3GPP TSG RAN WG1 #106b-e R1-210xxxx

e-Meeting, October 11th – 19th, 2021

Source: Moderator (ZTE)

Title: Summary of AI 8.4.3 for HARQ for NTN

Agenda Item: 8.4.3

**Document for: Discussion and Decision**

# **Introduction**

In previous meeting, progress on HARQ related issues have been achieved. In this meeting, companies’ views to refine the details and on other remaining issues are summarized with corresponding observations/proposals on following aspects with detailed proposals from each company listed in Appendix.

* Enhanced HARQ process ID indication
* HARQ codebook enhancements
* SPS PDSCH
* PDSCH scheduling restriction
* Performance enhancement
* Restriction on HARQ feedback disabling
* PUSCH scheduling restriction
* RRC parameters

# **Issue-1 Enhanced HARQ process ID indication**

In previous meeting, following agreements have been achieved:

Agreement:

For enhancement on the HARQ process indication, extend the HARQ process ID field up to 5 bits for DCI 0-1/1-1 when the maximum supported HARQ processes number is configured as 32.

Agreement:

For enhancement on the HARQ process indication, one of following options for DCI 0-0/1-0 can be considered:

* Option 2: Reusing one bit from other bit field
* Option 4: No enhancement

Then, in this meeting, regarding the enhancement on remaining DCI format, i.e., DCI 0-0/1-0, **following views are summarized as**:

* DCI 0-0/1-0
	+ Option 2: Huawei, CAICT, ZTE, Apple
	+ Option 4: Spreadtrum, vivo, OPPO, Nokia, MTK, CATT, CMCC, NEC, Xiaomi, Samsung, DCM, Baicells, APT, Panasonic, Ericsson, LG
	+ Others: ITL,QC (extend the HARQ process ID field up to 5bits by higher layer signaling)

According to the shared views from companies, the main controversial part is the necessity to enhance the DCI 0-0/1-0 for larger HARQ process indication with following arguments:

1. Enhancement is needed:
	1. In NTN case, with consideration on the channel condition, the fallback DCIs are sufficient for scheduling. Then, it’s preferred to enhance the corresponding indication. Otherwise, the flexibility will be limited.
	2. From UE’s perspective, it’s preferred to keep the static HARQ processes configuration and 32 HARQ process number should also be supported by fallback DCIs.
	3. NTN and terrestrial network will have mutually exclusive bands, there is no confusion about the fallback DCI, even if they are different in TN and NTN, to be used during initial access.
2. Enhancement is not needed:
	1. Fallback DCI is used in limited case, and prefer to use the DCI 0-1/1-1 for scheduling after initial access
	2. Keep the HARQ process ID field unchanged will avoid additional UE complexity

Also, in general, as highlighted by [CATT, MTK, Xiaomi], supports on the larger HARQ process is up to UE’s capability or based on the UE assistance information report [Samsung].

Then, from FL’s perspective, it’s recommended to define the solution to enable the flexible scheduling and unified UE behaviour. For DCI 0-0/1-0, since the views from companies are still not converged, it’s preferred for companies to share their views with justification:

|  |  |
| --- | --- |
| **Methods** | **Preference** |
| **Company** | **Justification** |
| Option-2 | ZTE | Enhancement on Fallback DCI can boost the benefits for scheduling and other benefits as shown above.  |
| Option-4 | Samsung |  |
|  CATT | Fallback DCI is usually used for initial access, mainly to ensure reliability, not for high throughput and flexibility. Therefore, in NTN case, 16 processes are sufficient for fallback DCI 0\_0/1\_0. |
| Nokia, Nokia Shanghai Bell | Fallback DCI is mainly used during RRC reconfiguration, where the gNB would be knowing that fallback DCI would be used for a short period of time. Hence, the gNB scheduler could take this into account and the HARQ processes with higher process ID would anyway be possible to schedule after completion of reconfiguration procedure. |
| Panasonic |  |
| CMCC |  |
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| **Methods** | **Strong concern** |
| **Company** | **Justification** |
| Option-2 | Samsung | Unnecessary support/specifications, unnecessary UE impact |
| Nokia, Nokia Shanghai Bell | This is not a strong concern, but if Option-2 is agreed, this would need to be part of the general feature of supporting NTN (no option for UE to have this as a feature, as it would also be needed during initial access – thereby implying that 32 processes would also be needed as part of baseline capability) |
| Panasonic | - Potential ambiguity on re-interpreted field - Need more standardization effort and spec impact on which field to be used |
|  |  |
| Option-4 |  |  |
| Others | QC | We support to extend the filed to 5 bits to enable frequent use of fallback DCIs instead of DCI formats 0\_1/1\_1 |

# **Issue-2 HARQ codebook enhancements**

In the previous meeting, following agreements have been achieved:

Agreement:

* For Type-1 HARQ codebook, if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, one of following options should be supported:
	+ Option-1: The UE will report NACK only for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH
	+ Option-2: The UE will report NACK/ACK for the feedback-disabled HARQ process depending on the decoding results of corresponding PDSCH
* FFS: Other cases, e.g., if only DCI carrying feedback-disabled HARQ process is detected by UE

Agreement:

For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, one of following options should be supported:

* Option-1: The UE’s behavior is same as the case if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE
* Option-2: The UE should skip the codebook feedback at least when the feedback is carried by PUCCH
	+ FFS: the case that feedback is carried by PUSCH.

Agreement:

For the DCI of PDSCH with feedback-disabled HARQ processes, only one of following is supported for Type-2 codebook:

* Option-1: The C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented, and are taken into account by the UE for type 2 codebook generation.
* Option-2: The C-DAI and T-DAI are ignored by the UE regardless of the value for Type 2 codebook generation.

Then, in this meeting, **views are summarized for each codebook Type as**:

# **Enhancement on Type-1 Codebook (Semi-static codebook):**

For this topic, discussion on following two cases are conducted based on the previous agreement:

* Case-1: if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE
	+ Option-1: The UE will report NACK only for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH
		- Supported by [Huawei, NEC, Xiaomi, Samsung, DCM, APT, ZTE, Apple]

Regarding this option, as highlighted by proponent, there are benefits to relax to decoding timeline at UE side and relax the scheduling at gNB. However, Option 2 is more complicated option rather easier one from perspectives of gNB scheduler and UE soft-buffer management due to processing time constraints.

Moreover, with inserting NACK at the position of feedback-disabled HARQ process, at least the pre-known NACKs, the decoder performance of Reed-Mueller code and polar code at gNB side can also be improved.

* + Option-2: The UE will report NACK/ACK for the feedback-disabled HARQ process depending on the decoding results of corresponding PDSCH
		- Supported by [Spreadtrum, OPPO, Nokia, CATT, CMCC, CAICT, Baicell, vivo, Panasonic]

Regarding this option, as highlighted by proponent, the main benefit is to enable the gNB to predict the channel state (e.g., chose the proper CQI) even it will be received at gNB with delay.

* Case-2: if only DCI carrying feedback-disabled HARQ process is detected by UE
	+ Option-1: The UE’s behavior is same as the case if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE
		- Supported by [Huawei, Xiaomi, APT, Apple, Spreadtrum, OPPO, Nokia, CATT]

Regarding this option, as highlighted by proponent, the case where all the scheduled HARQ processes are disabled is a corner case as there is a large possibility that the HARQ codebook contains the feedback for TAC and as long as one feedback-enabled HARQ process is scheduled, the gNB has to reserve feedback resources anyway.

* + Option-2: The UE should skip the codebook feedback at least when the feedback is carried by PUCCH
		- Supported by [vivo, Nokia, CMCC, CAICT,NEC, Samsung, DCM, Baicell, ZTE, Ericsson, ITL]

Regarding this option, as highlighted by proponent, there is clear benefits for UE battery consumption once the PUCCH carrying HARQ-ACK feedback can be reduced. Moreover, applicability of this Option to the case that feedback is carried by PUSCH is also preferred since no consensus and further discussion are assumed in the related for Rel-15/16 CR. But as also highlighted by company that this can be applicable to the case that the UCI consists of HARQ-ACK only.

Moreover, other solutions, e.g., new design on the semi-static HARQ codebook for the limit of PDSCH transmissions less than candidate occasions for HARQ processes with feedback enabled, with the aim of reducing the codebook size, is also proposed by the proponent.

Then, from FL’s perspective, since this topic has been discussed in several meetings, the down-selection is recommended and with benefits justified above for both cases, following proposals are made:

**[Initial Proposal 2-1]:** For Type-1 HARQ codebook, if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, the UE will report NACK only for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH.

Please provide your views below：

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| --- | --- |
| **Company** | **Comments and Views** |
| OPPO | We think the benefit of proposal 2-1 is not justified. With option 2, at least two benefits can be obtained over option 1, i.e.Benefit 1: less spec impact. Benefit 2: the consumed HARQ-ACK bit can provide network with correct decoding information. While option 1 has the following two drawbacksDrawback 1: it has higher spec impact than option 2.Drawback 2: with the added spec impact, there is no real useful information for the network, despite of the consumed HARQ-ACK bits.  |
| Samsung | Support. Needed in order to improve HARQ buffer management and maintain same UE behaviour as with Type-2 CB (and possibly Type-3 CB).Also, if the UE would report ACK/NACK, there is no need to support a joint configuration of HARQ-ACK disabling and Type-1 CB – i.e. HARQ-ACK disabling does not need to be supported in case of Type-1 CB. |
| CATT | Don’t support Initial Proposal 2-1.We still prefer Option-2. The network can adjust the transmission parameters according to decoding result. |
| ZTE | Support. The Option-1 is more aligned with the intention for HARQ feedback disabling. |
| QC | Support |
| Nokia, Nokia Shanghai Bell | We do not agree to this proposal. The UE will have to calculate the CRC prior to delivering the packet to higher layers. The information is available, the information bits are available for carrying the feedback is available, so why not provide the information to the gNB (the gNB may still be able to utilize the information for outer loop link adaptation). |
| Panasonic | Not supportive for proposal 2-1 (i.e. option 1). Option 2 allows gNB to obtain statistics on the actual error rate. This would be helpful to adjust link adaptation because quite low BLER need to be achieved for HARQ-feedback disabled processes.  |
| CMCC | Not supportive.We still prefer Option-2 for no spec impact and it can provide more feedback information by free.Furthermore, if Option-2 is supported and if an actual NACK feedback is received for the feedback-disabled HARQ process, the gNB may not need to wait to RLC ARQ feedback, but to quickly reschedule a new transmission carrying the old TB by network implementation. Thus, although the soft combination gain is lost, the retransmission delay may be significantly reduced if reliable transmission is still required. |
|  |  |

**[Initial Proposal 2-2]:** For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, the UE should skip the codebook feedback at least when the feedback is carried by PUCCH

* FFS: the case that feedback is carried by PUSCH.

