3GPP TSG RAN WG1 #107-e R1-210xxxx

e-Meeting, November 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.

* HARQ codebook enhancements
* SPS PDSCH
* PDSCH scheduling restriction
* Performance enhancement
* UE capability for new feature
* Restriction on HARQ feedback disabling
* PUSCH scheduling restriction
* RRC parameters

Companies are encouraged to provide the inputs on Issue-1/2/3/4/5/6 in the 1st round discussion.

# **Issue-1 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.

## **Type-1 Codebook:**

### **Company view (Round-1)**

For this topic, discussion on following two cases are conducted based on the previous agreement. It should be noticed that decision for down-selection is needed among options:

* 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, DCM, ZTE, Apple, QC]

Regarding this option, as highlighted by proponent, there are benefits to relax to decoding timeline at UE side and relax the scheduling at gNB. And 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, Apple, Spreadtrum, Nokia (1st priority), Samsung]

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 HARQ codebook feedback when it is not multiplexed with other feedback in the same UCI.
		- Supported by [vivo, Nokia (2nd preference), CMCC, CAICT,NEC, 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. Regarding HW’s concerns on drop the feedback as option-2, especially when UCI multiplexing with others occurs, it has been addressed by restricting the enhancement to the case without UCI multiplexing.

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 1.1.1-1]:** 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/ACK for the feedback-disabled HARQ process depending on the decoding results of corresponding PDSCH

Please provide your views below：

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| **Company** | **Comments and Views** |
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**[Initial Proposal 1.1.1-2]:** For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, the UE should skip the HARQ codebook feedback when it is not multiplexed with other feedback in the same UCI.

Please provide your views below：

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## **Type-2 Codebook:**

### **Company view (Round-1)**

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: For codebook generation, the UE assume that the C-DAI and T-DAI of the DCI of PDSCH with feedback-disabled process is the same as the C-DAI and T-DAI of the most recently transmitted DCI of PDSCH with feedback-enabled process by gNB. FFS: the case that all DCIs of PDSCH are associated with feedback-disabled HARQ process.
	+ Supported by [Huawei, Nokia Spreadtrum, CATT, 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 [Ericsson].

Moreover, regarding the FFS bullet, following part is proposed by [Huawei]:

*Up to current PDCCH monitor occasion, if all DCIs of PDSCH are associated with feedback disabled HARQ process, the value of C-DAI and T-DAI set to* $V\_{C-DAI}^{DL}=4$ *and* $V\_{T-DAI}^{DL}=4$.

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

Regarding this option, as highlighted by companies that in Option-1, additional specification impacts and a modification will require software updates at the UE and the gNB/NTN and new IIoT for deployments. 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. As pointed by [Samsung], assuming an equal split between enabled/disabled HARQ processes (a favorable assumption for using DAIs in DCI formats with disabled HARQ-ACK as it maximizes disabled HARQ processes for possibly obtaining same UE buffer management as in Rel-16), an equivalent benefit for the accuracy of the HARQ-ACK codebook construction would be as if the operation was with 0.5% BLER for the DCI format, instead of 1%. That would practically have no impact on throughput.

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 with majority support. Then, from moderator perspective, it’s preferred to further check the views from companies with consideration on all details in following proposals:

**[Initial Proposal 1.2.1-1]**

For the DCI of PDSCH with feedback-disabled HARQ processes, 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.
* If all DCIs of PDSCH are associated with feedback disabled HARQ process, the value of C-DAI and T-DAI set to $V\_{C-DAI}^{DL}=4$ and $V\_{T-DAI}^{DL}=4$.

Please provide your views below：

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| **Company** | **Comments and Views** |
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In addition, [OPPO, DCM] proposed to keep the same behaviour for DCI indicating Scell dormancy for Type-2 codebook feedback. From moderator’s perspective, it’s reasonable to confirm it with following proposal.

**[Initial Proposal 1.2.1-2]**

For DCI indicating SCell dormancy without scheduling a PDSCH reception, HARQ-ACK report is as in Rel-16.

