network has scheduled a retransmission grant for the PDU. FFS whether we specify some time restriction.   We prefer to specify something, to avoid double transmission of the deprioritized MAC PDU and UE complexity on how to handle two uplink grants for the deprioritized MAC PDU. The potential solutions can be:  - Either specify the time restriction by which either the CG or DG can be used.  - Or specify UE behaviour on DCI rescheduling reception, i.e. DG is prioritized no matter DCI is received before CG assembly/transmission or not. |
| Intel | 1 | We prefer to leave it to UE implementation. |
| Ericsson | 1 | A proper network would configure the parameters (e.g., *nrofHARQ-Processes, harq-procID-offset*, and *configuredGrantTimer*) to avoid having consecutive CG occasion with a very tight processing time (e.g., smaller than T\_Proc,2) for UE. |
| docomo | 1 | Leave the timeline restriction to UE implementation |
| Sequans | 1 |  |
| Sharp | 1 | Agree with Nokia that a proper UE-implementation can handle it. |
| Apple | 3 | The timer can used to avoid the waste of retransmission resource which is explicitly scheduled by NW.  If the retransmission can be performed by both NW scheduling and UE autonomous retransmission, NW can configure the timer for the period of potential the retransmission scheduling, and UE is allowed to perform the autonomous retransmission after this period.  We are also fine to leave it up to UE implementation. |

### *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?*

|  |  |  |
| --- | --- | --- |
| ***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. |
| ZTE | No | If it can be agreed, I have no idea why we introduce the auto-retranmission mechanism, it is obvious that the auto-retransmission is less perfect than the proposed mechanism. |
| Huawei, Hisilicon | No | Agree with CATT |
| LG | No | Nothing needs to be changed. We have a similar view as CATT. gNB can rely on autonomous transmission. |
| Samsung | Yes | We agree with Qualcomm’s observation: “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.”  If it is not allowed, NW implementation should only rely on the autonomous retransmission for the recovery of the data due to the inefficiency of retransmission data when the buffer is empty. |
| SONY | Yes | If the UE does not support autonomous retransmission feature and this issue is not fixed, the number of wasted retransmission grants (for example 4) would be multiplied by the number of CG resources at the gNB, hence resulting a lot of wasted resources as well as increased latency for IIOT traffic. |
| Lenovo | Yes | Agree with the reasoning given by Samsung |
| OPPO | Yes | According to legacy specification, when DG is addressed to CS-RNTI and the associated HARQ buffer is empty, the grant will be ignored, which will cause resource wastage and extra delay for URLLC data, considering the following cases:   * The data is available for the deprioritized grant but the deprioritized MAC PDU can not be generated due to collision. * The data is available after grant selection.   Thus, we prefer to consider some exception conditions for the UE to avoid ignoring the received UL grant for retransmission. |
| Intel | No |  |
| Ericsson | No | Agree with CATT and Nokia above. In addition, this change of behaviour would cause problem in soft-combining at the gNB. If UE transmits new data in the retransmission grant, gNB is not aware of that and might consider this as a retransmission and, hence, soft-combines the buffer from the previous transmission (which is noise but identified as the attempted transmission) and the new transmission. This will highly likely result in an unsuccessful decoding. |
| Docomo | No | Agree with CATT. |
| Sequans | Yes but | Agree with QC.  However, if agreed, a new PDU would be generated on retransmission grant of the CG. For correct PDU generation, LCH mapping restrictions of the CG shall apply in that case (issue #14). Otherwise, the generated PDU may not at all be the expected one and the proposed solution does not work. So, we agree only if the LCH mapping restrictions of the CG apply in that case. |
| Sharp | Yes | Autonomous retransmission is optional but gNB scheduled retransmission is mandatory. If autonomous retransmission is not configured, gNB should always schedule a retransmission for a deprioritized CG to avoid data loss. But gNB does not know whether a PDU for deprioritized CG was generated or not. Allow UE to use the retransmission grant for a new transmission when the associated HARQ ID buffer is empty can avoid waste of radio resource and may also avoid data transmission delay caused by collision on the next transmission occasion. |
| Apple | Yes | If no PDU generated before due to the deprioritization mechanism, we donot see any problem to use it for the new PDU transmission. |

