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

e-Meeting, August 16th – 27th, 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
* PDSCH/PUSCH scheduling restriction
* Performance enhancement
* Performance Restriction on HARQ feedback disabling

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

In previous meeting, following agreements have been achieved:

Agreement:

* Enhanced HARQ process ID indication is supported for DCI 0-2/1-2 and DCI 0-1/1-1 by at least one of following:
	+ Option 1: Slot index as the MSB
	+ Option 1-a:Slot index as the LSB
	+ Option 2: Reusing one bit from other bit field
	+ Option 3: Extending the HARQ process ID field up to 5 bits
* FFS: DCI 0-0/1-0
* Note: 32 is taken as maximal supported HARQ processes number for both UL and DL

Agreement:

For enhancement on the HARQ process indication, extend the HARQ process ID field up to 5 bits for DCI 0-2/1-2

Agreement:

For enhancement on the HARQ process indication at least for DCI 0-1/1-1, the Option-1 and Option-1a are lower priority for further discussion.

Then, in this meeting, w.r.t to the enhancement on remaining DCI formats, i.e., DCI 0-1/1-1 and DCI 0-0/1-0, **following views are summarized as**:

* DCI 0-1/1-1:
	+ Option 2: CATT, CAICT, Apple, ZTE
	+ Option 3: Huawei, vivo, Spreadtrum, Baicells, Samsung, NEC,MTK, CAICT (2nd priority), FGI, Asia Pacific Telecom, III, ITRI, CMCC, Panasonic, LG, Ericsson, DCM, Xiaomi, ITL, Nokia
	+ Others: OPPO (Option 1/1a)
* DCI 0-0/1-0
	+ Option 2: Huawei (idle bit), vivo(LSB of MCS), Apple, ZTE
	+ Option 3: MTK, CMCC, ITL, Nokia
	+ No supported: vivo, Baicell, Samsung, NEC, CATT, CAICT, FGI, Asia Pacific Telecom, III, ITRI, CMCC, LG, Ericsson, DCM
	+ Others: vivo (extend the number of scrambled CRC parity bits), CAICT (same as DCI 0-1/1-1), Xiaomi (Option 1/1a)

Also, as highlighted by [CATT, MTK, Xiaomi], supports on the larger HARQ process is up to UE’s capability and can be configured by gNB [Ericsson] or based on the UE assistance information report [Samsung]. However, [Nokia] prefers to take the 32 HARQ process default for NTN specific operation.

According to the above summary, it seems that majority is supportive to directly extent the bit field even for DCI 0-1/1-1, and following proposal is made:

**[Initial Proposal 1-1]:** For enhancement on the HARQ process indication, extend the HARQ process ID field up to 5 bits for DCI 0-1/1-1**.**

Please provide your views and justifications.

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| **Company** | **Comments and Views** |
| OPPO | Fine |
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For DCI 0-0/1-0, since the views from companies are still not converged, it’s preferred for companies to future share the views on following proposal with preference and justification:

**[Initial Proposal 1-2]:** Following options on HARQ process ID indication for DCI 0-0/1-0 can be considered:

* Option 2: Reusing one bit from other bit field
* Option 3: Extending the HARQ process ID field up to 5 bits
* Option 4: No enhancement

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| **Company** | **Comments and Views** |
| OPPO | Option 4, no enhancement is the safest solution. Any other options will cause potential ambiguity between gNB and UE.  |
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# **Issue-2 HARQ codebook enhancements**

In the previous meeting, following agreements have been achieved:

Agreement:

HARQ codebook enhancement is supported as:

* For Type-2 HARQ codebook:
	+ Option-1: Reduce codebook size with:
		- HARQ-ACK codebook only includes HARQ-ACK of PDSCH with feedback-enabled HARQ processes
			* FFS: the details of C-DAI and T-DAI counting for DCI of PDSCH with feedback-enable/disabled HARQ processes
		- FFS: at least DCI for SPS release/SPS PDSCH
	+ Option-2: No enhancement
	+ Other options are not precluded.
* For Type-1 HARQ codebook, further discuss is needed with down selection among following options:
	+ Option-1: No enhancement;
	+ Option-2: Report NACK on disabled process
	+ Option-3: Reduce codebook size with criteria
* FFS: Enhancements for Type-3 HARQ codebook

Agreement:

For Type-2 HARQ codebook in NTN: Reduce codebook size with HARQ-ACK codebook only including HARQ-ACK of PDSCH with feedback-enabled HARQ processes

* FFS: The details of C-DAI and T-DAI counting for DCI of PDSCH with feedback-enable/disabled HARQ processes

Agreement:

For Type-2 HARQ codebook in NTN,

* For the DCI of PDSCH with feedback-enabled HARQ processes, the C-DAI and T-DAI are the count of only feedback-enabled processes
* FFS: Whether DCI for SPS release and any other DCIs are included in counting of C-DAI and T-DAI

Then, in this meeting, **following views are summarized for each topic as**:

# **Clarification on the consequence/intention to support the feedback-disabled HARQ process:**

In order to facilitate the progress for discussion, following proposals to clarify the consequence/intention after the introduction of feedback-disabled HARQ process are highlighted:

* If HARQ feedback is disabled for a HARQ process, NW and UE have a common understanding that the PHY layer does not **generate** acknowledgment of the data in this TB for the HARQ process. [FGI, Asia Pacific Telecom, III, ITRI]
* Enhancements to minimize the UL feedback for DL transmission with feedback-disabled process should be prioritized. [ZTE]

From moderator’s perspective, based on the previous agreement to enable the feedback-disabled HARQ process, we need to be constructive on the remaining enhancements to harvest the benefits. Otherwise, the usage/gain of previous progress will be limited.