Please provide your views below：

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| OPPO | We wonder the necessity of this feature. But if majority wants to support this feature, we can accept.  |
| Samsung | Support. May also be a conclusion.It is Rel-16 UE behaviour that if a UE has no HARQ-ACK to report, the UE does not transmit PUCCH. |
| CATT | Don’t support Initial Proposal 2-2.This would lead to inconsistent understanding of the codebook size between gNB and the UE on codebook size when only one DCI carrying feedback-enabled HARQ process is missed |
| ZTE | We are support to take it since benefits to reduce the power consumption at UE is forseen. |
| QC | Not sure about the need of the agreement. It would be more useful to clarify the case where the feedback is carried by PUSCH. |
| Nokia, Nokia Shanghai Bell | This could potentially be agreed if this is isolated to cases where the only UCI that is transmitted by the UE is the HARQ-ACK feedback. There may be error cases of a UE not correctly decoding a DCI for a HARQ process with feedback enabled (only one expected feedback in the codebook), that would be troublesome, but that would be detectable at the gNB side, and the gNB would perform scheduling of retransmissions for that specific case. |
| Panasonic | Not supportive for proposal 2-2. We prefer the same behavior regardless of received DCI contents. Furthermore, because resources are anyway reserved, reporting HARQ-ACK codebook would be preferable. Benefit of power consumption from skipping the PUCCH for this particular case is not clear.  |
| CMCC | We support the proposal. If only DCI carrying feedback-disabled HARQ process is detected by UE, the UE may generate the legacy codebook but eventually drop it.If unsuccessful detection of DCI carrying feedback-enable HARQ process doesn’t occur, no ambiguity occurs since neither gNB nor UE expects for the report. In this case, both PUCCH resource overhead for carrying HARQ-ACK feedback as configured by the gNB and UE battery consumption for sending PUCCH can be reduced.Otherwise, if unsuccessful detection of DCI carrying feedback-enable HARQ process occurs, ambiguity due to missing detection of DCI for a PDSCH with a feedback-enabled HARQ processes occurs, i.e., gNB expected a HARQ-ACK feedback but UE missed it. But luckily the above ambiguity may be not an issue, since gNB knows to retransmit PDSCH with feedback-enabled HARQ processes, even if it receives no HARQ feedback. In this case, UE battery consumption for sending PUCCH carrying HARQ-ACK feedback can be reduced. |

# **Enhancement on Type-2 Codebook:**

For the Type-2 Codebook (Dynamic codebook), based on the previous agreement, w.r.t the C-DAI and T-DAI counting of the PDSCH with feedback disabled HARQ process, following options are listed:

* Option-1: The C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented, and are taken into account by the UE for type 2 codebook generation.
	+ Supported by [Huawei, Spreadtrum, OPPO, Nokia, CMCC, Xiaomi, DCM, Baicell, Sony, Panasonic, Ericsson, Apple, LG,QC]

Regarding this option, as highlighted by companies that this option can mitigate the impacts of DCI missing detection. W.r.t the detailed spec impact, for the DCIs of PDSCH with feedback-disabled HARQ processes, the values of the C-DAI and T-DAI are the same of the C-DAI and T-DAI of the most recent DCI of a PDSCH with a feedback-enabled HARQ process. And following UE’s behavior should also be specified as:

The UE should use the DAI in DCI of feedback-disabled HARQ process to detect if a previous DCI of feedback-enabled HARQ processes has been missed. In such case, the UE should chose the HARQ codebook size based on the DAI in DCI of the feedback-disabled HARQ process, and the feedback-enabled HARQ process detected to be missed should be NACKed.

* Option-2: The C-DAI and T-DAI are ignored by the UE regardless of the value for Type 2 codebook generation.
	+ Supported by [CAICT, NEC, Samsung, APT,ZTE]

Regarding this option, as highlighted by companies that in Option-1, additional specification impacts would be introduced. And w.r.t the potential improvement on the missing detection, since only HARQ-ACK of PDSCH with feedback-enabled HARQ processes is included in Type-2 HARQ codebook, the robustness of HARQ-ACK codebook size determination with the C-DAI and T-DAI in DCI for feedback-enabled processes is the same as in a territorial network. The further enhancement with more efforts is not necessary.

Moreover, as highlighted by company, the case that all DCI of PDSCH are associated with feedback-disabled HARQ process should be considered.

Based on the inputs above, although the views are still not converged, it seems that at least all required details for Option-1 is clear. Then, from moderator perspective, it’s preferred to further check the views from companies with consideration on all details for each option in following proposals:

**[Initial Proposal 2-3]**

For the DCI of PDSCH with feedback-disabled HARQ processes, only one of following is supported for Type-2 codebook:

* Option-1: The C-DAI and T-DAI are the same of the C-DAI and T-DAI of the most recent DCI of PDSCH with feedback-enabled processes, despite they are not incremented.
	+ For the codebook generation, the UE should use the DAI in DCI of feedback-disabled HARQ process to detect if a previous DCI of feedback-enabled HARQ processes has been missed. If so, the UE should chose the HARQ codebook size based on the DAI in DCI of the feedback-disabled HARQ process, and the feedback-enabled HARQ process detected to be missed should be NACK.
	+ FFS: the case that all DCIs of PDSCH are associated with feedback-disabled HARQ process
* Option-2: The C-DAI and T-DAI are ignored by the UE regardless of the value for Type 2 codebook generation.

Please provide your views below.

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| --- | --- |
| **Methods** | **Preference** |
| **Company** | **Justification** |
| Option-1 | OPPO | The indication bit is already in the DCI, it would be reasonable to use this bit instead of making it useless. |
| CATT | Reusing the DAI field can improve reliability. |
| Nokia, Nokia Shanghai Bell | On the FFS for this option, we may potentially follow whichever agreement is reached for Type 1 HARQ codebook (potentially dropping PUCCH transmission in case it will only carry HARQ-ACK feedback). |
| QC | The option improves the reliability with no additional impact on gNB other than repeating the DAI counter. |
| Panasonic  | Because DAI bits are available, to utilize the information would be preferable to have a robustness to DCI mis-detection cases.  |
| CMCC | Reusing the DAI field can improve robustness to the last DCI for a PDSCH with a feedback-enabled HARQ processes missing issue. |
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| Option-2 | Samsung | DCI for HARQ disabled TBs can have a smaller size. |
| ZTE | Simplified UE’s behaviour for HARQ codebook generation with same robustness as TN regarding to the DCI mis-detection. |
| **Methods** | **Strong concern** |
| **Company** | **Justification** |
| Option-1 | Samsung | There are several problems with Option 1. First, it mandates gNB behaviour – the value of the DAIs in a DCI format is completely up to the gNB and the UE does not care how the gNB sets the DAI values – that is the operation since LTE, including in NR R15/R16.The basic question is whether or not a DCI format associated with a HARQ disabled process is to be used for PUCCH/HARQ-ACK – option 1 picks the DAIs (BTW, there is no T-DAI as R17 NTN is single cell operation) but that is only one of the fields that may not be needed. We support an “all-or-nothing” approach instead of picking ‘yes’ for fields ‘A and C’ and ‘no’ for fields ‘B and D’. We support option 2 because DCI formats not associated with HARQ-ACK reports do not need to include fields associated with HARQ-ACK reports (e.g. if the NW disables HARQ-ACK for all HARQ processes, should DAI/PRI/HARQ timing/TPC for PUCCH be included in the DCI?)  |
| Option-2 | Nokia, Nokia Shanghai Bell | Blindly ignoring the content of the DAI values could create error cases of missed DCIs. On the other hand, agree with Samsung that we should not mandate what the gNB puts as DAI, but whichever value that is put into the DAI should be respected by the UE, no matter whether the HARQ-ACK is expected or not. |

# **Enhancement on Type-3 Codebook:**

For this topic, following views are shared in this meeting:

* 1. Supportive to enhancement: [Huawei, vivo, Xiaomi/Spreadtrum (if supported), CAICT, Samsung, Baicell, ZTE, Ericsson, LG]
		1. Solution 1: No feedback for HARQ process with disabled feedback (i.e., HARQ-ACK codebook only includes HARQ-ACK of all the enabled HARQ processes in one shot.)
		2. Solution 2: Skipping the feedback of PDSCH occasions if only disabled HARQ process are transmitted for one cell [ITL]
	2. Negative to enhancement: [OPPO, Nokia, CATT, Samsung, DCM]

Based on the inputs above, it seems that companies’ views including justification is same as before. From moderator perspective, the supports on the Type-3 can also be considered since it can also be used for licensed band. Meanwhile, only limited efforts are needed to specify the proposed enhancement. Then, following proposal is made based on majority views:

**[Initial Proposal 2-4]:** For Type-3 HARQ codebook in NTN, the UE should skip the codebook feedback for a feedback-disabled HARQ processes

Please provide your views below：

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| --- | --- |
| **Company** | **Comments and Views** |
| OPPO | Type-3 codebook was not designed for the purpose of overhead reduction. Could proponents explain why in R16 type3 codebook reports the HARQ-ACK for all the cells of the same cell group even if there is no scheduling received from one of the cells or even one of the cells is not activated, the HARQ-ACK of this inactive cell is also reported in the type-3 HARQ codebook. This is the R16 principle. There is no need to revert this principle.  |
| Samsung | OK with the proposal in principle - it is straightforward and consistent with preferred/agreed approaches for Type-1/Type-2. The proposal may need to be reworded – the UE skips HARQ-ACK feedback, not codebook feedback.However, in addition to being an optional feature, the Type-3 CB is both suboptimal for NTN and has limited functionality (e.g. does not support non-TB based HARQ-ACK such as for SPS activation/release, SCell dormancy (in case CA is introduced), and other cases introduced in Rel-17). Basically, OK with the proposal for completeness but without any other optimization. |
| CATT | For [Initial Proposal 2-4], we are not supportive of it.Type-3 HARQ codebook is still an optional UE feature and its performance is always worse than Type-2 which is a mandatory UE feature. There is no need to support and enhance it in NTN for Type-3 HARQ codebook. |
| ZTE | Supportive to complete the feature |
| Nokia, Nokia Shanghai Bell | Still, we do not really see a need for optimizing for a HARQ codebook that is both inefficient not likely to be used due to the associated high overhead for the UCI. Propose to not support Type-3 HARQ codebook for NTN.  |

# **Clarification on UE’s behaviour on LLR combination:**

In addition, [Samsung] proposed that RAN1 should conclude whether a UE should support DCI-based retransmissions for TBs with disabled HARQ-ACK reports. If such retransmissions are to be supported, the UE behavior regarding LLR combining is up to UE implementation.

From moderator’s perspective, regarding the re-transmission for TBs with disabled HARQ-ACK report, whether the retransmission will be done at gNB side after the reception of HARQ-ACK or blindly without any information, it’s up to the implementation. Meanwhile, as one key benefit to enable the HARQ-feedback disabling, there is no intention to increase to the soft-buffer for the UE’s implementation. And in case of the TBs with disabled feedback, the LLR combination at UE side should be up to the UE’s implementation. Then, following conclusion is proposed:

**[Initial Proposal 2-5** (As conclusion)]:

Regarding the retransmissions for TBs with disabled HARQ feedback, the LLR combination is up to the UE’s implementation.