Please provide your views below：

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| **Company** | **Comments and Views** |
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## **Type-3 Codebook:**

### **Company view (Round-1)**

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

* 1. Option-1: For Type-3, HARQ-ACK codebook only includes HARQ-ACK of all the enabled HARQ processes in one shot [Huawei, vivo, Xiaomi/Spreadtrum (if Type-3 is supported for NTN), Baicell, ZTE, Ericsson, LG]
	2. Option-2: No enhancement [OPPO, Nokia, CATT]

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. Moreover, as a generic solution for Rel-16, it’s also reasonable to take it for NTN in Rel-17 with limited efforts. Then, following proposal is made based on majority views:

**[Initial Proposal 1.3.1]:** 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** |
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# **Issue-2 SPS PDSCH**

## **Company view (Round-1)**

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

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 activation:
	+ Option-1: For SPS activation, HARQ feedback is not sent if the network has disabled HARQ feedback for the used HARQ process.
		- [Ericsson, Samsung]
	+ Option-2: For DCI indicating SPS PDSCH activation, DAI is increased for the DCI indicating SPS activation and ACK/NACK is reported by UE regardless of network configuration of enabled/disabled HARQ feedback for the first SPS PDSCH.
		- [Huawei, vivo, Spreadtrum, NEC, CATT, Sony, CAICT, ZTE, LG]

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, 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, are proposed by proponent

Then, from moderator’s perspective, regarding the new mechanism for HARQ disabling for SPS, companies’ views are still diverse. Since the clear benefits (e.g., reliability and flexibility of SPS operation) have been justified by enabling the HARQ-ACK feedback for SPS activation when the disabling of HARQ process will be used, e.g., SPS for GEO scenario. Let’s focus on the discussion for this aspect with following proposal:

**[Initial Proposal 2.1]:**

For DCI indicating SPS PDSCH activation, DAI is increased for the DCI indicating SPS activation and ACK/NACK is reported by UE regardless of network configuration of enabled/disabled HARQ feedback for the first SPS PDSCH.

Please provide your views below：

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

## **Company view (Round-1)**

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
* Keep the legacy OOO restriction for the disabled HARQ processes [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

* The legacy OOO restriction is not available for the disabled HARQ process [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). Therefore, nothing needs to be specified for “out-of-order” scheduling with respect to PDCCHs associated with HARQ processes with disabled HARQ-ACK reports. Only the PDSCH processing timeline constraint for $T\_{proc,1}$ is necessary.

1. Aspect-2: Whether the bit-field in DCI to determine the ACK/NACK feedback is still needed in case of feedback-disabled feedback.
* Potential optimization on the DCI indication: [Samsung, Ericsson]

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, and If OOO is not applicable for disabled, e.g., K1 can be ignored.

* Keep the legacy behavior for DCI interpretation: [ZTE, CMCC]

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.

From moderator’s perspective, the legacy OOO restriction is based on timeline for HARQ-ACK feedback. In NTN case, the Aspect-1 is also up to decision on the enhancement for codebook, e.g., whether the HARQ-ACK feedback is needed for feedback-disabled HARQ process in Type-1. The decision on the OOO issue can be done later once the remaining issues on codebook decision is concluded.

For the aspect-2, the point is the whether we need to introduce additional enhancement to optimize the DCI (e.g., reduce the DCI size or define new behavior on DCI interpretation) carrying the feedback-disabled HARQ process, especially when the feedback may not be needed. The benefits of this optimization may be marginal if HARQ feedback will be ignored for feedback-disabled HARQ process in limited cases. Although this aspect is also slightly related to the previous topic, companies are encouraged to share the view on the aspect -2 firstly with following proposal.

**[Initial Proposal 3.1-1]:** 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.

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| **Company** | **Comments and Views** |
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# **Issue-4 Performance enhancement**

## **Company view (Round-1)**

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, Ericsson]
	+ X = 32: [Huawei, ETRI, IDC, CMCC]
	+ X = 16: [OPPO, Nokia, CATT, MTK, Baicell, ZTE, CMCC]

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. *PDSCH is the channel with best coverage. It is not meaningful to enhance PDSCH coverage without enhancing coverage for other channels in NTN beyond what can be done in Rel-17.*

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. E.g., ETRI

* 32 aggregated transmission might be insufficient even if low SE MCS table is applied.

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, Ericsson, ETRI] prefer to introduce different configurations for different transmission, e.g., via HARQ process with enabled or disabled feedback.
		- [Apple] proposed to consider an adjustable aggregation factor in SPS PDSCH transmission
	+ Transmission scheme:

For the aggregated transmission, the solution as time interleaved aggregated transmission is proposed by [CATT]

In additional, others solutions, new UCI feedback in case of scheduling with disabled HARQ feedback [Xiaomi], requesting for guiding pdsch-AggregationFactor from gNB or reporting decoding statistics via MAC CE [ETRI], reporting UE assistant information [Huawei], recommended aggregation factor by UE [LG] and RV restriction (initial transmissions shall use RV 0 and retransmissions shall not use RV 0) for scheduling are proposed by proponent.