Please provide your views below：

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| **Company** | **Comments and Views** |
| OPPO | The intention for introducing HARQ-disable is to allow increase the DL transmission throughput. The RAN1 agreements (quoted below) at the current stage can already address this motivation. We think no further enhancement is needed to be discussed. Please note that reducing the PUCCH overhead is not the motivation of the HARQ-disabling feature.Agreement:For a DL HARQ process with disabled HARQ feedback, the UE is not expected to receive another PDSCH or set of slot-aggregated PDSCH scheduled for the given HARQ process that starts until X after the end of the reception of the last PDSCH or slot-aggregated PDSCH for that HARQ process.* Working assumption: X = T\_proc,1
* FFS: Whether X should be changed to X = max(T\_proc,1, K1) where K1 is the minimum k1 if it is configured, otherwise k1 = 0
* Note: The TB of the two PDSCHs can be either same or different

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 for the given HARQ process. |
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# **Enhancement on Type-1 Codebook (Semi-static codebook):**

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

* + Option-1: No enhancement
* Supported by [Spreadtrum, CATT (2nd priority), OPPO, Nokia, Apple, Xiaomi, Panasonic]
	+ As pointed by [Spreadtrum], for Type-1 codebook with semi-static size, the needs for enhancement is limited.
	+ Option-2: Report NACK or ACK on disabled process
		- Supported by [DCM (NACK), Ericsson, MTK,ITRI]
	+ Option-3: Reduce codebook size with additional limits
		- Supported by [Huawei, vivo Qualcomm, Ericsson, Sony, Samsung, NEC], more specifically, the detailed criteria can be :
		- Support configuration to a UE of a bitmap that indicates slots where the UE should generate HARQ-ACK information [Huawei, Samsung]
		- Skipping the feedback of PDSCH occasions from disabled HARQ processes [Baicell]
			* Skipping the feedback of PDSCH occasions if only disabled HARQ process are transmitted [vivo, CMCC, NEC]
			* Skipping the feedback of PDSCH occasions if only disabled HARQ process are transmitted for one cell [Sony, LG,ITL]
			* Skipping the feedback of PDSCH occasion if no DCI for a feedback-enabled HARQ process in any slot associated with the HARQ codebook is decoded [CATT, CAICT, Ericsson, CMCC, ZTE].
		- Others
			* Up to UE’s implementation on whether UE **sends** the codebook feedback if no DCI for a PDSCH with feedback enabled HARQ processes in the HARQ CB is decoded. [FGI, Asia Pacific Telecom, III, ITRI]
			* Introduce new codebook design for the limit of PDSCH transmissions less than candidate occasions for HARQ processes with feedback enabled [Qualcomm]
				+ E.g., reporting the position(s) in which the UE received an ACK/NACK enabled
			* When HARQ-ACK for a HARQ process with disabled HARQ-ACK report is included in a Type-1 HARQ-ACK codebook, the UE reports for the HARQ process: [Samsung]
				+ HARQ-ACK with NACK value when the Type-1 codebook size is not larger than 11 bits, and
				+ HARQ-ACK as in Rel-16 when the Type-1 codebook size is larger than 11 bits.
			* Restriction on the scheduling can be consider to reduce the codebook size [Sony]

Moreover, as highlighted by [DCM], for Type 1 HARQ-ACK CB, discussions on behaviour if no DCI for a PDSCH with a feedback-enabled HARQ processes in any slot (at least PUSCH case) is postponed till the corresponding Rel-15/16 CR is concluded.

Based on the inputs and previous discussion, it seems that companies’ views are still unchanged. From moderator’s perspective, there is clear benefits on UL overhead reduction with potential enhancement for Type-1 codebook, especially when only DCI carrying a feedback-disabled HARQ process is used and detailed condition can be future discussed with following proposal：

**[Initial Proposal 2-1]:**

For Type-1 HARQ codebook in NTN, the UE should skip the codebook feedback if only feedback-disabled HARQ processes is associated with PDSCH occasions:

* FFS: The case that DCI carrying a feedback-enabled HARQ process is not decoded at UE side
* FFS: Whether the principle is applied per serving cell
* FFS: Necessity on the indication of additional assistance information from gNB

Please provide your views below：

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| **Company** | **Comments and Views** |
| OPPO | No new agreement is needed. We can discuss other high priority topics. We suggest to deprioritize this discussion.  |
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# **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, Baicell, LG Ericsson, ZTE, ITL]
		1. Solution 1: No feedback for HARQ process with disabled feedback
		2. Solution 2: Skipping the feedback of PDSCH occasions if only disabled HARQ process are transmitted for one cell [ITL]
	2. Negative to enhancement: [CATT, OPPO, Nokia, Samsung, DCM]

As pointed by [CATT, OPPO], supports on Type-3 codebook is not needed and can be deprioritized [FGI, Asia Pacific Telecom, III, ITRI]. Same view is shared by [DCM] with consideration on workload.

Based on the inputs above, 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 2-2]:** 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 | No new agreement is needed. We can discuss other high priority topics. We suggest to deprioritize this discussion.  |
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# **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:

1. Option-1: The C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented [vivo, Baicell, CATT, CMCC, LG, Ericsson, Xiaomi]
2. Option-2: The C-DAI and T-DAI are ignored by the UE
	* No need to specify any value, i.e., any value can be used by gNB [Samsung, NEC, ZTE]
3. Option-3: The C-DAI/T-DAI are the count of feedback-disabled processes [Huawei]
4. Option-4: The C-DAI is a reserved value that can be ignored by the UE and T-DAI is the count of feedback-enabled processes despite it not incremented [Apple].

Based on the inputs above and consideration of previous meeting, it seems that the views from companies are not changed. From moderator perspective, there is strong need to clarify the behaviour for the case with feedback disabled HARQ process. Then, following proposal is made according to the majority views：

**[Initial Proposal 2-3]:** For the DCI of PDSCH with feedback-enabled HARQ processes, the C-DAI and T-DAI are the count of feedback-enabled processes, despite they are not incremented

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

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| **Company** | **Comments and Views** |
| OPPO | No new agreement is needed. We can discuss other high priority topics. We suggest to deprioritize this discussion.  |
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# **Discussion on SPS issue**

In this meeting, the following views are shared for SPS PDSCH activation/release and SPS transmission:

* For the SPS PDSCH activation/PDSCH release:
	+ Option-1: No enhancement [Spreadtrum, Sony, CAICT, DCM, Spreadtrum, Samsung, Sony, CAICT, OPPO, ITL, Nokia]
		- E.g., the counter DAI, total DAI and DAI in DCI format 0\_1 count for PDCCH indicating SPS PDSCH activation/release when the related SPS PDSCH is HARQ feedback disabled.
		- E.g., For SPS activation/release, UE reports HARQ-ACK regardless of any configuration of enabling/disabling HARQ feedback.
	+ Option-2: Additional scheduling restriction:
		- HARQ-ACK feedback for activation and release command should be enabled by one HARQ process with feedback [CATT, FGI, Asia Pacific Telecom, III, ITRI, Nokia]
		- 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. [LG]
* For SPS PDSCH transmission:
	+ HARQ codebook generation:
		- For SPS PDSCH, the HARQ-ACK codebook includes only HARQ-ACK information for enabled HARQ processes [Samsung]
	+ HARQ feedback configuration:
		- Enabling/disabling of HARQ feedback for DL SPS/UL CG is configured per configuration. [DCM,CAICT, Apple]
			* HARQ feedback-enabling/disabling configured per HARQ process is ignored for SPS.[DCM]
	+ Others
		- 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 [ITL]

In additional, [DCM, NEC] proposed to 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. And for SCell dormancy, UE should report HARQ-ACK regardless of any configuration of HARQ feedback-enabling/disabling as highlighted by [DCM], other cases as PDSCH reception scheduled by a fallback DCI and PDSCH reception including successRAR: e.g. CFRA in a handover case, can be further discussed.