Please provide your views below：

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| OPPO | We are a bit confused. Is there in the spec any UE behaviour defined for LLR combination? |
| Samsung | As proposal 2-5 seems to be based on a Samsung proposal, we would like to clarify. We see the main/only benefit of HARQ disabling to be for HARQ buffer management (in general, and particularly for >16 HARQ processes). One approach is to specify that the UE does not expect retransmission of a TB with disabled HARQ-ACK but that is less preferable (the NTN can have other means to determine whether or not to retransmit). Another approach is for the UE to indicate whether or not it can combine LLRs from such retransmissions – that is preferred. Otherwise, the UE either needs to increase HARQ buffer size for NTN (won’t happen) or there will be throughput loss.Basically, the proposal is “UE indicates to NTN whether or not the UE can combine LLRs for retransmissions of a TB with disabled HARQ-ACK”. |
| CATT | Agree. It is up to UE’s implementation. |
| ZTE | The intention of this proposal is clarify that after the introduction of HARQ disabling, whether to allow the LLR combination at UE side, which requires more UE buffer size is up to UE’s implementation. It can be up to UE’s implementation. |
| QC | Assume that the proposal does not include slot aggregation. If so, we prefer to clarify that ***UE is not required to buffer a PDSCH of a feedback-disabled process.*** |
| Nokia, Nokia Shanghai Bell | Ok to have as conclusion. The natural consequence of this would of course be increased UE power consumption (due to longer time needed for completing the session), but we assume that UE/chipset manufacturers are OK with that as well? |
| Panasonic | LLR combining up to UE implementation may be ok, but the spec impact and the necessity of such agreement/conclusion is not clear.  |

# **Issue-3 SPS PDSCH**

In RAN1#106e meeting, the discussion on SPS mainly focus on following aspects with the corresponding views summarized according to the inputs in this meeting:

* For SPS PDSCH transmission:
	+ Option-1: All HARQ process associated to SPS PDSCH should be feedback-enabled
	+ Option-2: The feedback for the HARQ process associated to SPS PDSCH can be disabled by RRC configuration per HARQ process.
		- Supported by [CMCC, Samsung, ZTE]
	+ Option-2a: Enabling/disabling HARQ feedback per HARQ process can separately be configured between dynamic PDSCH and SPS PDSCH.
		- Supported by [DCM, Samsung]
	+ Option-2b: UE sends feedback for all SPS PDSCH occasions irrespective of their HARQ process number.
		- Supported by [NEC]

Regarding Option-2/2a/2b, as mentioned by proponent, less spec impacts is preferred and the determination of HARQ process for each SPS PDSCH with feedback-enabled or disabled HARQ process can be up to implementation.

* + Option-3: The feedback for the HARQ process associated to SPS PDSCH can be disabled by RRC configuration per SPS configuration.
		- Supported by [Huawei, OPPO, CATT, CMCC, CAICT, Panasonic]

Regarding this option, as mentioned by proponent, it seems more reasonable that all the SPS PDSCHs are configured to correspond to enabled HARQ processes, or to correspond to disabled HARQ processes.

* For SPS PDSCH release:
	+ Option-1: As legacy behavior [vivo, OPPO, Spreadtrum, CAICT, NEC,DCM, Sony, ZTE,ITL]
		- Total DAI and DAI in DCI format 0\_1 count for PDCCH indicating SPS PDSCH release when the related SPS PDSCH is HARQ feedback disabled and UE reports HARQ-ACK regardless of any configuration of enabling/disabling HARQ feedback.
	+ Option-2: Additional scheduling restriction:
		- HARQ-ACK feedback for release command should be enabled by one HARQ process with feedback
* For SPS PDSCH activation:
	+ Option-1: As legacy behavior [vivo, CAICT, NEC, DCM, Sony]
		- Total DAI and DAI in DCI format 0\_1 count for PDCCH indicating SPS PDSCH activation when the related SPS PDSCH is HARQ feedback disabled and UE reports HARQ-ACK regardless of any configuration of enabling/disabling HARQ feedback.
	+ Option-2: Additional scheduling restriction:
		- Alt-1: HARQ-ACK feedback for activation should be enabled by one HARQ process with feedback
		- Alt-2: UE feedbacks acknowledgement for the reception of SPS activation DCI, if the first PDSCH after reception of the SPS activation DCI is associated with disabled HARQ process.

In additional, [Xiaomi] proposed to define a separate periodicity for feedback-enabled HARQ process in SPS PDSCH configuration. And [DCM] proposed to introduce enhancement to avoid many subsequent SPS PDSCH receptions before confirming successful activation command with following options.

* + Option 1: SPS PDSCH receptions are started after feedback slot corresponding to activation DCI.
	+ Option 2: 2nd SPS PDSCH is received after feedback slot corresponding to activation DCI.

Meanwhile, updates on the scheduling restriction is also proposed as below to update the previous agreement:

* + *Confirm the previous working assumption for X = T\_proc,1 where X is defined from the end of the reception of the last PDSCH or slot-aggregated PDSCH for a given HARQ process with disabled feedback to the start of the PDCCH carrying the DCI scheduling another PDSCH or set of slot-aggregated PDSCH or the PDSCH without corresponding PDCCH for the given HARQ process.*

Others, e.g., support explicit DCI signaling for skipping HARQ-ACK feedback by reusing PUCCH resource indication field in the DCI, keep the DCI for SPS release and DCI for SCell dormancy (any other DCIs which are included in counting of C-DAI and T-DAI in Rel-16) are included in counting of C-DAI and T-DAI regardless of feedback-enabling/disabling, are proposed by proponent

Then, based on the inputs above and consideration of previous meeting, it seems that at least views for SPS PDSCH activation/PDSCH release are converged with following proposal：

**[Initial Proposal 3-1]:** For the DCI carrying the SPS PDSCH activation/release, the legacy behaviour on HARQ-codebook feedback and DCI counting for SPS PDSCH activation/release is kept if feedback-disabled HARQ process is used for SPS PDSCH.

Please provide your views below：

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| OPPO | fine |
| Samsung | Support. HARQ feedback enabling/disabling is irrelevant for SPS PDSCH activation/release as there is no HARQ process involved and there is no impact on UE buffer. The same holds in general for any DCI which does not schedule a TB and for which the UE reports HARQ-ACK. |
| CATT | Fine with this proposal. |
| ZTE | Support |
| QC | Support in principle but prefer to clarify ***the legacy behaviour*** in the agreement. |
| Nokia, Nokia Shanghai Bell | OK |
| Panasonic | The legacy behavior is no HARQ-ACK feedback for DCI carrying SPS activation. But, we prefer HARQ-ACK feedback for SPS PDSCH activation regardless of feedback-enable/disable for the SPS PDSCH.  |
| CMCC | Support |
|  |  |

Regarding the disabling of feedback for HARQ process in SPS PDSCH, it seems that there are still views from companies to define the new solution in addition to legacy agreement. Then, it’s preferred to further check the views from companies with consideration on all details：

Please provide your views below：

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| OPPO | A straightforward way is to let SPS configuration to configure all disabled HARQ process number.  |
| Samsung | There is no need for separate treatment of SPS PDSCH and DG-PDSCH - the existing agreement for HARQ-ACK disabling per HARQ process does not need to be modified. It would actually be detrimental and overall more complex to have HARQ-ACK enabling/disabling per SPS configuration as such HARQ-ACK enabling/disabling will be time variant per HARQ process – that is undesirable.  |
| CATT | For SPS service, the service quality should be same for all assoiated PDSCH, per HARQ process disabling is not one good choice.Therefore, the feedback for the HARQ process associated to SPS PDSCH can be disabled by RRC configuration per SPS configuration. |
| ZTE | We prefer to keep the disabling per HARQ process for SPS and how to map it is up to the gNB’s scheduling. |
| QC | We do see some potential issues and understand that RAN2 will discuss them. Recommend to leave the decision to RAN2 as the original agreement about disabling/enabling feedback per HARQ process is made by RAN2. |
| Panasonic | We prefer HARQ feedback disabling/enabling for SPS PDSCH is configured per SPS configuration because it is preferable to configure the same enable/disable configuration for all SPS PDSCH in a SPS configuration to satisfy the QoS requirement for SPS traffic.  |
| CMCC | We are open to Option 2 (per HARQ process) and Option 3 (per SPS configuration).Option 2 is is preferred for less spec impact.In order to configure the same enable/disable configuration for all SPS PDSCH in a SPS configuration to satisfy the QoS requirement for SPS traffic, Option 3 is preferred. Otherwise, the scheduling flexibility for non SPS PDSCH may be restricted since some enable/disable HARQ processes are reserved by SPS PDSCH. |

# **Issue-4 PDSCH scheduling restriction**

In RAN1#106-e meeting, the OOO issue (out of order HARQ feedback scheduling restriction for PDSCHs with different HARQ process IDs) has been discussed. From the specification perspective, following two points should be clarified for this issue:

1. Aspect-1: Whether the legacy OOO restriction is applied to disabled HARQ processes
* Supported by [CATT,ZTE]

Regarding this option, companies highlight that since the OOO issue is a NR feature, which is used for unnecessary waste of resources and power, then it is nature to use it as the baseline with consideration on the joint existence of feedback-enabled and feedback-disabled HARQ processes

* No support [Samsung]

Regarding this option, company highlights that the Rel-16 “out-of-order” scheduling does not apply when a PDCCH is associated with a HARQ process having disabled HARQ-ACK report as there is no indication of a PUCCH transmission with HARQ-ACK (if PUCCH is transmitted, it would be due to another PDCCH associated with a HARQ process with enabled HARQ-ACK report – that is the case for any HARQ-ACK CB type). There is no need to consider any new support for “out of order” scheduling for PDCCH receptions associated with HARQ processes having disabled HARQ-ACK reports.

1. Aspect-2: Whether the bit-field in DCI to determine the ACK/NACK feedback is still needed in case of feedback-disabled feedback.
* Not needed: [CAICT, Samsung]

Regarding this option, proponent highlight that the redundancy of DCI format for scheduling of disabled HARQ process would make the system inefficient and bit field, e.g., “PDSCH-to-HARQ\_feedback timing indicator”, “PUCCH resource indicator”, PRI, counter DAI can be removed.

* Still needed: [ZTE]

Regarding this option, company highlight that there is no need to introduce additional efforts to optimize the DCI overhead and it will lead to complicate the UE’s behavior on the DCI detection, e.g., blind detection to determine whether the DCI carries the feedback-enabled HARQ process or disabled. Moreover, For Type-1 codebook, even the DCI of PDSCH carrying the feedback-disabled HARQ process, based on current progress, the feedback is still needed regarding the NACK-only or true value once the DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE

Moreover, [LG] highlights that virtual timeline should be considered for the OOO issue.

Based on the discussion in last meeting and inputs above, from moderator’s perspective, companies are encouraged to further share the view on the aspect -2 firstly. The decision on the OOO issue can be done later once the remaining issues on codebook decision is concluded:

**[Initial Proposal 4-1]:** No optimization on bit-field related to the HARQ-ACK feedback for the DCI of PDSCH with feedback-disabled HARQ process.

Please provide your views below.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| OPPO | Agree |
| Samsung | We do not agree with the characterizations used in the proposal (e.g. “optimization”) – it is not appropriate or necessary for a proposal to include opinions. As previously mentioned, the choice to be made is a binary/simple one between using or removing all PUCCH/HARQ-ACK related fields from DCI formats scheduling TBs associated with disabled HARQ-ACK reports. No other agreement is needed. We support removing because those 8-10 bits are unnecessary (Rel-16 operation is the result). If the fields are kept, they are all used or they are all not used.  |
| CATT |  OK with the proposal. |
| ZTE | We are fine to this proposal and based on contribution review, optimization mainly refers to remove the bits from DCI, which requires additional efforts. |
| Nokia, Nokia Shanghai Bell | OK |
| Panasonic | Support proposal 4-1.  |
| CMCC | Support. |
|  |  |

# **Issue-5 Performance enhancement**

In RAN1#106e meeting, following agreement has been achieved:

Agreement:

The maximum number of supported aggregation factor (i.e., pdsch-AggregationFactor) for DL PDSCH is [X]

* FFS: X = 8, 16 or 32

In this meeting, regarding the value of X, following views are shared:

* + X = 8: [Samsung]
	+ X = 32: [Huawei, Baicell, ETRI, IDC, Apple]
	+ X = 16: [OPPO, Nokia, CATT, Baicell, ZTE, Apple]

More specifically, regarding this topic, [Samsung] points that it may be meaningless to enhance the PDSCH only without consideration on other channels and prefers to take this topic in Rel-18. However, according to the analysis for others, it’s still beneficial to enlarge the value in Rel-17 since 8 aggregated transmission might be insufficient even if low SE MCS table is applied for some cases. Moreover, as alternative solution, 16 slots being aggregated can be considered to mitigate the HACK stalling.