According to the above discussion, from moderator’s perspective, it seems that based on the inputs from proponent, the needs to enlarge the aggregation number are justified by the corresponding analysis to address the companies’ concerns. Moreover, for the enhancement on DL, except for the improvement on coverage, the gain on throughput is also considerable once larger aggregation factor can be considered. Then, it’s recommended that before taking into account the further enhancement, we can conclude to enlarge the aggregation factor firstly with following proposal:

**[Initial Proposal 4.1]:**

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

Please provide your views below：

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| **Company** | **Comments and Views** |
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# **Issue 5 UE capability for new feature**

## **Support more than 16 HARQ process**

### **Company view (Round-1)**

For this topic, [CATT, MTK, Xiaomi] prefer to define it as UE capability with signaling. And [Samsung] propose to select one of following two options to enable up to 32 HARQ processes without increasing the soft buffer size:

* + 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}.

From moderator’s perspective, it’s reasonable to define the new UE capability with signalling for 32 HARQ processes, which can also address the concerns on the buffer size, e.g., for NTN scenario with conservative scheduling (e.g., non-CA, lower RANK), supports of up to 32 HARQ processes can be reported to network. Once the following proposal can be concluded, updates on the UE capability in AI 8.16.4 via [107-e-R17-UE-features-NR-NTN-01] is expected:

**[Initial Proposal 5.1.1**]:

The new UE capability with signalling is defined for the support of 32 HARQ process.

Please share your views on this proposal and potential way forward if there is concern.

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| **Company** | **Comments and Views** |
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## **UE’s behaviour on LLR combination for the retransmissions for TBs with disabled HARQ feedback**

### **Company view (Round-1)**

For this topic,

* + [Ericsson] propose that RAN1 should conclude that the configuration of HARQ feedback as enabled or disabled does not impact the UE capability to buffer and combine HARQ retransmissions.
	+ [Samsung] propose to support either *for a UE to not expect retransmissions of TBs with disabled HARQ-ACK reports* or *for a UE to provide capability signaling for whether it can store LLRs of TBs with disabled HARQ-ACK reports.*

Furthermore, support UE assistance information to indicate full soft buffer or to request HARQ-ACK enabling/disabling for HARQ processes is also proposed to address this issue.

* + [CMCC, Baicell] highlights that such behavior should be up to UE’s implementation.

From moderator’s perspective, the intention to introduce the feature to enable the HARQ-feedback disabling is to resolve the HARQ stabling issue without increasing soft-buffer for the UE’s implementation. Then, it’s preferred to keep such issue to UE’s implementation regardless of whether more HARQ process is supported or not.

 **[Initial Proposal 5.2.1** (As conclusion)]:

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

Please share your views on this proposal and potential way forward if there is concern.

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| **Company** | **Comments and Views** |
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# **Issue-6 Restriction on HARQ feedback disabling**

## **Company view (Round-1)**

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]
	1. except for TA command indication [CMCC]
2. Option 2: Up to gNB’s implementation for scheduling [NEC, Panasonic]

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

From moderator’s perspective, since we already conclude that ACK-NACK will be reported for DCI carrying SPS release signaling and no need to further mandate the scheduling for this part. Since 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, following proposal can be considered:

**[Initial Proposal 6.1]:** UE expects that MAC-CEs (except for the TAC command) are transmitted using HARQ processes with feedback enabled.

Please provide your views below.

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| **Company** | **Comments and Views** |
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# **Issue-7 PUSCH scheduling restriction [L]**

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, according to the discussion in previous meeting, 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

Agreement:

1. For HARQ state B, FFS to run drx-RetransmissionTimerUL for blind UL retransmission

2. UE configured with an UL HARQ retransmission state (i.e. A or B) will always act as indicated in a grant/assignment provided during a valid occasion (i.e. subject to legacy restrictions in e.g. MAC and RAN1 specifications). (No RAN2 specification impact)

1. 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 inputs for this meeting and discussion in previous meeting, it seems that the group is still not converging on this topic. From moderator’s perspective, proponents are encouraged to have the offline discusses with other companies and we can come back to this topic if there is progress.