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 2-4]:** For the SPS PDSCH activation/release, one of following should be supported:

* Alt-1: The legacy behavior on HARQ-codebook feedback and DCI counting for SPS PDSCH activation/release is kept for the case that DCI is associated with either feedback-enabled or feedback-disabled HARQ process
* Alt-2: UE expects that SPS PDSCH activation/release information are transmitted using HARQ processes with feedback enabled.

Please provide your views below：

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| **Company** | **Comments and Views** |
| OPPO | SPS PDSCH activation is related to a PDSCH reception. While SPS SPDCH release is independent of PDSCH reception. Thus, why these two things should be jointly discussed and have a joint UE behaviour. To us, SPS PDSCH release and activation should be separately discussed. For SPS PDSCH activation: there is no need to separate SPS PDSCH activation and DCI dynamically scheduled PDSCH. In legacy system, they are not separated. And they are commonly defined as PDSCH reception scheduled by a DCI format. For NTN, there is no need to extract SPS PDSCH activation. The C-DAI/T-DAI interpretation can simply follow RAN1 agreementAgreement:For Type-2 HARQ codebook in NTN, * For the DCI of PDSCH with feedback-enabled HARQ processes, the C-DAI and T-DAI are the count of only feedback-enabled processes
* FFS: Whether DCI for SPS release and any other DCIs are included in counting of C-DAI and T-DAI

 For SPS PDSCH release: it is independent of HARQ disabling and enabling, so naturally, it should follow legacy behaviour.  |
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# **Additional limits on PDCCH construction:**

In this meeting, following proposals on the potential limits on PDCCH restriction are made by proponent to enhance the performance of PDCCH detection.

* A DCI format scheduling a PDSCH reception for a HARQ process with disabled HARQ-ACK does not include the PRI, a PUSCH-to-HARQ\_feedback timing, counter DAI, and TPC command fields. [Samsung]
* For Type-2 HARQ-ACK codebook, HARQ-ACK feedback related bit fields including C-DAI/T-DAI are not included in the DCI with a feedback-disabled HARQ process. [CAICT]

From moderator’s perspective, it’s the first time to discuss this topic and benefits on corresponding proposal may need further justification. Then, views from companies are welcomed:

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| **Company** | **Comments and Views** |
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# **Issue-3 PDSCH/PUSCH scheduling restriction**

In RAN1#105-e meeting, the OOO issue (out of order HARQ feedback scheduling restriction for PDSCHS with different HARQ process IDs) has been identified for further discussion with consideration on the joint existence of feedback-enabled and feedback-disabled HARQ process. In this meeting, following views are shared by companies:

* In case of two PDSCHs are associated with different HARQ process ids, introduce default/virtual ACK/NACK timing or timing offset for feedback-disabled HARQ process. [LG]
* [Regarding the “out-of-order restriction” for transmission of different HARQ processes corresponding to different PDSCHs, RAN1 to down-select between following alternatives:](#_Toc79154036) [Ericsson]
	+ [Alt-1: Preserve the same “out-of-order restriction” for (enabled) HARQ processes in specification for the disabled HARQ processes](#_Toc79154037)
	+ [Alt-2: the “out-of-order restriction” for (enabled) HARQ processes does not apply to disabled HARQ processes.](#_Toc79154038)
* For joint scheduling with feedback enable and disabled process, the legacy restriction on the out-of-order HARQ timing restriction should be kept. [ZTE]

Based on the inputs above, it seems that it’s still feasible and available to keep the legacy restriction in NTN case and following proposal is made:

**[Initial Proposal 3-1]:** For transmission of different PDSCHs with different HARQ processes, the legacy restriction on the out-of-order for HARQ process should be kept for both feedback-enabled and feedback-disabled HARQ process.

Please provide your views below.

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| **Company** | **Comments and Views** |
| OPPO | Legacy OOO restriction should be kept. The network should ensure that OOO is not happened by indicating a suitable value of K1. This is same as R15/R16.  |
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In RAN1#105-e meeting, following agreement is achieved on the processing time for PDSCH.

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 for the given HARQ process.

 Then, in this meeting, potential updates for the SPS case is proposed with following proposal from DCM as

* *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.*

Since it’s first time to discuss the related topic for SPS and whether additional enhancements on SPS case including HARQ codebook enhancement and potential restriction on HARQ feedback disabling for SPS are still pending in section 2, the discussion can be postponed and please your views below:

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| **Company** | **Comments and Views** |
| OPPO | Proposal is reasonable, we propose the following updates. * + *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 PDSCH with SPS or the PDCCH carrying the DCI scheduling another PDSCH or set of slot-aggregated PDSCH for the given HARQ process.*
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Moreover, in this meeting, same proposal from [Qualcomm] 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.

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.

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| **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.
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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.

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| **Company** | **Comments and Views** |
| OPPO | From the last meeting, we have expressed that the constraint that a second DCI should already be received after the previous PUSCH transmission is not necessary in NTN. Therefore, companies should provide justification on the necessity of having this constraint. Otherwise, this constraint is artificial and should be removed.  |
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# **Issue-4 Performance enhancement**

In RAN1#105e meeting, following agreement has been achieved:

Agreement:

Discussion of enhancement(s) on the aggregated transmission (including repetition) is prioritized to improve the performance in NTN.

In this meeting, following enhancements related to the aggregated transmission are summarized as:

* + Enhancement for DL vs UL

As highlighted by [Samsung], there is on-going discussion in Coverage Enhancement WI to improve the UL performance and corresponding progress is also applicable for NTN. Then, only downlink related enhancement should be considered in Rel-17 NTN and solutions to improve the PRACH/PDCCH will be postponed in Rel-18.