Additionally, following enhancements are proposed by companies to further optimize the transmission:

* + Indication/configuration of aggregation factor/repetition factor:
		- DCI based indication: [Huawei, NEC, IDC] prefer to indicate the value via DCI, e.g., by reinterpreting the idle bits with configuration depending on the orbit parameters [Huawei] or *extension/modification of TDRA field [NEC]*.
		- Different parameters configurations:
		- [OPPO, ETRI] prefer to introduce different configurations for different transmission, e.g., via HARQ process with enabled or disabled feedback. But [IDC] highlights that such enhancement can be applied for both cases.
		- [Ericsson] proposed that different configuration can be considered for the cases.
		- [APT] highlights that different value can be configured per HARQ process or per SPS configuration for SPS PDSCH transmission.
		- [Apple] proposed to consider an adjustable aggregation factor in SPS PDSCH transmission
	+ Transmission scheme:

For the aggregated transmission, following solutions are proposed to optimize the transmission：

* DM-RS related enhancement:
	+ DM-RS density reduction in frequency domain [ZTE]
* Time interleaved aggregated transmission [CATT]

But for this aspect, further investigation is preferred by [NEC]

In additional, others solutions, e.g., enhancements on CQI/MCS table with new BLER for feedback disabled HARQ process [Qualcomm, Interdigital] with concern from [CATT], new UCI feedback in case of scheduling with disabled HARQ feedback[Xiaomi, QC], requesting for guiding pdsch-AggregationFactor from gNB or reporting decoding statistics via MAC CE[ETRI], reporting UE assistant information [Huawei], introduction on the priority order for transmission [CAICT], TB size scaling in case of repetition [Panasonic] are proposed by proponent.

According to the above discussion, it’s recommended from feature leader perspective that before taking into account the further enhancement, we can conclude to enlarge the aggregation factor firstly with following proposal:

**[Initial Proposal 5-1]:**

The maximum number of supported aggregation factor (i.e., pdsch-AggregationFactor) for DL PDSCH is 16

Please provide your views below：

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| OPPO | Agree |
| Samsung | Do not support. Coverage will be UL limited (even more so than for TN) and any new value for the aggregation factor is ad-hoc and not supported by any study on required NTN coverage enhancements. |
| CATT | Agree.We do see the benefit of having larger aggregation factor especially for very low SINR case. |
| ZTE | Agree |
| Nokia, Nokia Shanghai Bell | OK |
|  |  |

# **Issue-6 Restriction on HARQ feedback disabling**

In RAN1#102e meeting, following agreement has been achieved:

Agreement:

Enabling/disabling on HARQ feedback for downlink transmission should be at least configurable per HARQ process via UE specific RRC signaling

However, in current specification, some mechanisms, i.e., delivering MAC CE command, depend on the ACK-NACK feedback. To avoid the potential misalignment between gNB’s and UE’s behaviour, corresponding enhancements have been discussed in past meetings. In this meeting, ***following views are summarized:***

1. Option 1: UE expects that MAC-CEs are transmitted using HARQ processes with feedback enabled.[CATT,CMCC, CAICT, DCM, Baicell, Sony, IDC]
2. Option 2: Up to gNB’s implementation for scheduling [NEC, Panasonic]

In addition, [vivo] prefer to introduce semi-static configured and dynamically switched on the HARQ disabling and [OPPO] asks for clarifying whether the configured disabling HARQ process should applied for all cases, e.g., assume DL HARQ process 0 is configured as disabling for one UE via UE specific RRC signalling. If the UE receives an msg4 scheduling using this DL HARQ process 0, the behavior of the UE is not clear.

Meanwhile, [Nokia] and [DCM] prefer to mandate that the DCI carrying SPS release signalling and successRAR are transmitted using the HARQ process with enabled feedback.

As mentioned before, this issue has been discussed for several meetings and it seems that views from minority is still not changed. However, from specification perspective, it’s better to complete the design to avoid potential error case in future commercial deployment at early stage. Then, from moderator perspective, Option-1 can be taken with following proposal for MAC related issue and the SPS part will treated along the discussion for the general HARQ codebook enhancement in section 3:

**[Initial Proposal 6-1]:** UE expects that MAC-CEs are transmitted using HARQ processes with feedback enabled.

Please provide your views below. If you have strong concerns on this proposal, views on way-forward including justification are appreciated.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| OPPO | Disagree with this proposal. This can be left for gNB implementation.  |
| Samsung | This is another proposal, in addition to the DAI one, that mandates NW operation and has no relevance to the UE. It has already been discussed several times but for some reason it is being brought back again and again – it should have been more than clear by now that the proposal is inappropriate. |
| CATT | Support the proposal.If HARQ feedback of MAC signalling is disabled, the efficiency and reliability will be challenged. |
| ZTE | Agree, it’s to mandate the scheduling to avoid the potential error case. |
| QC | The proposal is a bit too restrictive. We may clarify the type of MAC-CEs that needs to be send by feedback-enabled HARQ processes, such as MAC-CEs about DL configurations. |
| Nokia, Nokia Shanghai Bell | We have understanding for Samsung’s views. Regarding CATT’s comment, if efficiency and reliability is a concern, the operator would simply not disable the HARQ-ACK feedback. After all, the default operation is to have feedback enabled, so an active decision from network side would be needed (and potentially also a UE capability/feature to support it as well). The configuration and operation of the network should be the responsibility of the network. |
| Panasonic | Not support. As discussed in several meetings, whether to use feedback-enabled process or feedback-disabled process for MAC-CE transmissions should be network implementation matter. There are no reasons to restrict the usage of feedback enabled/disabled process. |
| CMCC | Support. In order to avoid the potential error case of misunderstanding of MAC CE signalling, it is better to mandate the scheduling with enabled HARQ process. |
|  |  |

# **Issue-7 PUSCH scheduling restriction**

In this meeting, same proposal from [Qualcomm] is provided to enable UE, which may receive a DCI scheduling a PUSCH of a given HARQ process before the end of the transmission of another PUSCH of that HARQ process as shown below.



[OPPO] also propose to define a minimum gap (e.g., T\_proc,2) between two PUSCHs of a HARQ process and clarify the PUSCH transmission constraint and PDSCH reception constraint for a given enabled UL and DL HARQ process, respectively.





However, as pointed by [APT], no enhancement is expected for UL HARQ process. From moderator perspective:

1. According to existing process, only HARQ feedback disabling for the DL transmission is agreed, no additional enhancement has been considered for UL transmission.

*Agreement:*

*Enabling/disabling on HARQ feedback for downlink transmission should be at least configurable per HARQ process via UE specific RRC signaling*

Agreement from RAN2#112e:

1. From RAN2 perspective, for dynamic grant, one possibility for "enabling"/"disabling" HARQ uplink retransmission at UE transmitter is without introducing an additional mechanism (i.e. gNB can send grant with NDI not toggled/toggled without waiting for decoding result of previous PUSCH transmission). FFS on the handling of RTT timers. Other solutions for enabling/disabling HARQ UL reTX are not precluded
2. In the existing specification, w.r.t the PUSCH scheduling, followings are defined in 38.214:

*The UE is not expected to be scheduled to transmit another PUSCH by DCI format 0\_0, 0\_1 or 0\_2 scrambled by C-RNTI or MCS-C-RNTI for a given HARQ process until after the end of the expected transmission of the last PUSCH for that HARQ process.*

*If the first uplink symbol in the PUSCH allocation for a transport block, including the DM-RS, as defined by the slot offset K2 and the start and length indicator SLIV of the scheduling DCI and including the effect of the timing advance, is no earlier than at symbol L2, where* *L2 is defined as the next uplink symbol with its CP starting* $T\_{proc,2}$ *after the end of the reception of the last symbol of the PDCCH carrying the DCI scheduling the PUSCH, then the UE shall transmit the transport block.*

Moreover, following conclusion has been achieved in RAN1#104e to further clarify the potential ambiguity on the scheduling part for legacy spec. And further discussion on other cases are still discussed parallel in this meeting.

|  |
| --- |
| **Conclusion**For the sentence “The UE is not expected to be scheduled to transmit another PUSCH by DCI format 0\_0 or 0\_1 scrambled by C-RNTI or MCS-C-RNTI for a given HARQ process until after the end of the expected transmission of the last PUSCH for that HARQ process.” in TS 38.214 Clause 6.1, * The common understanding is that the DCI is expected to be received after the end of the last PUSCH.
 |

Then, based on the above analysis and discussion in previous meeting, it seems that no consensus to introduce corresponding enhancement and companies are still encouraged to justify the necessity.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Samsung | Support to not introduce further changes to Rel-16 UE behaviours that have nothing to do with the reasons for introducing HARQ-ACK disabling.  |
| CATT | Follow the legacy restriction is ok. |
| ZTE | Legacy behaviour is fine. |
| QC | The legacy restriction was designed with TN in mind and will seriously limit UE’s throughput in some scenarios. Hence, we believe the legacy restriction should be removed. |
| Nokia, Nokia Shanghai Bell | We do not see a need to address PUSCH scheduling restrictions. |
|  |  |

# **RRC parameters**

Regarding the RRC parameter, updates on the RRC parameters are proposed by companies [ZTE, Ericsson]. According to chair’s guidance, the corresponding discussion will be handled in [106bis-e-R17-RRC-NR-NTN].