# **Issue-8 RRC parameters [Closed]**

Regarding the RRC parameter, updates on the RRC parameters (e.g., nrofHARQ-ProcessesForPUSCH, Feedback-disablingperHARQ-Process-r17) are proposed by companies [Huawei (R1-2110806), Ericsson (R1-2111415), ZTE (R1-2111660)]. According to chair’s guidance, the corresponding discussion will be handled in [107-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 |
| R1-2110806Huawei | Observation 1: For type-1 HARQ-ACK codebook, the pre-known NACKs at the position of feedback-disabled HARQ process can be beneficial for channel decoding at the gNB.Observation 2: 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 3: 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 4: 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 5: When HARQ-ACK feedback multiplexing with other UCIs in PUCCH or PUSCH, skipping feedback would lead to misalign between UE and gNB.Observation 6: There is no need to optimize the corner case that only DCIs carrying feedback-disabled HARQ processes are decoded by UE separately.Observation 7: 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 8: 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 9: When all DCIs of PDSCH are associated with feedback disabled HARQ process, if both values of C-DAI and T-DAI set as ‘0’, it would lead to confusion with miss-detected DCI case.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.Observation 11: The “HARQ process number” field of a DCI indicating a SPS PDSCH activation do not indicate any valid HARQ process number.Proposal 1: For type-1 HARQ-ACK codebook, the UE always reports NACK for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH. Proposal 2: For type-1 HARQ-ACK codebook, when 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 3: 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 4: Up to current PDCCH monitor occasion, if all DCIs of PDSCH are associated with feedback disabled HARQ process, the value of C-DAI and T-DAI set to $V\_{C-DAI}^{DL}=4$ and $V\_{T-DAI}^{DL}=4$.Proposal 5: For Type-3 HARQ-ACK codebook, skip the feedback for the 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: For SPS PDSCH, ACK/NACK is reported by UE for the first SPS PDSCH regardless of network configuration of enabled/disabled for this SPS configuration.Proposal 8: Aggregation/repetition transmission parameters can be configured depending on orbital height.Proposal 9: To guarantee BLER target in GEO deployment, the maximum number of supported aggregation factor for PDSCH is 32.Proposal 10: Aggregation/repetition transmission parameters can be indicated via DCI.Proposal 11: Reinterpret idle bits in DCI for indicating transmission parameters.Proposal 12: UE assistance information reporting in reserved resource can be considered for NTN.Proposal 13: For uplink in NTN, a new RRC parameter of “nrofHARQ-ProcessesForPUSCH” is added and the value should choose from {16, 32}. |
| R1-2110901 Nokia | 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 NTN operation, the maximum level of slot aggregation to be considered should be 16 slots. |
| R1-2111011 vivo | Proposal 1: For Type-1 codebook, if both feedback-enabled HARQ processes and feedback-disabled HARQ processes are received by UE, support the legacy behaviour.Proposal 2: For Type-1 codebook, if only feedback-disabled HARQ processes are received by UE (including dynamic PDSCH and/or SPS PDSCH), the UE skips the HARQ-ACK codebook feedback except for other information multiplexed in the same UCI.Proposal 3: For Type-2 codebook, DAI counts only DCI of PDSCH associated with feedback-enabled HARQ processes and SPS PDSCH release.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-3 HARQ-ACK codebook, HARQ-ACK codebook only includes HARQ-ACK information for all the feedback-enabled HARQ processes in one shot.Proposal 6: For SPS activation PDSCH, DAI is increased and HARQ-ACK information is reported by UE regardless of disabling/enabling HARQ configuration.The SPS period is kept for the subsequent SPS PDSCHs. |
| R1-2111099Spreadtrum | Proposal 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/ACK for the feedback-disabled HARQ process depending on the decoding results of corresponding PDSCH.Proposal 2: 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 3: For codebook generation, the UE assume that the C-DAI and T-DAI of the DCI of PDSCH with feedback-disabled process is the same as the C-DAI and T-DAI of the most recently transmitted DCI of PDSCH with feedback-enabled process by gNB.Proposal 4: For Type-3 HARQ codebook in NTN, the UE should skip the HARQ-ACK feedback for a feedback-disabled HARQ processes, if it is supported in NTN.Proposal 5: For DCI indicating SPS PDSCH activation, DAI is increased for the DCI indicating SPS activation and ACK/NACK is reported by UE regardless of network configuration of enabled/disabled HARQ feedback for the first SPS PDSCH. |