* + Larger aggregation factor:

For this aspect, as highlighted by [CATT, ETRI, MTK, IDC, Nokia, Samsung, ZTE], supports of larger aggregation factor is considered to be beneficial for NTN case. More specifically, [IDC] prefers to enlarge the value from 16 to 32.

* + Indication/configuration of aggregation factor/repetition factor:

For this aspect, following solutions are proposed to enhance the indication/configuration of corresponding parameter for enhanced transmission:

* + - DCI based indication: [Huawei, IDC] prefer to indicate the value via DCI by reinterpreting the idle bits with configuration depending on the orbit parameters.
		- [OPPO, Ericsson, Apple, ETRI] prefer to introduce different configurations for the transmission via HARQ process with enabled or disabled feedback.

Moreover, UE recommended repetition number is also proposed by [LG].

* + 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]
	+ DM-RS bundling in time domain [MTK]
* 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 [Qualcomm, Interdigital] with concern from [CATT], new UCI feedback in case of scheduling with disabled HARQ feedback[ETRI, Xiaomi], UE assistant information [Huawei], introduction on the priority order for transmission [CAICT], RV limitation for DL scheduling and different configuration on transmission parameters [Qualcomm] are proposed by proponent.

According to the above discussion and corresponding consideration on the overlapping/progress of other WI (i.e., CE WI), it’s recommended from feature leader perspective that the enhancement on DL is prioritized with following proposal:

**[Initial Proposal 4-1]:**

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

* FFS: X = 16 or 32
* FFS: Whether different configurations are considered for the transmission via feedback-enabled or feedback-disabled-HARQ process

Please provide your views below：

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| **Company** | **Comments and Views** |
| OPPO | Fine |
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# **Issue-5 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, MTK, CAICT, CMCC, DCM, Nokia, Sony, InterDigital]
2. Option 2: Up to gNB’s implementation for scheduling [vivo, Baicell, NEC, Panasonic]

In addition, [vivo] prefer to introduce semi-static configured and dynamically switched on the HARQ disabling for addressing these two issues.

Moreover, as pointed by [Nokia], to avoid the same ambiguity for DCI carrying SPS release signalling, it’s preferred to also mandate corresponding scheduling via feedback enabled HARQ process.

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 5-1]:** 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 | Not agree. It is up to gNB implementation.  |
|  |  |

# **Conclusion**

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

# **Appendix**

|  |  |
| --- | --- |
| Contribution | Observation/Proposals |
| R1-2106484 Huawei | Observation 1: For DCI format 0\_0/1\_0, extending the HARQ process ID field would introduce extra complexity at UE side.Observation 2: The case where all the scheduled HARQ processes are disabled is a rare corner case as there is a high likelihood that the HARQ codebook contains the feedback for TAC. Observation 3: With disabling mechanism, if gNB still reserve all feedback resources based on the $M\_{A,C}$ occasions, a large number of resources would be waste.Observation 4: As long as one enabled HARQ process is scheduled, the gNB has to reserve feedback resources anyway as UE miss-detection is unpredictable. Observation 5: For Type-1 HARQ-ACK codebook, by skipping the feedback of PDSCH occasions from disabled HARQ process, the signalling overhead can be reduced as large as 32x.Observation 6: UE can be configured to know whether a PDSCH occasion is for feedback disabled or enabled HARQ processes.Observation 7: For Type-1 HARQ-ACK codebook, when the only enabled DCI miss-detected, the benefit of skipping feedback to reduce signalling overhead is marginal.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 to detect DCI missing at the UE. 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.Proposal 1: For DCI format 0\_1/1\_1, the field of HARQ process number is extended to 5 bits in NTN.Proposal 2: For DCI format 0\_0/1\_0, keep the fixed 4 bits of HARQ process number field and support indication of HARQ process ID via reusing idle bits of DCI.Proposal 3: For Type-1 HARQ-ACK codebook, a UE can be configured with a bitmap which indicates a set of PDSCH occasions for which HARQ-ACK feedback is provided.Proposal 4: In Type-2 codebook, for the DCI of PDSCH with feedback-disabled HARQ process, give true values of C-DAI and T-DAI as the count of feedback-enabled processes. Proposal 5: For Type-3 HARQ-ACK codebook, skip the feedback of PDSCH occasions from disabled HARQ processes.Proposal 6: Aggregation/repetition transmission parameters can be configured depends on orbital height.Proposal 7: Aggregation/repetition transmission parameters can be indicated via DCI.Proposal 8: Reinterpret idle bits in DCI for indicating transmission parameters.Proposal 9: UE assistance information reporting in reserved resource can be considered for NTN. |
| R1-2106593vivo | Proposal 1：Support to indicate enhanced HARQ process ID by the following:* For DCI 0-1/1-1, extend the HARQ process ID field to 5 bits if the maximum number of HARQ processes is configured to 32 by the high layer.
* For DCI 0-0/1-0, at least the following alternatives can be considered:
	+ Alt 1: do not support 32 HARQ processes.
	+ Alt 2: re-interpret existing DCI field to indicate the extension of HARQ process ID, e.g. the LSB of the MCS indication.
	+ Alt 3：extend the number of scrambled CRC parity bits to indicate the MSB of the HARQ process ID.

Proposal 2: The scheduling with a given HARQ process to enable/disable HARQ feedback to send MAC CE is up to gNB implementation.Proposal 3: The functionality of enabling/disabling HARQ feedback per HARQ process can be semi-static configured and dynamically switched.Proposal 4：Support to enhance HARQ-ACK codebook as below:* For Type-1 HARQ-ACK codebook:
	+ If enabled HARQ processes or SPS PDSCH release are transmitted in the occasions, no enhancement.
	+ If only disabled HARQ processes are transmitted in the occasions, omit the HARQ-ACK report.
* For Type-2 HARQ-ACK 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.
* For Type-3 HARQ-ACK codebook:
	+ HARQ-ACK codebook includes HARQ-ACK of all the enabled HARQ processes in one shot.
 |
| R1-2106703 Spreadtrum | Proposal 1: For enhancement on the HARQ process indication, extend the HARQ process ID field up to 5 bits for DCI 0-1/1-1 should also be supported.Proposal 2: No enhancement is needed for the Type-1 codebook.Proposal 3: PDCCH indicating SPS PDSCH activation when the related SPS PDSCH is HARQ feedback disabled should be included in counting of C-DAI and T-DAI.Proposal 4: Enhancement for Type-3 HARQ codebook should be considered, if it is supported in NTN. |
| R1-2106756Baicells | 1. If 32 HARQ processes are configured, extending the HARQ process ID field up to 5 bits for non-fallback DCI 0-1/1-1.
2. No HARQ enhancement for DCI 0-0/1-0 is needed.
3. 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.
4. Type-1 codebook can be enhancement by ignoring the transmission occasions with disabled HARQ processes.
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.
 |
| R1-2106807Sony | 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 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.Proposal 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) who’s associated PDSCH is HARQ feedback enabled.