# **Conclusion**

In this summary, following proposals are made according to the contribution submitted in AI 8.4.3:

# **Appendix**

|  |  |
| --- | --- |
| Contribution | Observation/Proposals |
| R1-2108749Huawei | Observation 1: Keeping the maximum number of HARQ processes for DCI 0\_0/1\_0 to be 16 limits the scheduling flexibility to some extent.Observation 2: For DCI format 0\_0/1\_0, extending the HARQ process ID field would introduce extra complexity at UE side.Observation 3: For Type-1 codebook, the pre-known NACKs at the position of feedback-disabled HARQ process can be beneficial for channel decoding at the gNB.Observation 4: The case where all the scheduled HARQ processes are disabled is a corner case as there is a large possibility that the HARQ codebook contains the feedback for TAC. Observation 5: As long as one feedback-enabled HARQ process is scheduled, the gNB has to reserve feedback resources anyway as UE miss-detection is unpredictable. Observation 6: With the disabling mechanism, even if UE drop the feedback due to the mis-detection of DCI, gNB still reserve all feedback resources based on the $M\_{A,C}$ occasions, a large number of resources would be wasted.Observation 7: There is no need to optimize the case that only DCIs carrying feedback-disabled HARQ processes are decoded by UE separately.Observation 8: For Type-2 HARQ-ACK codebook, keeping the true values of C-DAI and T-DAI as the count of feedback-enabled HARQ processes can be useful for UE to determine codebook size and detect DCI missing.Observation 9: If one serving cell is configured and only C-DAI is present in the DCI, C-DAI for the disabled HARQ process should not be reserved in order to detect DCI missing.Observation 10: If the disabled HARQ-ACK configuration between dynamic PDSCH and SPS PDSCH is shared, there would be both feedback-enabled and feedback-disabled PDSCHs with one SPS configuration.Proposal 1: For DCI format 0\_0/1\_0, keep the existing 4 bits of HARQ process number field and reusing one bit from MSC or RV field of DCI for MSB of HARQ process ID indication.Proposal 2: For Type-1 codebook, the UE always reports NACK for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH. Proposal 3: For the case if only DCI carrying feedback-disabled HARQ process is detected by UE, the UE behaviour is same as the case if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE.Proposal 4: In Type-2 codebook, for the DCI of PDSCH with feedback-disabled HARQ process, the C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented, and are taken into account by the UE for codebook generation.Proposal 5: For Type-3 HARQ-ACK codebook, skip the feedback of PDSCH occasions from disabled HARQ processes.Proposal 6: For SPS PDSCH, the feedback for the HARQ process associated to SPS PDSCH can be disabled by RRC configuration per SPS configuration.Proposal 7: Aggregation/repetition transmission parameters can be configured depending on orbital height.Proposal 8: To guarantee BLER target in GEO deployment, the maximum number of supported aggregation factor for PDSCH is 32.Proposal 9: Aggregation/repetition transmission parameters can be indicated via DCI.Proposal 10: Reinterpret idle bits in DCI for indicating transmission parameters.Proposal 11: UE assistance information reporting in reserved resource can be considered for NTN. |
| R1-2108911Spreadtrum | Proposal 1: For the HARQ process indication, no enhancement is needed for DCI 0-0/1-0.Proposal 2: For Type-1 HARQ codebook, if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, The UE will report NACK/ACK for the feedback-disabled HARQ process depending on the decoding results of corresponding PDSCH.Proposal 3: If only DCI carrying feedback-disabled HARQ process is detected by UE, the UE’s behavior is same as the case if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE.Proposal 4: For the DCI of PDSCH with feedback-disabled HARQ processes, the C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented, and are taken into account by the UE for type 2 codebook generation.Proposal 5: Enhancement for Type-3 HARQ codebook should be considered, if it is supported in NTN. |
| R1-2108973 vivo | Observation 1: The scheduling with a given HARQ process to enable/disable HARQ feedback to send MAC CE can be left to gNB’s implementation.Observation 2: The scheduling with a given HARQ process to enable/disable HARQ feedback to send SPS activation can be left to gNB’s implementation.Proposal 1: For DCI 0-0/1-0, do not support 32 HARQ processes.Proposal 2: The functionality of enabling/disabling HARQ feedback per HARQ process can be semi-static configured and dynamically switched.Proposal 3: For Type-1 codebook, the UE still generates HARQ-ACK information with ACK or NACK for the feedback-disabled HARQ processes.* When UE detects disabled HARQ processes only with HARQ-ACK information feedback on PUCCH, it will skip the HARQ-ACK information feedback.

Proposal 4: For Type-2 codebook, DAI counts only PDSCH with enabled HARQ processes and SPS PDSCH release.* The value of T-DAI in a DCI format denotes the total number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH reception(s) with enabled HARQ and SPS PDSCH release associated with the DCI formats up to the current PDCCH monitoring occasion.
* The value of C-DAI in a DCI format denotes the accumulative number of {serving cell, PDCCH monitoring occasion}-pair(s) in which PDSCH reception(s) with enabled HARQ or SPS PDSCH release associated with the DCI formats up to the current serving cell and current PDCCH monitoring occasion.

Proposal 5: For Type-3 HARQ-ACK codebook, if applied in NTN, HARQ-ACK codebook only includes HARQ-ACK of all the enabled HARQ processes in one shot. |
| R1-2109078OPPO | For HARQ disabling configuration and HARQ-ACK codebook generation:Proposal 1: Clarify whether the configured disabling HARQ process should apply for all the cases or not. Proposal 2: HARQ enabling/disabling for SPS PDSCH should be configured per SPS configuration.Proposal 3: For Type-1 HARQ codebook, support Option-2: The UE will report NACK/ACK for the feedback-disabled HARQ process depending on the decoding results of corresponding PDSCH.Proposal 4: C-DAI interpretation for type-1 and type-2 HARQ codebook should be unified. Proposal 5: support Option-1: The C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented, and are taken into account by the UE for type 2 codebook generation.Proposal 6: For Type-2 HARQ codebook, DCI for SPS release and DCI for indicating SCell dormancy should be included in counting of C-DAI and T-DAI. Proposal 7: Type-3 HARQ codebook is not supported in NR-NTN. For enhanced HARQ process ID indication:Proposal 8: Support Option 4: No enhancement for DCI format 0-0/1-0. For PDSCH/PUSCH reliability enhancement:Proposal 9: Configure different aggregation factors for PDSCH reception with or without HARQ-ACK feedback. * The maximum number of supported aggregation factor for DL PDSCH is 16.

For PUSCH processing timeline:Proposal 10: PUSCH transmission constraint for a given disabled UL HARQ process should be considered. Proposal 11: PUSCH processing time should be updated in NTN. For extension of K1 range:Proposal 12: The size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI should not be changed.  |
| R1-2109166Nokia | Observation 1: The gNB may still blindly schedule HARQ retransmissions for processes that are not expected to provide HARQ feedback.Observation 2: Even that HARQ feedback may be disabled for a HARQ process, the UE still need to evaluate the CRC for the received packet on the PDSCH.Observation 3: The information on successful or failed packet reception may still be useful for the gNB, even that it is received with delay.Proposal 1: For Type-1 HARQ codebook with DCIs carrying both feedback-disabled and feedback enabled HARQ processes, select Option-2 such that the UE will always generate the true HARQ feedback value.Proposal 2: For Type-1 HARQ codebook with DCIs carrying only feedback-disabled HARQ processes, select Option-1 such that the UE will always generate a HARQ codebook for transmission.Proposal 3: In case of the group agreeing on selecting Option-2 for the case of Type-1 HARQ codebook with DCIs carrying only feedback-disabled HARQ processes, this should be limited to cases where the HARQ codebook is the only UCI for the PUCCH.Proposal 4: For Type-2 HARQ codebook, select Option-1 such that C-DAI and T-DAI are the count of the feedback-enabled processes.Proposal 5: No enhancements or optimizations are implemented for Type-3 HARQ codebook. The codebook size should not be depending on the configuration for HARQ-ACK feedback (feedback enabled or disabled).Proposal 6: For DCI 0-0/1-0, select option 4, such that no enhancements are introduced for HARQ process indication.Proposal 7: For NTN operation, the maximum level of slot aggregation to be considered should be 16 slots. |
| R1-2109170MTK | Proposal 1: Option 4: no enhancements for DCI 0-0/1-0.Proposal 2: Explicit indication of NTN Cell is indicated on SIB* FFS which SIB – i.e. MIB, SIB1

Proposal 3: Support of 32 HARQ processes in the device is a UE capability in NR NTN. |
| R1-2109222CATT | 1. There is no enhancement on the HARQ process indication for DCI 0-0/1-0.
2. 32 processes can be supported based on UE capability.
3. For Type-1 HARQ codebook in NTN, The UE will report NACK/ACK depending on the decoding results of corresponding PDSCH Regardless of the feedback-disabled or feedback-enabled HARQ process.
4. Type-2 HARQ-ACK codebook can be optimized, and the C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented, and are taken into account by the UE for Type-2 codebook generation.
5. For SPS case, the HARQ-ACK feedback for activation and release command can be enabled.
6. For SPS PDSCH reception transmission, the feedback for the HARQ process associated to SPS PDSCH reception transmission can be disabled per SPS configuration.
7. Type-3 HARQ-ACK codebook is not needed in NTN case.
8. The OOO legacy restriction is applied when feedback-disabled is configured.
9. The HARQ-ACK feedback should be true HARQ-ACK in case that HARQ-ACK feedback is reported for feedback-disabled HARQ process.
10. UE expects that at least one HARQ process with feedback is configured for the scheduling of MAC-CE.
11. Slot aggregation factor can be extended to 16 for very low SINR case.
12. Support time interleaved slot aggregation to improve transmission reliability.
13. There is no need for MCS enhancement.
 |
| R1-2109281CMCC | Observation 1: For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, the UE should skip the codebook feedback, including:* The UE may generate the legacy codebook but finally drop it.

Observation 2: For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, and if the UE skip the codebook feedback when the feedback is carried by PUCCH, at least UE battery consumption for sending PUCCH carrying HARQ-ACK feedback can be reduced, including,* If unsuccessful detection of DCI carrying feedback-enable HARQ process doesn’t occur, both PUCCH resource overhead for carrying HARQ-ACK feedback as configured by the gNB and UE battery consumption for sending PUCCH can be reduced.
* If unsuccessful detection of DCI carrying feedback-enable HARQ process occurs, UE battery consumption for sending PUCCH carrying HARQ-ACK feedback can be reduced.

Proposal 1: For HARQ process indication, support Option 4 (i.e., no enhancement) for DCI 0-0/1-0, i.e., * Keep the HARQ process ID field up to 4 bits unchanged for DCI 0-0/1-0.

Proposal 2: For Type-1 HARQ codebook, if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, support Option-2, i.e.,* The UE will report NACK/ACK for the feedback-disabled HARQ process depending on the decoding results of corresponding PDSCH.

Proposal 3: For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, and if the UE skip the codebook feedback when the feedback is carried by PUCCH, support Option-2, i.e.,* The UE should skip the codebook feedback at least when the feedback is carried by PUCCH.

Proposal 4: For the DCI of PDSCH with feedback-disabled HARQ processes, support Option-1, i.e.,* The C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented, and are taken into account by the UE for type 2 codebook generation.

Proposal 5: For the SPS PDSCH activation/release, support Alt-2, i.e.,* UE expects that SPS PDSCH activation/release information are transmitted using HARQ processes with feedback enabled.

Proposal 6: For the SPS PDSCH, one of following should be supported:* Option-2: The feedback for the HARQ process associated to SPS PDSCH can be disabled by RRC configuration per HARQ process.
* Option-3: The feedback for the HARQ process associated to SPS PDSCH can be disabled by RRC configuration per SPS configuration.