| R1-2111179 NEC | Proposal 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.Proposal 2.If only DCI carrying feedback-disabled HARQ process is detected by UE, the UE should skip the codebook feedback.Proposal 3. The C-DAI and T-DAI are ignored by the UE regardless of the value for Type 2 codebook generation.Proposal 4. For DCI indicating SPS PDSCH activation, DAI is increased for the corresponding DCI and ACK/NACK is reported by the UE regardless the HARQ feedback is enabled/disabled for the first SPS PDSCH.Observation 1. HARQ process ID of SPS PDSCH is not determined before the DL transmission is started/activated.Proposal 5. The feedback for the HARQ process associated to SPS PDSCH can be disabled by RRC configuration per SPS configuration.Observation 2. 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 3. Codebook size reduction can be achieved if only HARQ disabled processes and SPS PDSCHs are scheduled in MA,c occasions.Proposal 6. Indication/configuration of aggregation factor/repetition factor is DCI-based.Proposal 7. Consider extension/modification of TDRA field to indicate number of repetitions to a UE.Proposal 8. Whether to use HARQ enabled or disabled process for the transmission of MAC CE is left up to gNB implementation. |
| R1-2111254 CATT | 1. 32 processes can be supported based on UE capability.
2. 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.
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 for feedback-disabled process.
4. For SPS PDSCH reception transmission, the feedback for the HARQ process associated to SPS PDSCH reception transmission can be disabled per SPS configuration.
5. ACK/NACK is reported by UE for DCI indicating SPS PDSCH activation when the feedback for the HARQ process associated to SPS PDSCH reception transmission is disabled.
6. Type-3 HARQ-ACK codebook is not needed in NTN case.
7. The OOO legacy restriction is applied when feedback-disabled is configured.
8. The HARQ-ACK feedback should be true HARQ-ACK in case that HARQ-ACK feedback is reported for feedback-disabled HARQ process.
9. UE expects that at least one HARQ process with feedback is configured for the scheduling of MAC-CE.
10. Slot aggregation factor can be extended to 16 for very low SINR case.
11. Support time interleaved slot aggregation to improve transmission reliability.
12. There is no need for MCS enhancement.
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| R1-2111316 OPPO | 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 indicating SCell dormancy should be included in counting of C-DAI and T-DAI if supported. Proposal 7: Type-3 HARQ codebook is not supported in NR-NTN and do not support type-3 HARQ codebook enhancement. For PDSCH/PUSCH reliability enhancement:Proposal 8: 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 9: PUSCH transmission constraint for a given disabled UL HARQ process should be considered. Proposal 10: PUSCH processing time should be updated in NTN. For extension of K1 range:Proposal 11: The size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI should not be changed.  |
| R1-2111372 MTK | Enhanced HARQ process ID indication:Observation 1: The UE should not be mandated to support feature with maximum number of HARQ processes to avoid significant impact on complexity un-necessarily since high peak data rates can be achieved by disabling HARQ feedback for HARQ processes.Proposal 1: In NR NTN, support on greater than 16 HARQ processes in UL and DL is a UE capability. Performance enhancement:Observation 2: There is no need for the [Note: This UE feature group is applicable only for NR NTN cell, for terrestrial cell this feature is not supported] in the summary of UE features. It is sufficient to indicate that this UE feature is for NR NTN. Observation 3: A value of pdsch-AggregationFactor of X =16 can allow UE operations consistent with the link budget for DL in TR 38.821 Table 6.1.3.3-1: Link budgets results for all cases in Table 6.1.1.1-9: List of calibration study cases. Proposal 2: In NR NTN, the maximum number of supported aggregation factor (i.e., pdsch-AggregationFactor) for DL PDSCH is X=16.  |
| R1-2111395 Sony | 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 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. |