Proposal 3: UE reports 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 count for PDCCH indicating SPS PDSCH activation when the related SPS PDSCH is HARQ feedback disabled.Proposal 5: The UE reports HARQ feedback information for the SPS PDSCH release, either the related SPS PDSCH is HARQ feedback disabled or enabled.Proposal 6: The counter DAI, total DAI and DAI in DCI format 0\_1 count for PDCCH indicating SPS PDSCH release, either the related SPS PDSCH is HARQ feedback disabled or enabled. |
| [R1-2106886](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2106886.zip)Samsung | Proposal 1: For the Type-1 HARQ-ACK codebook, support configuration to a UE of a bitmap that indicates slots where the UE should generate HARQ-ACK information. Proposal 2: When HARQ-ACK for a HARQ process with disabled HARQ-ACK report is included in a Type-1 HARQ-ACK codebook, the UE reports for the HARQ process:* HARQ-ACK with NACK value when the Type-1 codebook size is not larger than 11 bits, and
* HARQ-ACK as in Rel-16 when the Type-1 codebook size is larger than 11 bits.

Proposal 3: A DCI format scheduling a PDSCH reception for a HARQ process with disabled HARQ-ACK does not include the PRI, a PUSCH-to-HARQ\_feedback timing, counter DAI, and TPC command fields.Proposal 4: For SPS PDSCH, the HARQ-ACK codebook includes only HARQ-ACK information for enabled HARQ processes.Proposal 5: Support coverage enhancements in NTN based on the Rel-17 WI on coverage enhancements* For PUCCH/PUSCH, the Rel-17 mechanisms are applicable for NTN.
* For PDSCH, introduce larger repetition numbers.
* Consider coverage enhancements for PRACH/PDCCH in Rel-18.

Proposal 6: When a UE is configured more than 16 UL/DL HARQ processes, the HPN field size in DCI formats 0\_1/1\_1 is 5 bits. The HPN field size in DCI formats 0\_0/1\_0 is as in Rel-16.Proposal 7: A UE indicates a capability for a maximum number of UL HARQ processes.Proposal 8: For the maximum number of HARQ processes, support one of the following options. * Option 1. A gNB informs a maximum TBS to a UE and the UE reports its capability for a number of HARQ processes.
* Option 2. A UE reports separate capabilities for a number of predefined pairs of {maximum number of HARQ processes, maximum TBS}.

Proposal 9: Consider UE assistance information to support up to 32 HARQ processes without increasing the soft buffer size.Observation 1: HARQ-ACK feedback disabling offers marginal benefits for UE power savings in Rel-17 NTN. Observation 2: Enhancements for Type-3 and enhanced Type-2 HARQ codebooks are not necessary for NTN in Rel-17. Observation 3: There is no need to specify any value for the DAI in a DCI format scheduling PDSCH reception for a HARQ process having disabled HARQ-ACK.Observation 4: There is no need to change the Rel-16 Type-2 HARQ-ACK codebook construction that is for HARQ processes with enabled HARQ-ACK reports.Observation 5: There is no need to change Rel-16 operation for HARQ-ACK report in response to SPS PDSCH release.Observation 6: There is no need for PDSCH coverage enhancements to depend on whether a HARQ-ACK report for a respective HARQ process is enabled or disabled. |
| R1-2106969 CATT | Observation 1:Additional HARQ bit can be taken from second block DCI field if only one layer tansmission supported in NTN. 1. Consider to use DCI field of second block as additional HARQ bit indication to support 32 HARQ processes in DCI 0-1/1-1.
2. 16 HARQ processes for DCI 0-0 /1-0 can be supported.
3. 32 processes can be supported based on UE capabilities.
4. For Type-1 HARQ codebook in NTN, if no DCI for a PDSCH with a feedback-enabled HARQ processes in any slot associated with the HARQ codebook is decoded, the UE should not generate and send the codebook feedback. Otherwise, legacy behavior is assumed.
5. Type 2 HARQ-ACK codebook can be optimized, and the counter DAI and total DAI for a PDSCH with a feedback disabled HARQ process are the same as the previous PDSCH with a feedback enabled HARQ process.
6. For SPS case, the HARQ-ACK feedback for activation and release command can be enabled.
7. Type 3 HARQ-ACK codebook is not needed in NTN case.
8. UE expects that at least one HARQ process with feedback is configured for the scheduling of MAC-CE.
9. Slot aggregation factor can be extended to 16 for very low SINR case.
10. Support time interleaved slot aggregation to improve transmission reliability.
11. There is no need for MCS enhancement.
 |
| R1-2107015NEC | Proposal 1: gNB can use any value for the C-DAI and T-DAI in the DCI of PDSCH with feedback-disabled HARQ process.Proposal 2: DCI for SPS release and any other DCIs which are included in counting of C-DAI and T-DAI in Rel-16 should be treated as in current specification.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 reports HARQ 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:* Support option 3 for HARQ process ID indication for DCI 0-1/1-1
* 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. |
| R1-2107066MTK | 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: For enhancement on the HARQ process indication, extend the HARQ process ID field up to 5 bits for DCI 0-1/1-0.Proposal 3: Support of 32 HARQ processes in the device is a UE capability in NR NTN.Proposal 4: UE expects that MAC-CEs are transmitted using HARQ processes with feedback enabled.Observation 1: In NR specifications, the MCS selection, time domain allocation, and frequency resource allocation type 0 and type 1 can be done first as in the specifications. Then, repetitions with values 2, 4, or 8 to increase the reliability of each transmissions as in URLLC can be done based on pdsch-AggregationFactor for DL or repK for UL based on RRC configuration. Increasing value for pdsch-AggregationFactor for DL or repK for UL to 16 has minimum impact on the specification.Observation 2: With repetitions or aggregation slots, DMRS time bundling for channel estimation across slots could allow lower DMRS density without significant channel estimation performance loss compare to not using DMRS time bundling.Proposal 5: Support higher level of slot aggregation / repetitions 16 for NTN NR.Proposal 6: Support DMRS time bundling with level of slot aggregation / repetitions for NTN NR. |
| R1-2107168CAICT | Proposal 1: For DCI 0-1/1-1, option 2 is used if scheduling flexibility is not impacted much. Reusing the bit field of TPC command for PUCCH/PUSCH is preferred. Otherwise, option 3 is also acceptable. Proposal 2: For DCI 0-0/1-0, if it is used during TN/NTN identification period, keep the current 4 bits with no extension of HARQ process number. Otherwise, unified solution for DCI 0-0/1-0 as DCI 0-1/1-1.Proposal 3: For Type-1 HARQ-ACK codebook, the UE should not generate and send the codebook feedback if no DCI for a PDSCH with a feedback-enabled HARQ processes in any slot associated with the HARQ codebook is decoded.Proposal 4: For Type-2 HARQ-ACK codebook, HARQ-ACK feedback related bit fields including C-DAI/T-DAI are not included in the DCI with a feedback-disabled HARQ process.Proposal 5: 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 6: Type-3 HARQ-ACK codebook could be used as a complement way if no more specification requirements are identified than removing HARQ-ACK for feedback-disabled HARQ processes in the codebook.Proposal 7: At least one DL HARQ process with HARQ-ACK feedback enabled is configured for the scheduling of MAC-CE.Proposal 8: Enabling/disabling of HARQ feedback for DL SPS/UL CG is configured per configuration.Proposal 9: Provide higher priority order for the HARQ disabled transmission than the priority order for HARQ enabled transmission. |
| R1-2107245OPPO | Proposal 1: The enabling/disabling of HARQ processes for both DL and UL scheduling via RRC or DCI should be supported.Proposal 2: For Type-1 HARQ codebook, Option-1 is supported, i.e., HARQ-ACK information for disabled DL HARQ processes should be reported in Type-1 HARQ-ACK codebook.Proposal 3: 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 4: Type-3 HARQ codebook is not supported in NR-NTN. Proposal 5: PUSCH transmission constraint for a given disabled UL HARQ process should be considered. Proposal 6: Enhancements to PDSCH/PUSCH with disabled HARQ process to achieve a higher reliability should be considered. * Configure different aggregation factors for PDSCH reception with or without HARQ-ACK feedback.