Proposal 7: UE expects that MAC-CEs are transmitted using HARQ processes with feedback enabled. |
| R1-2109344CAICT | Proposal 1: For DCI 0-0/1-0, option 2 is preferred if TN/NTN identification is finished before initial access. Otherwise, option 4 is to be prioritized.Proposal 2: For Type-1 HARQ codebook, if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, option 2 is supported.Proposal 3: For Type-1 HARQ-ACK codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, option 2 is supported when the feedback is carried by PUCCH. If the HARQ-ACK codebook is transmitted through PUSCH, the corresponding solution in Rel-15/16 CR could be reused.Proposal 4: For the DCI of PDSCH with feedback-disabled HARQ processes, the C-DAI and T-DAI are ignored by the UE regardless of the value for Type 2 codebook generation.Proposal 5: For Type-2 HARQ-ACK codebook, HARQ-ACK feedback related bit fields including C-DAI/T-DAI, “PDSCH-to-HARQ\_feedback timing indicator”, “PUCCH resource indicator” are not included in the DCI with a feedback-disabled HARQ process.Proposal 6: For Type-2 HARQ-ACK codebook, the count of C-DAI and T-DAI in SPS activation/release PDCCH is kept when it is for HARQ-ACK feedback-disabled HARQ processes.Proposal 7: Enabling/disabling of HARQ feedback for DL SPS is configured per configuration by RRC configuration.Proposal 8: Provide higher priority order for the HARQ disabled transmission than the priority order for HARQ enabled transmission.Proposal 9: UE expects that MAC-CEs are transmitted using HARQ processes with feedback enabled. |
| R1-2109359NEC | Proposal 1: The C-DAI and T-DAI are ignored by the UE regardless of the value for Type 2 codebook generation.Proposal 2: For Type-1 HARQ codebook, if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, the UE will report NACK only for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH.Proposal 3: When all HARQ processes for a UE are configured disabled, HARQ-ACK feedback is omitted.Observation 1: Dynamic indication to inform the UE if HARQ-feedback is expected or not for MA,c occasions can be useful to reduce codebook size.Observation 2: Codebook size reduction can be achieved if only HARQ disabled processes and SPS PDSCHs are scheduled in MA,c occasions.Proposal 4: Type-1 codebook enhancement is supported as:* Layer1/Layer2 signalling is used to indicate that only HARQ disabled processes are scheduled in MA,c occasions.
* If there are no SPS PDSCH(s) configured within MA,c occasion, UE omits HARQ feedback.
* If there are SPS PDSCH(s) configured within MA,c occasion, UE omits HARQ feedback for non SPS PDSCH occasions.
	+ UE sends feedback for all SPS PDSCH occasions irrespective of their HARQ process number.

Proposal 5: If 32 HARQ processes are configured, scheduling is carried out with non-fallback DCI formats and no enhancement is needed for DCI 0-0/1-0.Proposal 6: Whether to use HARQ enabled or disabled process for the transmission of MAC CE is left up to gNB implementation. Proposal 7: Consider extension/modification of TDRA field to indicate number of repetitions to a UE. Proposal 8: Interleaving factor for repetition transmission needs further investigation. |
| R1-2109411Xiaomi | Proposal 1: The number of supported HARQ processes is subject to the UE’s capability.Proposal 2: Support no enhancement for DCI format 0-0 and 1-0.Proposal 3: For Type-1 HARQ codebook, UE to report NACK only for the feedback-disabled HARQ process regardless of the decoding results of corresponding PDSCH.Proposal 4: For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, the UE’s behavior is same as the case if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE.Proposal 5: For the type 2 codebook, the C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented, and are taken into account by the UE for type 2 codebook generation.Proposal 6: For the type 3 codebook, the codebook should not include the HARQ feedback for a feedback-disabled HARQ processes if it is supported in NTN scenario.Proposal 7: Define a separate periodicity for feedback-enabled HARQ process in SPS PDSCH configuration. Proposal 8: Enhancement on the UCI reporting such as the data decoding statistics should be introduced. |
| R1-2109488Samsung | Proposal 1: RAN1 to conclude whether a UE should support DCI-based retransmissions for TBs with disabled HARQ-ACK reports. If such retransmissions are to be supported, the UE behavior regarding LLR combining is up to UE implementation. Proposal 2: A UE configured Type-1 HARQ-ACK codebook reports NACK/DTX values for decoding outcomes of TBs associated with HARQ processes with disabled HARQ-ACK reports. The UE does not transmit a PUCCH with a Type-1 codebook when the UE receives only TBs for HARQ processes with disabled HARQ-ACK reports. Proposal 3: A UE does not transmit a PUCCH with a Type-1 HARQ-ACK codebook when the UE receives only TBs for HARQ processes with disabled HARQ-ACK reports. Rel-16 applies for the UE behavior when a Type-1 HARQ-ACK codebook is to be multiplexed in a PUSCH. Proposal 4: A Type-3 HARQ-ACK codebook does not include HARQ-ACK reports for HARQ processes with disabled HARQ-ACK reports. Proposal 5: A DCI format 1\_1 for a HARQ process with disabled HARQ-ACK does not include the PRI, PUSCH-to-HARQ\_feedback timing and counter DAI and is size matched to DCI format 0\_1.Proposal 6: To enable up to 32 HARQ processes without increasing the soft buffer size, support one of the following: * Option 1. gNB informs a maximum TBS and UE reports its capability for a number of HARQ processes.
* Option 2. UE reports separate capabilities for a number of predefined pairs of {maximum number of HARQ processes, maximum TBS}.

Proposal 7: Support UE assistance information to indicate full soft buffer or to request HARQ-ACK enabling/disabling for HARQ processes. Observation 1: For a DCI format scheduling a TB for a HARQ process with disabled HARQ-ACK, there is no need for any agreement on the UE behavior for fields associated with HARQ-ACK codebook construction or PUCCH (Option-2).Observation 2: There is no need to consider any new support for “out of order” scheduling for PDCCH receptions associated with HARQ processes having disabled HARQ-ACK reports.Observation 3: No new agreement is needed for HARQ processes with HARQ-ACK reports for SPS PDSCH (Option-2). Same UE behavior applies for HARQ-ACK reports for SPS PDSCH and for DG PDSCH in a HARQ-ACK codebook. Observation 4: There is no need to support more than 16 HARQ processes by DCI formats 0\_0/1\_0 (“Option 4”).Observation 5: PDSCH is the channel with best coverage and it is not meaningful to enhance PDSCH coverage without enhancing coverage for other channels in NTN. General coverage enhancements for NTN can be part of a Rel-18 SI/WI.  |
| R1-2109677DCM | Observation 1:* It seems that 16 HARQ processes indication is sufficient for DCI format 0\_0/1\_0.

Proposal 1:* Option 4, i.e. no enhancement on the indication of HARQ process number in DCI format 0\_0/1\_0.

Observation 2:* If feedback-enabling/disabling configuration per HARQ process is common between dynamic PDSCH and SPS PDSCH, many HARQ processes would be configured with enabled feedback so that enabled feedback is applied to all of the SPS receptions.
	+ This aspect degrades flexibility of dynamic PDSCH scheduling with disabled feedback.

Proposal 2:* Enabling/disabling HARQ feedback per HARQ process can separately be configured between dynamic PDSCH and SPS PDSCH.

Observation 3:* Success/failure of the activation/release command reception should be informed to gNB in any case; otherwise, many subsequent SPS PDSCHs are missed or many wasted SPS receptions are tried at the UE if the activation/release is missed.
* Configurations of disabled feedback per HARQ process might allow not to report HARQ-ACK corresponding to activation/release DCI.

Proposal 3:* For SPS activation/release, UE reports HARQ-ACK regardless of indication via HARQ process number field in activation/release DCI and HARQ process number corresponding to the initial SPS PDSCH (if any).

Observation 4:* When small periodicity is used for the SPS compared to slot offset between the initial PDSCH reception and the corresponding HARQ feedback, many subsequent SPS PDSCHs shall be transmitted before this HARQ feedback reception at gNB.
	+ This situation leads to less efficiency and higher difficulty of PUSCH scheduling due to misalignment between gNB and UE.

Proposal 4:* Introduce enhancement to avoid many subsequent SPS PDSCH receptions before confirming successful activation command. The following are possible options.
	+ Option 1: SPS PDSCH receptions are started after feedback slot corresponding to activation DCI.
	+ Option 2: 2nd SPS PDSCH is received after feedback slot corresponding to activation DCI.

Proposal 5:* Update the RAN1#105-e agreement:
	+ Confirm the previous working assumption for X = T\_proc,1 where X is defined from the end of the reception of the last PDSCH or slot-aggregated PDSCH for a given HARQ process with disabled feedback to the start of the PDCCH carrying the DCI scheduling another PDSCH or set of slot-aggregated PDSCH or the PDSCH without corresponding PDCCH for the given HARQ process.

Observation 5:* For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, Option 2 is more complicated option rather easier one from perspectives of gNB scheduler and UE soft-buffer management due to processing time constraints.

Proposal 6:* For Type-1 HARQ codebook, if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, Option 1 is supported.

Proposal 7:* For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, Option 2 is supported. Option 2 is applied also to the case that feedback is carried by PUSCH.

Proposal 8:* For the DCI of PDSCH with feedback-disabled HARQ processes, Option 1 is supported for type-2 HARQ-ACK CB.

Observation 6:* Similarly to SPS activation/release, HARQ feedback for SCell dormancy is essential behavior.
	+ When DCI format indicating SCell dormancy without scheduling a PDSCH reception, HPN field is used for indication of SCell index.

Proposal 9:* For SCell dormancy, UE reports HARQ-ACK regardless of indication via HARQ process number field in DCI format 1\_1 indicating SCell dormancy without scheduling a PDSCH reception.

Proposal 10:* Specify that UE expects that MAC-CEs are transmitted using HARQ processes with enabled feedback.
* Specify that UE expects that successRAR is transmitted using HARQ processes with enabled feedback.
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| R1-2109765Baicells | 1. No HARQ enhancement for DCI 0-0/1-0 is needed.
2. If DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, the UE will report NACK/ACK for the feedback-disabled HARQ process depending on the decoding results of corresponding PDSCH.
3. if only DCI carrying feedback-disabled HARQ process is detected by UE, the UE should skip the codebook feedback.
4. Type 2 HARQ-ACK codebook can be enhanced, and the C-DAI and T-DAI are the count of feedback-enabled processes despite they are not incremented, and are taken into account by the UE for type 2 codebook generation.
5. For Type-3 HARQ codebook, enhancement should be considered to reduce the unnecessary overhead.
6. The MAC-CEs are transmitted with enabled/disabled HARQ processes depending on the specific implementation of network operators.
7. UE expects an SPS PDSCH release is transmitted using HARQ processes with feedback enabled.
8. For NTN operation, the maximum level of slot aggregation to be considered could be 32 slots, but 16 is ok.
 |
| R1-2109788Sony | Proposal 1: UE expects that any PDSCH carrying a MAC CE command, whose activation/deactivation time is coupled to the transmission time of the associated HARQ-ACK, is scheduled via a HARQ process with HARQ feedback enabled.Observation 1: When HARQ feedback is disabled for some HARQ processes, the redundant feedback bits of Type-1 / semi-static HARQ-ACK codebook would be large based on current HARQ-ACK codebook designProposal 2: HARQ codebook enhancement is supported as:* For Type-1 HARQ codebook, reduce codebook size with keeping the codebook size semi-static.
	+ When all HARQ processes are feedback disabled for one secondary cell, the UE does not reserve HARQ ACK/NACK bits for that secondary cell.
	+ Reduce the Type-1 HARQ codebook size by restricting the scheduling occasion, e.g., restricted TDRA table of feedback enabled HARQ process.
* For Type-2 HARQ codebook, the value of the counter/total DAI field in the DCI of PDSCH with feedback-disabled HARQ process are given the count value of {serving cell, PDCCH monitoring occasion}-pair(s) whose associated PDSCH is HARQ feedback enabled.

Proposal 3: Support UE reporting HARQ feedback information for the SPS PDSCH activation when the related SPS PDSCH is HARQ feedback disabled. Proposal 4: The counter DAI, total DAI and DAI in DCI format 0\_1 should count for PDCCH indicating SPS PDSCH activation when the related SPS PDSCH is HARQ feedback disabled.Proposal 5: The UE always reports HARQ feedback information for the SPS PDSCH release whether the related SPS PDSCH is HARQ feedback disabled or enabled.Proposal 6: The counter DAI, total DAI and DAI in DCI format 0\_1 should always count for PDCCH indicating SPS PDSCH release whether the related SPS PDSCH is HARQ feedback disabled or enabled.  |
| R1-2109812ETRI | Observation 1 : For NTN, DL geometry SINR might range from -5.9 dB to 9.2 dB* For SC19 (worst case), DL geometry SINR might range from -5.9 dB (5%) to -2.1 dB (95%).
* For SC3 (best case), DL geometry SINR might range from 6 dB (5%) to 9.2 dB (95%).