### *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)?*

|  |  |  |
| --- | --- | --- |
| ***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. |
| 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. |
| ZTE | No | Share the same view with Qualcomm |
| Huawei, Hisilicon | Yes/No | We may need to clarify the behavior in the following text:  5> start or restart the configuredGrantTimer, if configured, for the corresponding HARQ process when the transmission is performed.  It is not crystal clear what “the transmission is performed” means. When the MAC PDU is delivered to L1 but it is fully deprioritized, do we consider the transmission is performed from MAC perspective and then the configured grant timer should be started/restarted? |
| LG | No |  |
| Samsung | No | Agree with Qualcomm |
| SONY | No | Agree with Qualcomm. |
| Lenovo | No |  |
| OPPO | Yes | If the CG timer for the HARQ process associated to deprioritized MAC PDU is running, the latency of the deprioritized MAC PDU transmission will not be alleviated since the PUSCH resource is blocked by configuredGrantTimer. The result is against to the purpose of introducing UE-based autonomous transmission. Thus, to support UE autonomous transmission, we propose to modify the condition of CG timer start if the deprioritized MAC PDU is in the identified HARQ process.  Additionally, we agree with Huawei, at least we need to clarify UE behavior for the text of “start or restart the configuredGrantTimer, if configured, for the corresponding HARQ process when the transmission is performed”. |
| Intel | No |  |
| Ericsson | No | Agree with Qualcomm |
| Docomo | No | Agree with Qualcomm. |
| Sequans | Yes/No | If this issue needs to be solved, we would prefer to add stopping the timer upon deprioritization to avoid changing legacy behavior. |
| Sharp | Yes/No | We think if autonomous retransmission is configured, gNB will rely on it other than schedule a UL grant for retransmission. But *configuredGrantTimer* keeps onrunningwill delay the transmission of the MAC PDU. It is not proper to start /restart CG timer (which specified in MAC) in the first symbol after the end of the corresponding PUSCH transmission (which specified in PHY).  Agree with Sequans that the solution of stopping the CG timer for the deprioritized CG is more reasonable. |
| Apple | No | Agree with Qualcomm. |

### *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?*

|  |  |  |
| --- | --- | --- |
| ***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. |
| Huawei, Hisilicon | No | The gNB may select to schedule to leave the UE to autonomous retransmit even some DMRS has been received. |
| LG | No | This needs to be discussed in RAN1(e.g., DM-RS symbol) |
| Samsung | No | We think configuration *autonomousReTx* is sufficient. |
| SONY | No | It is just optimizations. |
| Lenovo | No |  |
| OPPO | No | In principle we agree with the intention, but not sure the solution. |
| Intel | No |  |
| Ericsson | No |  |
| Docomo | No |  |
| Sequans | No |  |
| Sharp | No | Agree with Qualcomm. |
| Apple | No |  |

### *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?*

|  |  |  |
| --- | --- | --- |
| ***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. |
| ZTE | No | It seems no reasonable for NW to dynamically schedule this retransmission. |
| Huawei, Hisilicon | No | Not sure there is an issue, because the configured grant timer should be started when the PDCCH is received, so that anyway the subsequent configured grant will not be used for autonomous retransmission. |
| LG | No | It is up to gNB implementation. This case can be avoided. |
| Samsung | No |  |
| SONY | No |  |
| Lenovo | No |  |
| OPPO | No | Agree with Nokia. |
| Intel | No |  |
| Ericsson | No |  |
| Docomo | No |  |
| Sequans | No |  |
| Sharp | No | Agree with Huawei that this may not happen for that the CG is not a valid UL grant because the CG timer is running. |
| Apple | No |  |

### *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.*

|  |  |  |
| --- | --- | --- |
| ***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. |
| ZTE | Yes |  |
| Huawei, Hisilicon | Yes/No | Agree with the intention, but not sure about the solution. To be simple, we may not need to consider the CG configuration to be the same one if the configuration has been reconfigured for type-1 or reactivated for type-2. A clarification is useful. |
| LG | Yes | Regarding QC’s comment, we have some sympathy. The simplest and easiest way not to perform the autonomous transmission is to flush the HARQ buffers of all UL HARQ processes upon reactivation. |
| Samsung | Yes | Agree with Huawei. After the initiation of CG, UE should not perform the autonomous transmission of the previous deprioritized configured grant. |
| SONY | Yes |  |
| Lenovo | Yes |  |
| OPPO | No | A proper gNB implementation can avoid this issue because gNB is aware of potential grant collision. |
| Intel | No | We agree with the intention but do not think additional condition should be added. |
| Ericsson | Yes | We agree with the intention, but further discussion how to implement in the spec is needed. |
| docomo | Yes | Agee with Qualcomm’s view, but concern about the solution. |
| Sequans | Yes |  |
| Sharp |  | Agree with Huawei. |
| Apple | Yes | Some clarification maybe needed. |