Proposal 7: PUSCH processing time should be updated in NTN. Proposal 8: Option 1 or Option 1a is slightly preferred for enhanced HARQ process ID indication for DCI format 0-1/1-1. Proposal 9: PDSCH reception constraint for a given enabled DL HARQ process should be clarified in NTN. Proposal 10: PUSCH transmission constraint for a given enabled UL HARQ process should be clarified in NTN. Proposal 11: The size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI should not be changed. |
| R1-2107289FIG,APT,ITRI | [Observation 1 If PDCCH contents indicate an SPS PDSCH release, UE shall clear the configured DL assignment for this Serving Cell, thus the associated HARQ feedback shall be mandatory.](#_Toc79066285)[Proposal 1 If HARQ feedback is disabled for a HARQ process, NW and UE have a common understanding that the PHY layer does not generate acknowledgment of the data in this TB for the HARQ process.](#_Toc79066278)[Proposal 2 UE expects an SPS PDSCH release is transmitted using HARQ processes with feedback enabled.](#_Toc79066279)[Proposal 3 For Type-1 HARQ CB, it can be up to UE implementation whether UE sends the codebook feedback if no DCI for a PDSCH with feedback enabled HARQ processes in the HARQ CB is decoded.](#_Toc79066280)[Proposal 4 Deprioritize Type-3 HARQ CB enhancement for NTN in Rel-17, considering there might be no use case when Type-1 and Type-2 HARQ CBs can be supported in NTN.](#_Toc79066281)[Proposal 5 Support Option 3: Extending the HARQ process ID field up to 5 bits, considering it has nearly no impact on the DCI size budget, i.e., a UE can monitor up to (3+1) different sizes of DCI formats.](#_Toc79066282)[Proposal 6 For Fallback DCI format (0-0, 1-0), no extension is needed, regarding no need to support more than 16 HARQ processes for initial access.](#_Toc79066283)[Proposal 7 Support on the maximal HARQ process number is up to UE capability and configure via UE-specific RRC signaling.](#_Toc79066284) |
| R1-2107343Qaulcomm | 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: Consider new CQI BLER targets for HARQ processes without feedbacks.Proposal 2: 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 3: For DL HARQ processes with HARQ feedback disabled, initial transmissions shall use RV 0 and retransmissions shall not use RV 0.Proposal 4: 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 5: 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 6: 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 7: 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 8: 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.  |
| R1-2107401CMCC | Observation 2: In the case of both DCIs of PDSCH with feedback-enabled/disabled HARQ processes are mixed transmitted by the gNB, skipping feedback transmission due to error cause may save UE battery consumption and reduce UL interference, but it can NOT bring any benefit on UL resources overhead saving at the gNB side.Observation 3: In the case of only DCIs of PDSCH with feedback-disabled HARQ processes are transmitted by the gNB, skipping feedback transmission will save UE battery consumption, reduce UL interference, and save UL resources overhead at gNB side.Proposal 1: Support extending the HARQ process ID field up to 5 bits for DCI 0-1/1-1.Proposal 2: For DCI 0-0/1-0, one of the followings is considered* Option 3: Extending the HARQ process ID field up to 5 bits
* Option x: “no enhancement”, i.e., keep the HARQ process ID field up to 4 bits unchanged

Proposal 3: For Type-1 HARQ codebook in NTN, the UE should not generate and send the codebook feedback if no DCI for a PDSCH with a feedback-enabled HARQ processes in any slot associated with the HARQ codebook is decoded.Proposal 4: For Type-2 HARQ codebook in NTN, for the DCI of PDSCH with feedback-disabled HARQ process, the counting of T-DAI is the count of feedback-enabled processes, despite they are not incremented.Proposal 5: UE expects that MAC-CEs are transmitted using HARQ processes with feedback enabled. |
| R1-2107469Panasonic | Proposal 1: 1 bit is added for HARQ process ID indication in DCI format 0\_1/1\_1.Proposal 2: No enhancement for type 1 HARQ-ACK codebookProposal 3: For type 2 HARQ-ACK codebook, PDSCH for feedback-disabled HARQ processes should not be counted in both C-DAI and T-DAI.Proposal 4: T-DAI field in the DCI of PDSCH with feedback-disabled process indicates the total DAI value while C-DAI field is reserved. Proposal 5: DAI indication in the DCI of PDSCH with feedback-disabled process when the number of HARQ-ACKs is zero should be discussed. Proposal 6: Whether to use feedback-disabled process or enabled process for SPS PDSCH is up to network implementation.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.  |
| R1-2107475ETRI | 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)