| R1-2111415Ericsson | [Observation 1 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.](#_Toc87031479)[Observation 2 RAN1 already agreed that Type-3 HARQ codebook can be applied in licensed spectrum.](#_Toc87031480)[Observation 3 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.](#_Toc87031481)[Observation 4 There should not be some artificial restriction that Type-3 HARQ codebook is not applicable to NTN.](#_Toc87031482)[Observation 5 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.](#_Toc87031483)[Observation 6 Since feedback-enabling/disabling of HARQ processes is configured by the network, the UE must support the case that all HARQ processes are feedback-enabled, i.e., have sufficient soft-buffer for all HARQ processes. Thus, there is no benefit in not using the soft-buffer if HARQ retransmissions are sent for feedback-disabled HARQ processes.](#_Toc87031484)[Observation 7 Even if HARQ feedback is disabled by the network, the HARQ process remains configured and HARQ retransmissions may occur.](#_Toc87031485)[Observation 8 Increased aggregation factor for PDSCH has not been justified.](#_Toc87031486)Based on the discussion in the previous sections we propose the following:[Proposal 1 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.](#_Toc87031487)[Proposal 2 In case of Type-1 HARQ codebook, when 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 when it is not multiplexed with other feedback in the same UCI.](#_Toc87031488)[Proposal 3 In case of Type-1 HARQ codebook, when the UE has decoded DCI for both feedback-enabled and feedback-disabled HARQ process in slots associated with the same HARQ codebook , 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.](#_Toc87031489)[Proposal 4 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.](#_Toc87031490)[Proposal 5 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.](#_Toc87031491)[Proposal 6 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.](#_Toc87031492)[Proposal 7 For SPS activation, HARQ feedback is not sent if the network has disabled HARQ feedback for the used HARQ process.](#_Toc87031493)[Proposal 8 RAN1 should conclude that the configuration of HARQ feedback as enabled or disabled does not impact the UE capability to buffer and combine HARQ retransmissions.](#_Toc87031494)[Proposal 9 Do not increase the aggregation factor for PDSCH.](#_Toc87031495)[Proposal 10 Add RRC parameter nrofHARQ-ProcessesForPUSCH-r17 indicating the number of HARQ processes to be used on the PUSCH of a serving cell if separate UE capabilities are defined for supported number of HARQ processes in UL and DL.](#_Toc87031496)[Proposal 11 For RRC parameters HARQ-ProcessNumberSizeDCI-0-1-r17 and HARQ-ProcessNumberSizeDCI-1-1-r17, the value range should be {4,5}.](#_Toc87031497) |
| R1-2111443 Baicell | Proposal 1: For DCI 0-0/1-0, no enhancement to support indication of more than 16 HARQ processes is considered in Rel-17.Observation 2: For the feedback-disabled process in Type-1 HARQ codebook, reporting actual NACK/ACK result is helpful for link adaptation. The performance gain of reporting NACK only for the feedback-disabled HARQ process may exist but need support by simulations.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/ACK based on the actual decoding results for the feedback-disabled HARQ process. 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.Observation 3: For Type 2 HARQ-ACK codebook in NTN, the C-DAI and T-DAI of PDSCH with feedback-disabled process can be used to address the last DCI missing issue.Proposal 3: For Type 2 HARQ-ACK codebook in NTN, the C-DAI and T-DAI of PDSCH with feedback-disabled process is the same as the C-DAI and T-DAI of the most recently transmitted DCI of PDSCH with feedback-enabled process .Proposal 4: For Type-3 HARQ codebook in NTN, the UE should skip the codebook feedback for a feedback-disabled HARQ processes.Proposal 8: For NTN operation, the maximum level of slot aggregation to be considered could be 16 or 32 slots, and 16 is preferred. |
| R1-2111572 Xiaomi | Proposal 1: The number of supported HARQ processes is subject to the UE’s capability.Proposal 2: 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 3: For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, the UE’s behaviour is same as the case if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE.Proposal 4: 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 5: 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 6: Define a separate periodicity for feedback-enabled HARQ process in SPS PDSCH configuration. Proposal 7: Enhancement on the UCI reporting such as the data decoding statistics should be introduced. |
| R1-2111607 CMCC | 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 or when the HARQ codebook feedback is not multiplexed with other feedback in the same UCI, 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.