### *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?*

|  |  |  |
| --- | --- | --- |
| ***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. |
| ZTE | No | RAN1 have already confirmed that. |
| Huawei, Hisilicon | No | Fine with the proposal to avoid complexity. |
| LG | Yes | We think that either shared or separate HARQ processes among CGs should be allowed. This is because only allowing separate HARQ process reduces scheduling flexibility. |
| Samsung | No | This introduces unnecessary complexity especially on autonomous transmission and configuredGrantTimer handling |
| SONY | No |  |
| Lenovo | No |  |
| OPPO | No | We are not sure the benefit. |
| Intel | No | We prefer that HARQ processes are not shared between different CGs. But we also note that current RRC spec does not preclude such configurations, even with the introduction of *harq-procID-offset*. |
| Ericsson | No |  |
| docomo | No |  |
| Sequans | No |  |
| Sharp | No |  |
| Apple | No |  |

### *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)*

|  |  |  |
| --- | --- | --- |
| ***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. |
| ZTE | Yes, but | We can understand the basic intention from P3 and P2 is to save a configured grant to start a new transmission. But I think it can be included another issue in data- data collision. |
| Huawei, Hisilicon | Yes | It may not be crystal clear about the issue in our paper.  For P2, the DG new transmission may be scheduled on a HARQ process which is shared with a CG when the configured grant timer is running. In case there is no data for the new transmission, the HARQ buffer would be flushed, but the timer is not stopped, which would disallow further using the CG unnecessarily.  For P3, the DG may be scheduled for retransmission of the CG and the timer is started when the PDCCH is received, but there is no data available in the HARQ buffer (the CG new transmission was not performed). In this case, the grant is ignored but the timer is still running unnecessarily. |
| LG | No |  |
| Samsung | No | Our understanding is that P2 is for the initial transmission and P3 is for the retransmission resource.  We do not agree with P2. The HARQ buffer is flushed only if MAC PDU has not been obtained. But configuredGrantTimer is started only if MAC PDU has been obtained. So the scenario of P2 does not occur.  We do not agree that P3. This case exists from Rel-15 that UE receives the UL grant addressed to CS-RNTI with NDI=1. Then, configuredGrantTimer is started and if the buffer is empty, UE ignores the uplink grant. In this case, gNB does not allocate an additional resource with the same HARQ process. Thus, configuredGrantTimer does not need to be stopped. |
| SONY | No | Agree with Qualcomm. |
| Lenovo | No | We don’t understand the use case for P2 |
| OPPO | No | We do not understand the rationale behind the proposal. If the MAC PDU is delivered and transmitted, the CG timer will be running, otherwise the CG timer will not be running. In addition, regarding the issue of CG timer running for the deprioritized CG, more details can refer to our paper [10]. |
| Intel | No |  |
| Ericsson | No | The timer is configured at the network, also considering the network processing time to decode the UL transmission and prepration time for a retransmission UL grant. The timer should be running, even if the buffer is empty since network needs time to process. In other words, there is no practical gain in stopping the timer. |
| docomo | No | Corner case for HARQ process is flushed despite corresponding CG timer running |
| Sharp | Yes | Agree with Huawei. |
| Apple | No | Agree with Samsung. |

### *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).*

|  |  |  |
| --- | --- | --- |
| ***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. |
| ZTE | No | We do not hope to complicate the current auto-retransmission mechanism. |
| Huawei, Hisilicon | No | We think the good network implementation can somehow avoid the issue. |
| LG | No |  |
| Samsung | No | Agree with MediaTek |
| SONY | No | Rely on gNB to provide an appropriate grant. |
| Lenovo | No |  |
| OPPO | No | Reply on gNB implementation. |
| Intel | No | Our understanding is that if a new transmission DG is used, the original MAC PDU of the deprioritized CG cannot be transmitted according to current MAC spec. gNB has to use a retransmission DG for the deprioritized CG, or rely on autonomous retransmission in CG. |
| Ericsson | No |  |
| Docomo | No | gNB implementation could solve this issue. |
| Sequans | Yes | It seems some companies misunderstood.  1) This applies when autonomous retransmission is not used. E.g. for TSN traffic.  2) This applies when the PDU was not already generated.  3) This is needed if Issue#6 solution is agreed, in order to generate the new PDU according to LCP restrictions that would have applied on the original deprioritized CG. Otherwise PDU generated it different and Issue #6 proposal does not work.  4) This can also apply even without Issue#6 solution  Regarding Nokia: “how is the UE going to know if this new DG is specifically for a dropped CG or for arbitrary purposes?”  - That can be known easily if Issue#6 solution is adopted  - Otherwise, a proposal is to say that a DG with same HARQ process and TBS as the previous dropped CG is for “retransmission” of such CG, and corresponding LCH restrictions shall apply. |
| Sharp | No |  |
| Apple | No | It can be up to NW implementation. |

# 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