Observation 5 : The slot aggregation (aggregation factor>1) could enhance BLER and SE simultaneously within low S(I)NR ranges.Observation 6 : The slot aggregation (aggregation factor> 1) might be inevitable for achieving target BLER.Observation 7 : The change of aggregation factor might be needed for achieving optimal SE performance.Observation 8 :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 9 :larger aggregation factor might be inevitable for NTN.* for PUSCH : 8 aggregated transmission might be insufficient even if low SE MCS index is applied.
* for PDSCH :
	+ if target BLER $\geq $ 0.1%, 8 aggregated transmission might be enough.
	+ otherwise, 8 aggregated transmission might be insufficient

Observation 10 : larger aggregation factor method has less specification impact and could be more effective than low SE MCS index table method.Observation 11 : For optimal adaptation, different aggregation factor might be applied depending on the parameter (especially IMCS).Observation 12 : For optimal adaptation, different aggregation factor should be applied depending on the target performance.Observation 13 : 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 14 : In NTN, different target performance might be defined by the HARQ feedback availability.Observation 15 : 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 16 : 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 17 : 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 18 : 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 19 : 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 20 : 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 21 : 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 the enhancement via “larger aggregation factor” as the one of the NTN’s transmission enhancement solutions to achieve target BLER performance.* for PUSCH : 8 aggregated transmission might be insufficient even if low SE MCS table is applied.
* for PDSCH :
	+ 8 aggregated transmission might be enough only if both condition#1 and condition#2 are met.
		- condition#1 : target BLER ≥ 0.1%
		- condition#2 : low SE MCS table is applied,
	+ otherwise, 8 aggregated transmission might be insufficient

Proposal 2 : 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 3 : 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
 |
| R1-2107450LG | Proposal 1: For enhanced HARQ process id identification in NTN, support followings enhancement. * For DCI format 0-1/1-1, increase the HARQ process ID field up to 5 bits
* For DCI format 0-0/1-0, support no enhancement

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 or timing offset for feedback-disabled HARQ process. Proposal 4. For Type-1 HARQ-ACK codebook, codebook is generated by excluding HARQ-ACK for serving cells not having any feedback-enabled HARQ process.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.Proposal 6. For Type-3 HARQ codebook, the codebook is generated based only on feedback-disabled HARQ processes.Proposal 7. 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.  |
| R1-2107638Ericsson | [Observation 1 Extending the HARQ process ID field in DCI formats 0\_1/1\_1 to support 32 HARQ processes minimizes the impacts on specification and scheduling.](#_Toc79154017)[Observation 2 Reusing one bit from other bit field to indicate 32 HARQ processes is not a clean design approach. Such hack in the specification should in general be avoided, as it can easily cause confusion and complications in the specification.](#_Toc79154018)[Observation 3 If a bit from the RV field, the MCS field or a field related to the second data block is reused, other functionality will be limited.](#_Toc79154019)[Observation 4 It is not necessary to schedule 32 HARQ processes using fallback DCI format 0\_0/1\_0.](#_Toc79154020)[Observation 5 If fallback DCI format 0\_0/1\_0 are extended to support 32 HARQ processes, blind decoding among two fallback DCI formats is needed to read SIB.](#_Toc79154021)[Observation 6 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.](#_Toc79154022)[Observation 7 RAN1 already agreed that Type-3 HARQ codebook can be applied in licensed spectrum.](#_Toc79154023)[Observation 8 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.](#_Toc79154024)[Observation 9 There should not be some artificial restriction that Type-3 HARQ codebook is not applicable to NTN.](#_Toc79154025)[Observation 10 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.](#_Toc79154026)[Proposal 1 Whether 32 HARQ processes are used or not in the uplink can be configured by RRC.](#_Toc79154027)[Proposal 2 Whether 32 HARQ processes are used or not in the downlink can be configured by RRC.](#_Toc79154028)[Proposal 3 If 32 HARQ processes are configured, the size of the HARQ process ID field in DCI formats 0\_1/1\_1 is extended to 5 bits.](#_Toc79154029)[Proposal 4 Do not support 32 HARQ processes with fallback DCI.](#_Toc79154030)[Proposal 5 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.](#_Toc79154031)[Proposal 6 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.](#_Toc79154032)[Proposal 7 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 to reduce UL interference and save UE battery consumption.](#_Toc79154033)[Proposal 8 In case of Type-2 HARQ codebook, when HARQ processes are enabled/disabled on a per HARQ process basis, C-DAI/T-DAI count only PDSCH with feedback-enabled HARQ processes. In the DCI, the C-DAI and T-DAI are given their actual values (i.e., the count of feedback-enabled HARQ processes) regardless of whether a feedback-enabled or feedback-disabled HARQ process is scheduled.](#_Toc79154034)[Proposal 9 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.](#_Toc79154035)[Proposal 10 Regarding the “out-of-order restriction” for transmission of different HARQ processes corresponding to different PDSCHs, RAN1 to down-select between following alternatives:](#_Toc79154036)[a. Alt-1: Preserve the same “out-of-order restriction” for (enabled) HARQ processes in specification for the disabled HARQ processes](#_Toc79154037)[b. Alt-2: the “out-of-order restriction” for (enabled) HARQ processes does not apply to disabled HARQ processes.](#_Toc79154038) |
| R1-2107738Apple | Proposal 1: Enhanced HARQ process number indication is supported for DCI 0\_0/1\_0 or 0\_1/1\_1 by reusing one bit from another DCI bit field (e.g., RV field).Proposal 2: In type-1 HARQ-ACK codebook construction, UE does not reduce the HARQ-ACK codebook size for HARQ processes with disabled HARQ feedback, even if no DCI for the PDSCH with feedback-enabled HARQ processes, associated with HARQ-ACK codebook, is detected.Proposal 3: In type-2 HARQ-ACK codebook construction, for the DCI of PDSCH with feedback disabled HARQ processes, T-DAI is given its true value (i.e., the count of feedback-enabled processes) and C-DAI is given a reserved value.Proposal 4: For type-1 HARQ-ACK codebook only for SPS PDSCH and for type-2 HARQ-ACK codebook for SPS PDSCH, consider whether to support the case where SPS configuration includes HARQ processes with different feedback settings.Proposal 5: Support to have different configurations for HARQ processes with or without HARQ feedback. |
| R1-2107777ZTE | Proposal 1: Re-interpretation of bits in DCI should be support to enable the HARQ process indication with extended maximum HARQ process number for DCI 0-1/1-1 and 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, the UE should not generate and send the codebook feedback if no DCI for a PDSCH with a feedback-enabled HARQ processes in any slot associated with the HARQ codebook is decoded.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: Enlarged aggregation factor and reduced DM-RS density should be supported to improve the performance for NTN for aggregated transmission. |
| R1-2107857NTT DCM | Observation 1:* It seems that 16 HARQ processes indication is sufficient for DCI format 0\_0/1\_0.