Observation 3: For Type-2 HARQ codebook, if all DCIs of PDSCH are associated with feedback-disabled HARQ process, no matter UE sends or drops the HARQ-ACK feedback, no error case will occur.* If UE sends the HARQ-ACK feedback, less spec impact can be expected since UE behaviors as legacy.
* If UE drops the feedback, UE battery consumption for HARQ-ACK feedback can be reduced.

Proposal 1: 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 2: For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE (down-select between Option-1 and 1a)* Option-1: the UE should skip the codebook feedback at least when the feedback is carried by PUCCH.
* Option-1a: the UE should skip the codebook feedback, the UE should skip the HARQ codebook feedback when it is not multiplexed with other feedback in the same UCI.

Proposal 3: For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, Option-1a is preferred.* Option-1a: the UE should skip the codebook feedback, the UE should skip the HARQ codebook feedback when it is not multiplexed with other feedback in the same UCI.

Proposal 4: For Type-2 HARQ codebook generation, the UE assume that the C-DAI and T-DAI of the DCI of PDSCH with feedback-disabled process is the same as the C-DAI and T-DAI of the most recently transmitted DCI of PDSCH with feedback-enabled process by gNB.Proposal 5: Regarding the retransmissions for TBs with disabled HARQ feedback, the LLR combination is up to the UE’s implementation.Proposal 6: For the SPS PDSCH transmission, 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: No optimization on the bit-field related to the HARQ-ACK feedback for the DCI of PDSCH with feedback-disabled HARQ process.Proposal 8: The maximum number of supported aggregation factor (i.e., pdsch-AggregationFactor) for DL PDSCH is 16 or 32.Proposal 9: UE expects that MAC-CEs are transmitted using HARQ processes with feedback enabled, except for TA command indication. |
| R1-2111647 Panasonic | Proposal 1: For type 1 HARQ codebook, UE shall transmit ACK/NACK for the feedback-disabled HARQ process depending on the decoding resultsProposal 2: C-DAI and T-DAI in the DCI of PDSCH with feedback-disabled process is the count of feedback-enabled processes (Option-1) Proposal 3: When the number of HARQ-ACKs is zero, DAI 1,1 is indicated in the DCI of PDSCH with feedback-disabled process.Proposal 4: Whether to use feedback-disabled process or enabled process for SPS PDSCH is up to network implementation.Proposal 5: HARQ feedback-disabling for SPS PDSCH is configured per SPS configuration. Proposal 6: 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. |
| R1-2111653CAICT | Proposal 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/ACK for the feedback-disabled HARQ process depending on the decoding results of corresponding PDSCH.Proposal 2: For Type-1 HARQ-ACK codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, the UE should skip the codebook feedback when it is not multiplexed with other feedback in the same UCI (option 1a).Observation 1: The HARQ-feedback configuration for SPS PDSCH should be separated by the HARQ-feedback configuration for DG-PDSCH.Proposal 3: HARQ-feedback configuration for DL SPS is configured per SPS by RRC.Proposal 4: Try to get consistent assumptions about whether the SPS is activated at gNB and UE side when HARQ-feedback is disabled for SPS PDSCH.Proposal 5: For SPS PDSCH activation, HARQ-ACK corresponds to the DCI carrying the activation is reported when HARQ-feedback is disabled for the SPS PDSCH. For Type-2 HARQ-ACK codebook, DAI should be increased in the DCI indicating SPS activation. |
| R1-2111660 ZTE | Proposal 1: 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 2: In Type-2 codebook, for the DCI of PDSCH with feedback-disabled HARQ processes, the C-DAI and T-DAI value should be directly ignored by UE.Proposal 3: For Type-3 codebook, enhancement can be enabled by only allowing the ACK-NACK generation for HARQ process with enabled feedback.Proposal 4: For joint scheduling with feedback enable and disabled process, the legacy restriction on the out-of-order HARQ timing restriction should be kept.Proposal 5: No optimization on the bit field related to the HARQ feedback is considered for the DCI associated with feedback-disabled HARQ process. Proposal 6: Confirming that the feedback for the HARQ process associated to SPS PDSCH can be disabled by RRC configuration per HARQ process.Proposal 7: Regarding the HACK-ACK feedback for SPS PDSCH:* No feedback is expected for the SPS PDSCH associated with feedback-disabled HARQ process
* For DCI indicating SPS PDSCH activation, DAI is increased for the DCI indicating SPS activation and ACK/NACK is reported by UE regardless of network configuration of enabled/disabled HARQ feedback for the first SPS PDSCH.

Proposal 8: The maximum number of supported aggregation factor (i.e., pdsch-AggregationFactor) for DL PDSCH can be extended to 16. |
| R1-2111736Samsung | Proposal 1: Support either for a UE to not expect retransmissions of TBs with disabled HARQ-ACK reports or for a UE to provide capability signaling for whether it can store LLRs of TBs with disabled HARQ-ACK reports. Proposal 2: For the Type-1 HARQ-ACK codebook, conclude on one of the following alternatives for the value of HARQ-ACK bits for TBs with disabled HARQ processes1. HARQ-ACK bits for TBs with disabled HARQ processes have a predetermined value (e.g. NACK value)
2. The value of HARQ-ACK bits for TBs with disabled HARQ processes is not defined – no further agreement is needed for the Type-1 HARQ-ACK codebook
3. The Type-1 HARQ-ACK codebook is not supported for NTN

Proposal 3: No differentiation of the UE behavior in case a Type-1 HARQ-ACK codebook does not include HARQ-ACK information for a HARQ process with enable HARQ-ACK report (Option 1).Proposal 4: For the Type-3 HARQ-ACK codebook, conclude on one of the following alternatives for the value of HARQ-ACK bits for TBs with disabled HARQ processes1. HARQ-ACK bits for TBs with disabled HARQ processes are not included in the Type-3 codebook
2. The value of HARQ-ACK bits for TBs with disabled HARQ processes is not defined – no further agreement is needed for the Type-3 HARQ-ACK codebook
3. The Type-3 HARQ-ACK codebook is not supported for NTN