Observation 2 : For NTN, DL geometry SINR difference between 5% and 95% might range from 1 dB to 8.4 dB* For SC{8,13} (narrowest), DL geometry SINR might range from 7.5 dB (5%) to 8.5 dB (95%). (1dB=8.5-7.5)
* For SC28 (widest), DL geometry SINR might range from -1.4 dB (5%) to 7 dB (95%). (8.4dB=7+1.4)

Observation 3 : For NTN, UL geometry SINR might range from -13.9 dB to 14.8 dB.* For SC19 (worst case), the UL geometry SINR might range from -13.9 dB (5%) to -9.3 dB (95%).
* For SC23 (best case), the UL geometry SINR might range from 3 dB (5%) to 14.8 dB (95%).

Observation 4 : For NTN, UL geometry SINR difference might range from 3.4 dB to 13.4 dB.* For SC5 (narrowest), the UL geometry SINR might range from 1.5 dB (5%) to 4.9 dB (95%). (3.4dB=4.9-1.5)
* For SC26 (widest), the UL geometry SINR might range from -8.5 dB (5%) to 4.9 dB (95%). (13.4dB=4.9+8.5)

Enhancement via Larger Aggregation Factor (value)Observation 5 :BLER improvement by legacy low SE MCS index table is not enough to cover all NTN study cases* for PUSCH : low SE MCS index table in legacy NR might be insufficient
* for PDSCH :
	+ low SE MCS index table in legacy NR might be enough only if target BLER $\geq $ 0.1%
	+ otherwise, low SE MCS index table in legacy NR might be insufficient

Observation 6 :larger aggregation factor might be inevitable for NTN.* for PUSCH : 8 aggregated transmission might be insufficient for NTN.
	+ 8 aggregated transmission might be insufficient even if low SE MCS index is applied.
* for PDSCH :
	+ normal SE MCS index table
		- target BLER=1% : 8 aggregated transmission (marginal), 16 aggregated transmission (sufficient)
		- target BLER=0.1%: 16 aggregated transmission (marginal), 32 aggregated transmission (sufficient)
	+ low SE MCS index table
		- if target BLER $\geq $ 0.1%, 8 aggregated transmission might be sufficient
		- otherwise, 8 aggregated transmission might be insufficient

Observation 7 : larger aggregation factor method has less specification impact and could be more effective than lower SE MCS index table method.Enhancement via Different Aggregation Factors (configuration)Observation 8 : For optimal adaptation, different aggregation factor might be applied depending on the parameter (especially IMCS).Observation 9 : For optimal adaptation, different aggregation factor should be applied depending on the target performance.Observation 10 : In NR, various kinds of transport channels are multiplexed into PDSCH/PUSCH.* Target performance of each transport channel might be distinguishable by checking the RNTI
	+ PDSCH related RNTI : {P,SI,RA,MSGB,TC,C,MCS-C,CS}-RNTI
	+ PUSCH related RNTI : {TC,C,MCS-C,CS}-RNTI

Observation 11 : In NTN, different target performance might be defined by the HARQ feedback availability.Enhancement via UL Feedback (for guidance of aggregation factor)Observation 12 : The value of aggregation factor should be determined properly if slot aggregation is used. * Too un-reliable parameter : reliability/latency loss (might be unable to communicate)
* Proper parameter : optimal adaptation
* Too reliable parameter : throughput loss

Observation 13 : NR gNB cannot distinguish between just proper parameter and too reliable parameter, if the slot aggregation is used. * 0 CRC OK in a bundle (too un-reliable parameter) : NACK
* only 1 CRC OK in a bundle (proper parameter) : ACK
* multiple(>1) CRC OK in a bundle (too reliable parameter) : ACK

Observation 14 : NR gNB cannot optimally react to some cases, if the slot aggregation is used.* toward better reliability : possible (reaction for receiving NACK quite consistently)
* maintain : possible (reaction for receiving ACKs quite consistently)
* toward better throughput : (seems to be )impossible

Observation 15 : In NR, there is no feedback mechanism to guide aggregation factor into lower value for better throughput* Once the aggregation factor value gets larger, it may be impossible to be reduced again

Observation 16 : If all the HARQ feedback are disabled, gNB cannot optimally react to all cases* toward better reliability : (seems to be )impossible
* maintain : (seems to be )impossible
* toward better throughput : (seems to be )impossible

Observation 17 : UL feedback might be helpful to guide aggregation factor into optimal value* Non-optimal value (fixed aggregation factor) might lead the throughput loss
	+ for PDSCH: from 20.8% to 45.7%.
	+ for PUSCH: from 16.2% to 51%

Observation 18 : UL feedback via MAC-CE/RRC might be preferred rather than UL feedback via UCI.* specification impact would be minimized
* soft combinable retransmission mechanism on PUSCH might be beneficial for compensating in low S(I)NR under NTN

Proposal 1 : Consider “X=32” for NTN PDSCH according to the below agreement in RAN1#106-e.* agreement @ RAN1#106-e:
	+ “The maximum number of supported aggregation factor (i.e., pdsch-AggregationFactor) for DL PDSCH is [X]. FFS: X = 8, 16 or 32”
* Note :
	+ 8 aggregated transmission might be marginal for 1% target BLER
	+ 16 aggregated transmission might be marginal for 0.1% target BLER and sufficient for 1% target BLER
	+ 32 aggregated transmission might be sufficient for 0.1% target BLER

Proposal 2 : Consider more than 8 aggregated transmission for NTN PUSCH to achieve target BLER performance.* 8 aggregated transmission might be insufficient even if low SE MCS table is applied.

Proposal 3 : Consider the enhancement via “different aggregation factors” as the one of the NTN’s transmission enhancement solutions.* the followings might be a start point for configuring different aggregation factors
	+ (a group of) MCS index
	+ (a group of) RNTI type (or search space)
	+ HARQ feedback availability (enabled/disabled)
	+ combinations of the above
	+ subsets of the above

Proposal 4 : Consider the enhancement on the aggregated transmission guidance via “UL feedback” for adaptive aggregated transmission as the one of the NTN’s transmission enhancement solutions to achieve better adaptation performance.* UL feedback can include information such as
	+ request for guiding pdsch-AggregationFactor
	+ decoding statistics
	+ combination of the above
* MAC-CE/RRC might be also acceptable, instead of UCI.
	+ for minimizing specification impact.
	+ for compensating low S(I)NR in NTN by using soft combinable retransmissions on PUSCH
* if aggregation factor is not guided by UL feedback, fixed aggregation factor (non-optimal value) might cause the throughput loss
	+ for PDSCH: from 20.8% to 45.7% loss
	+ for PUSCH: from 16.2% to 51% loss
 |
| R1-2109827FGI, Asia Pacific Telecom, III | Based on observations, the following proposals are made[Proposal 1 For HARQ process indication, support no enhancement for DCI 0-0/1-0 (Option 4).](#_Toc82252401)[Proposal 2 For the Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, the UE’s behavior is the same as the case if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE (Option-1).](#_Toc82252402)[Proposal 3 For the Type-1 HARQ codebook, if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, the UE will report NACK only for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH (Option-1).](#_Toc82252403)[Proposal 4 If C-DAI and T-DAI are not incremented for feedback-disabled HARQ, UE shall remove padding NACKs if they are added by triggering the condition of $VC-DAI,c,mDL\leq Vtemp$ in the pseudo-code.](#_Toc82252404)[Proposal 5 For the DCI of PDSCH with feedback-disabled HARQ processes, the C-DAI and T-DAI are ignored by the UE regardless of the value for Type 2 codebook generation (Option-2).](#_Toc82252405)[Proposal 6 For a UL HARQ process with disabled HARQ retransmission, i.e., RRC configures HARQ state B (UL retransmission grant is not based on UL decoding result), the UE is not expected to be scheduled to transmit another PUSCH for a given HARQ process until after the end of the expected transmission of the last PUSCH for that HARQ process. (No enhancement)](#_Toc82252406)[Proposal 7 For UE PUSCH preparation procedure time, the first uplink symbol in the PUSCH allocation shall be defined by the slot offset K2, the slot offset K\_offset, and the start S and length L of the PUSCH allocation.](#_Toc82252407)[Proposal 8 For a UL HARQ process with disabled HARQ retransmission, i.e., RRC configures HARQ state B (UL retransmission grant is not based on UL decoding result), T\_(proc, 2) shall be reused in Rel-17 NTN. (No enhancement)](#_Toc82252408)[Proposal 9 The new aggregation factor IE, e.g., pdsch-AggregationFactor-r17, shall be configured per HARQ process via RRC signaling.](#_Toc82252409)[Proposal 10 If pdsch-AggregationFactor-r17 and pdsch-AggregationFactor are both provided in PDSCH-Config, UE shall ignore the value provided by pdsch-AggregationFactor.](#_Toc82252410)[Proposal 11 A new aggregation factor, e.g., 16 or 32, for SPS PDSCH shall be supported and its configuration shall be per SPS configuration via RRC signaling.](#_Toc82252411) |
| R1-2109845ZTE | Proposal 1: Re-interpretation of bits in DCI (e.g., one of bit in RV field) should be support to enable the HARQ process indication with extended maximum HARQ process number for DCI 0-0/1-0.Proposal 2: Enhancements to minimize the UL feedback for DL transmission with feedback-disabled process should be prioritized. Proposal 3: In Type-2 codebook, for the DCI of PDSCH with feedback-enabled HARQ processes, the C-DAI and T-DAI value should be directly ignored by UE.Proposal 4: In Type-1 codebook, * If DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, the UE will report NACK only for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH
* If only DCI carrying feedback-disabled HARQ process is detected by UE, the UE should skip the codebook feedback.