Proposal 1:* No enhancement on the indication of HARQ process number in DCI format 0\_0/1\_0.

Observation 2:* Disadvantage of option 3 for DCI format 0\_1/1\_1 is quite small while option 3 can reduce RAN1 workload.

Proposal 2:* For DCI format 0\_1/1\_1, extend the HARQ process ID field up to 5 bits.

Proposal 3:* Disabling HARQ feedback is applicable to SPS PDSCH.

Observation 3:* If the feedback-enabling/disabling configuration per HARQ process is used for SPS, many HARQ processes would be configured with enabling so that feedback enabling is applied to all of the SPS receptions.
	+ This aspect degrades flexibility of dynamic PDSCH scheduling with disabled feedback.

Proposal 4:* For SPS, enabling/disabling HARQ feedback is configured per SPS-Config.
	+ HARQ feedback-enabling/disabling configured per HARQ process is ignored for SPS.

Proposal 5:* For SPS activation/release, UE reports HARQ-ACK regardless of any configuration of enabling/disabling HARQ feedback.

Proposal 6:* 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 4:* For Type 1 HARQ-ACK CB with disabled feedback,
	+ Option 1 is not reasonable since processing time constraints become quite complicated.
	+ Option 3 is not reasonable since this leads to CB size misalignment, which is not aligned with Type 1 concept.

Proposal 7:* For Type 1 HARQ-ACK CB, take option 2, i.e. report NACK on disabled process.

Proposal 8:* For Type 1 HARQ-ACK CB, discussions on behavior if no DCI for a PDSCH with a feedback-enabled HARQ processes in any slot (at least PUSCH case) is postponed till the corresponding Rel-15/16 CR is concluded.

Proposal 9:* For Type 2 HARQ-ACK CB, DCI for SPS release and DCI for SCell dormancy are included in counting of C-DAI and T-DAI regardless of feedback-enabling/disabling.

Proposal 10:* No further discussion on Type 3 HARQ-ACK CB.

Proposal 11:* For SCell dormancy, UE reports HARQ-ACK regardless of any configuration of HARQ feedback-enabling/disabling.
* Discuss whether disabling is applied for some specific cases or not, e.g.
	+ PDSCH reception scheduled by a fallback DCI
	+ PDSCH reception including successRAR: e.g. CFRA in a handover case

Proposal 12:Specify that UE expects that MAC-CEs are transmitted using HARQ processes with feedback enabled. |
| R1-2107920Xiaomi | Proposal 1: The number of supported HARQ processes is subject to the UE’s capability.Proposal 2: Support option 1 or 1-a for DCI format 0-0 and 1-0.Proposal 3: support option 3 for DCI format 0-1 and 1-1.Proposal 4: The enhancement on the type 1 codebook design is not desired.Proposal 5: For the type 2 codebook, the C-DAI and T-DAI in the DCI of PDSCH with feedback-disabled HARQ processes are the count of only feedback-disabled processes with their true values.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: Enhancement on the UCI reporting such as the data decoding statistics should be introduced. |
| R1-2107993ITL | Proposal 1. Support to indicate extended HARQ process ID by the followings:* For both DCI 0-1/1-1 and 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  |
| R1-2108033InterDigital | 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 16 or 32Proposal-2: slot aggregation number for a PDSCH is dynamically indicated in DCIProposal-3: a CQI table with a new target BLER (e.g., 1%) is considered when HARQ feedback is disabledProposal-4: HARQ feedback is enabled for at least one HARQ process numberProposal-5: the PDSCH carrying MAC-CE command is transmitted in the HARQ process with HARQ feedback enabled |
| R1-2108092Nokia | Observation 1: MAC procedures will generate an acknowledgement message for lower layers when detecting a SPS release message.Observation 2: When a DL SPS resource is activated, a HARQ process ID is associated to the SPS resource.Observation 3: gNB knows in advance which HARQ processes are assigned for DL SPSObservation 4: Using option 1 or option 1-a would create scheduling impacts due to the time-wise dependency of the HARQ process ID.Observation 5: Using option 1 or option 1-a may not be feasible if PDCCH is not monitored in all slots.Observation 6: If UEs are not supporting the additional HARQ processes, there is a high risk of having HARQ stalling with reduced network performance as a consequence.Proposal 1: UE should always provide acknowledgement for SPS release.Proposal 2: Adopt the conclusion from FL summary: “Conclusion: UE expects that MAC CE and SPS release information is scheduled via one HARQ process configured with HARQ feedback.”Proposal 3: No enhancements or optimizations are implemented for Type-1 HARQ codebook. The codebook size should not be depending on the configuration for HARQ-ACK feedback (feedback enabled or disabled).Proposal 4: 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 5: Do a down-selection between option 2 and option 3 for indication of HARQ process ID such that only one option is specified. Proposal 6: Enhanced HARQ process ID indication is supported for DCI 0-1/1-1 by extending the HARQ process ID field up to 5 bits when configured.Proposal 7: Assign one additional bit for indicating the MSB of the HARQ process ID for DCI format 0-0 and DCI format 1-0.Proposal 8: UEs supporting NTN should by default support the maximum number of HARQ processes to ensure network efficiency.Proposal 9: Support slot aggregation for NR over NTN.Proposal 10: For NTN operation, the maximum level of slot aggregation to be considered should be 16 slots. |