Proposal 5: For Type-3 codebook, enhancement can be enabled by only allowing the ACK-NACK generation for HARQ process with enabled feedback.Proposal 6: For joint scheduling with feedback enable and disabled process, the legacy restriction on the out-of-order HARQ timing restriction should be kept.Proposal 7: No optimization on the bit field related to the HARQ feedback is considered for the DCI associated with feedback-disabled HARQ process. Proposal 8: Confirming that the feedback for the HARQ process associated to SPS PDSCH can be disabled by RRC configuration per HARQ process.Proposal 9: Regarding the DCI for SPS release, the legacy behavior is expected.Proposal 10: Regarding the HACK-ACK feedback for SPS PDSCH:Proposal 11: The maximum number of supported aggregation factor (i.e., pdsch-AggregationFactor) for DL PDSCH can be extended to 16.Proposal 12: The reduced DM-RS density in frequency should be supported to improve the performance for NTN for aggregated transmission.Proposal 13: Updates on the RRC parameters listed in Table 2 should be considered. |
| R1-2109868Panasonic | Proposal 1: For HARQ process ID indication, no enhancement for DCI 0\_0/1\_0. Proposal 2: For type 1 HARQ codebook, UE shall transmit ACK/NACK for the feedback-disabled HARQ process depending on the decoding resultsProposal 3: C-DAI and T-DAI in the DCI of PDSCH with feedback-disabled process is the count of feedback-enabled processes (Option-1) Proposal 4: When the number of HARQ-ACKs is zero, DAI 1,1 is indicated in the DCI of PDSCH with feedback-disabled process.Proposal 5: Whether to use feedback-disabled process or enabled process for SPS PDSCH is up to network implementation.Proposal 6: HARQ feedback-disabling for SPS PDSCH is configured per SPS configuration. Proposal 7: Whether to use feedback-disabled process or enabled process for MAC CE transmission is up to network implementation. MAC CE action timing when feedback-disabled process is used is well covered by the current specification text.Proposal 8: Enhancement of PDSCH/PUSCH transmission to improve user throughput without further increasing the number of HARQ processes should be discussed.Proposal 9: Transport block size scaling in case of repetition should be considered to improve user throughput with a limited number of HARQ processes. Alternatively, it should be considered to apply the same solution as multi-slot PUSCH in coverage enhancement WI for both PUSCH and PDSCH in NTN.  |
| R1-2109880IDC | Observation-1: lowering target BLER for PDSCH when HARQ feedback is disabled is beneficial in terms of resource utilization and latency as it can reduce the number of retransmissions in higher layerObservation-2: use of a CQI table with a lower BLER target (e.g., 1%) could provide a better link adaptation with lower PDSCH BLER target when HARQ feedback is disabledProposal-1: the maximum number of aggregated slots is increased to 32Proposal-2: slot aggregation number for a PDSCH is dynamically indicated in DCIProposal-3: a larger slot aggregation number for a PDSCH can be also used when HARQ feedback is enabled.Proposal-4: a CQI table with a new target BLER (e.g., 1%) is considered when HARQ feedback is disabledProposal-5: HARQ feedback is enabled for at least one HARQ process numberProposal-6: the PDSCH carrying MAC-CE command is transmitted in the HARQ process with HARQ feedback enabled |
| R1-2109929Ericsson | [Observation 1 It is not necessary to schedule 32 HARQ processes using fallback DCI format 0\_0/1\_0.](#_Toc84017316)[Observation 2 If DCI scheduling feedback-enabled DL HARQ processes is transmitted but no Type-1 HARQ codebook is transmitted by the UE, the network can interpret that as implicit NACK for the feedback-enabled HARQ processes.](#_Toc84017317)[Observation 3 RAN1 already agreed that Type-3 HARQ codebook can be applied in licensed spectrum.](#_Toc84017318)[Observation 4 NR is a toolbox of features. Each feature should not be limited to a certain use case or deployment and it is up to implementation to use it as fit.](#_Toc84017319)[Observation 5 There should not be some artificial restriction that Type-3 HARQ codebook is not applicable to NTN.](#_Toc84017320)[Observation 6 Currently out-of-order HARQ timing restriction is defined for PDSCH scheduling based on the HARQ-ACK feedback in TS 38.214. It is not clear what UE should expect regarding PDSCH scheduling timing when HARQ feedback is disabled. Therefore, it is necessary to discuss the scheduling restriction when HARQ feedback is disabled.](#_Toc84017321)[Proposal 1 Do not modify fallback DCI to support 32 HARQ processes.](#_Toc84017322)[Proposal 2 RAN1 to discuss what parameters need to be configured differently for HARQ processes with feedback and HARQ processes without feedback. One example parameter is aggregation factor.](#_Toc84017323)[Proposal 3 In case of Type-1 HARQ codebook, when HARQ processes are enabled/disabled on a per HARQ process basis and the UE has not decoded DCI for a feedback-enabled HARQ process in any slot associated with the HARQ codebook, the UE omits sending the HARQ-ACK feedback at least when the feedback is carried on PUCCH to reduce UL interference and save UE battery consumption.](#_Toc84017324)[Proposal 4 In case of Type-1 HARQ codebook, when HARQ processes are enabled/disabled on a per HARQ process basis, RAN1 to downselect among the following: 1) the UE inserts NACK in positions corresponding to PDSCHs associated with feedback disabled HARQ processes. 2) the UE inserts ACK or NACK in positions corresponding to PDSCHs associated with feedback disabled HARQ processes, depending on the decoding outcome.](#_Toc84017325)[Proposal 5 In case of Type-2 HARQ codebook: - When HARQ processes are enabled/disabled on a per HARQ process basis, C-DAI/T-DAI count PDSCH with feedback-enabled HARQ processes. In the DCI, the C-DAI and T-DAI give the count of feedback-enabled HARQ processes regardless of whether a feedback-enabled or feedback-disabled HARQ process is scheduled. - The UE should use the DAI in DCI of feedback-disabled HARQ process to detect if a previous DCI of feedback-enabled HARQ processes has been missed. In such case, the UE should chose the HARQ codebook size based on the DAI in DCI of the feedback-disabled HARQ process, and the feedback-enabled HARQ process detected to be missed should be NACKed.](#_Toc84017326)[Proposal 6 In the case of the NR Type-3 HARQ codebook, when HARQ processes are enabled/disabled on a per HARQ process basis, the codebook size is dimensioned to include ACK/NACK information only for HARQ processes that are enabled.](#_Toc84017327)[Proposal 7 Regarding the “out-of-order restriction” for transmission of different HARQ processes corresponding to different PDSCHs, RAN1 to down-select between following alternatives:Alt-1: Preserve the same “out-of-order restriction” for (enabled) HARQ processes in specification for the disabled HARQ processes Alt-2: the “out-of-order restriction” for (enabled) HARQ processes does not apply to disabled HARQ processes.](#_Toc84017328) |
| R1-2109933ITL | Proposal 1. For DCI 0-0/1-0, extend the HARQ process ID field up to 5bits by higher layer signaling Proposal 2. For both type-1 and type-3 HARQ-ACK codebook, it is at least supported to skip the HARQ-ACK feedback associated with PDSCH occasions if the PDSCHs on only disabled HARQ processes are transmitted. Proposal 3. For type-2 HARQ-ACK codebook, it is supported that UE does not expect to multiplex in Type-2 HARQ-ACK codebook HARQ-ACK information that is in response to a detection of the DCI format 1\_2 that does not include a DAI field.Proposal 4. For SPS release for HARQ-ACK feedback, it is proposed to always perform the HARQ-ACK feedback corresponding to the PDCCH indicating SPS release.Proposal 5. It is proposed to support explicit DCI signaling for skipping HARQ-ACK feedback by reusing PUCCH resource indication field in the DCI.Proposal 6. It is proposed to support that SPS PDSCH with HARQ FB enabling with lowest configured sps-ConfigIndex should be firstly selected/prioritized when more than one SPS PDSCH configurations are in a slot  |
| R1-2110033Apple | Proposal 1: Enhanced HARQ process number indication is supported for DCI 0\_0/1\_0 by reusing one bit from another DCI bit field (e.g., RV field).Proposal 2: For Type-1 HARQ-ACK codebook, if DCIs carrying the feedback disabled and feedback enabled HARQ processes are detected by UE, the UE always reports NACK for the feedback disabled HARQ process. Proposal 3: For Type-1 HARQ-ACK codebook, if only DCI carrying feedback disabled HARQ process is detected by UE, the UE’s behavior is same as the case if DCIs carrying the feedback disabled and feedback enabled HARQ processes are detected by UE. Proposal 4: In Type-2 HARQ-ACK codebook construction, for the DCI of PDSCH with feedback disabled HARQ processes, C-DAI and T-DAI are given the count of feedback enabled processes.Proposal 5: For Type-1 HARQ-ACK codebook only for SPS PDSCH and for Type-2 HARQ-ACK codebook for SPS PDSCH, if a SPS configuration includes feedback disabled HARQ processes, then the HARQ-ACK codebook does not include the ACK/NACK bits for those feedback disabled HARQ processes. * Strive for a mechanism where all HARQ processes in a SPS configuration have the same feedback setting.

Proposal 6: Support to increase the aggregation factor for both dynamic grant PDSCH and SPS PDSCH. Proposal 7: Consider an adjustable aggregation factor in SPS PDSCH transmission.  |
| R1-2110086LG | Proposal 1: For DCI format 0-0/1-0, support no enhancement for enhanced HARQ process id identification in NTN.Proposal 2. For transmission enhancement when HARQ feedback is disabled, consider following enhancements: * Repetition number is recommended/reported by UE

Proposal 3. In case of two PDSCHs are associated with different HARQ process ids, introduce default/virtual ACK/NACK timing for feedback-disabled HARQ process. Proposal 4. For Type-1 HARQ-ACK codebook, UE ignores K1 and/or PRI field if DCIs carrying the feedback-disabled process are detected. Proposal 5. For Type-2 HARQ-ACK codebook, for the DCI of PDSCH with feedback-disabled HARQ processes, the C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented, and are taken into account by the UE for type 2 codebook generation.Proposal 6. RAN1 needs to discuss on the case where all DCIs scheduling PDSCHs are with disabled HARQ processes for Type-2 codebook. Proposal 7. For Type-3 HARQ codebook, the codebook is generated based only on feedback- enabled HARQ processes.Proposal 8. UE feedbacks acknowledgement for the reception of SPS activation DCI, if the first PDSCH after reception of the SPS activation DCI is associated with disabled HARQ process.  |
| R1-2110185Qualcomm | Observation 1: Within a lookback window of size $N$ (corresponding to a PUCCH occasion), for up to $M (M<N)$ PDSCHs of HARQ processes with feedback enabled (in any of the $N$ candidate occasions), $1+\sum\_{i=0}^{M-1}\left(\genfrac{}{}{0pt}{}{N}{i}\right) $codepoints are sufficient to construct a lossless semi-static ACK/NACK codebook.Proposal 1: For enhancement on the HARQ process indication, extend the HARQ process ID field up to 5 bits for DCI 0-0/1-0.Proposal 2: Consider new CQI BLER targets for HARQ processes without feedbacks.Proposal 3: Support a new UCI feedback for reporting DL transmission disruption and/or requesting DL scheduling changes when HARQ feedback is disabled. * To study the new UCI format and associated resource allocation.

Proposal 4: For DL HARQ processes with HARQ feedback disabled, initial transmissions shall use RV 0 and retransmissions shall not use RV 0.Proposal 5: For the DCIs of PDSCH with feedback-disabled HARQ processes, the values of the C-DAI and T-DAI are the same of the C-DAI and T-DAI of the most recent DCI of a PDSCH with a feedback-enabled HARQ process. Proposal 6: For Type-2 HARQ codebook, support spatial bundling of all feedback bits in a codebook if the number of feedback bits without bundling is less than or equal to N. * FFS: the value of N.

Proposal 7: For semi-static HARQ ACK codebooks, within a lookback window of size $N$ PDSCHs candidate occasions, a UE may be scheduled with up to $M (M<N)$ PDSCHs of HARQ processes with feedback enabled, where the PDSCHs may be scheduled in any of the $N$ candidate position(s) within the lookback window.* The value of $M$ as a function of N are to be configured for the UE.
* At least support M=1.

Proposal 8: RAN1 to consider semi-static HARQ codebook designs for the limit of PDSCH transmissions less than candidate occasions for HARQ processes with feedback enabled, with the aim of reducing the codebook size.Proposal 9: Support different transmit parameters and/or configurations per HARQ process or per HARQ process type (retransmissions is enabled/disabled), including* Power control
* MCS table
* UCI multiplexing parameters
* FFS other parameters

Proposal 10: For NTN, UE may receive a DCI scheduling a PUSCH of a given HARQ process before the end of the transmission of another PUSCH of that HARQ process.  |