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. |
|  R1-2111822IDC | 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 enabledProposal-7: a UE is not expected to receive a MAC-CE command in a PDSCH associated with a HARQ process number of which HARQ feedback is disabled |
| R1-2111872Apple | Proposal 1: 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 2: 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 3: 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 4: Enabling/disabling on HARQ-ACK feedback for all HARQ processes in a SPS is part of SPS configuration.Proposal 5: Support to increase the aggregation factor for both dynamic grant PDSCH and SPS PDSCH. Proposal 6: Consider an adjustable aggregation factor in SPS PDSCH transmission.  |
| R1-2111970LG | Proposal 1. For Type-1 HARQ-ACK codebook enhancement, UE ignores K1 and/or PRI field if DCIs carrying the feedback-disabled process are detected. Proposal 2. For Type-2 HARQ-ACK codebook generation, the UE assume that the C-DAI and T-DAI of the DCI of PDSCH with feedback-disabled process is the same as the C-DAI and T-DAI of the most recently transmitted DCI of PDSCH with feedback-enabled process by gNB.* FFS: the case that all DCIs of PDSCH are associated with feedback-disabled HARQ process.

Proposal 3. For Type-3 HARQ codebook, the codebook is generated based only on feedback-enabled HARQ processes.Proposal 4. 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. Proposal 5. For transmission enhancement when HARQ feedback is disabled, consider following enhancements: * Repetition number is recommended/reported by UE

Proposal 6. In case of two PDSCHs are associated with different HARQ process ids, introduce default/virtual ACK/NACK timing for feedback-disabled HARQ process.  |
| R1-2111991 ETRI | 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 insufficient if target BLER $\leq $ 0.1%
	+ otherwise, low SE MCS index table in legacy NR might be sufficient.

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

Observation 7 : larger aggregation factor method could be considered as a solution to secure more reliable transmission.* less specification impact than new lower SE MCS index table method
* more effective than new lower SE MCS index table method.
* more reliable transmission for normal SE MCS index table (more reliable regardless of MCS index table usage)

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>8” 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.* 32 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
 |
| R1-2112106NTT DCM | Observation 1:* Success/failure of SPS activation command reception should be informed to gNB in any case; otherwise, all subsequent SPS PDSCHs are missed at the UE if the activation command is missed.
* UE always reports HARQ-ACK for release DCI as agreed. The same direction for activation DCI is the most reasonable.
* gNB cannot control this issue appropriately without reliability degradation or wasted resources.
* Configurability of whether this mechanism is used or not is a good direction for both NTN and MBS.

Proposal 1:* Introduce a higher layer parameter to control feedback enabling/disabling for SPS activation.
	+ If configured, UE performs HARQ feedback corresponding to the initial SPS PDSCH assigned by DCI with SPS activation command, regardless of feedback-enabled/disabled configuration.
	+ Otherwise, UE follows the feedback-enabled/disabled configuration.

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.

Proposal 3:* 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 3:* 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 other HARQ feedback scheduling and 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.

Observation 4:* For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, Option 2 is a more complicated option rather than an easier option from perspectives of gNB scheduler and UE soft-buffer management due to the following scheduling restriction in current spec, which is not aligned with the agreed processing time constraints.
	+ From 38.214: ... The UE is not expected to receive another PDSCH for a given HARQ process until after the end of the expected transmission of HARQ-ACK for that HARQ process, where the timing is given by Clause 9.2.3 of [6]. ...
* In Option 1, Decoding performance can be improved since the NACK bits are pre-known at gNB

Proposal 5:* For Type-1 HARQ codebook, if DCIs carrying the feedback-disabled and feedback-enabled HARQ processes are detected by UE, Option 1 is supported.

Observation 5:* There is no special handling in Rel-15/16 for the case when gNB transmits a DCI with feedback request but the UE misses the DCI. For example, if the indicated PUCCH for the feedback is overlapped with other PUCCH with SR/CSI, the UE will transmit only the PUCCH with SR/CSI in this case.

Proposal 6:* For Type-1 HARQ codebook, if only DCI carrying feedback-disabled HARQ process is detected by UE, UE skips the codebook feedback.

Proposal 7:* For the DCI of PDSCH with feedback-disabled HARQ processes, Option 1 is supported for type-2 HARQ-ACK CB.

Observation 6:* Indication of SCell dormancy without scheduling a PDSCH reception is quite similar to SPS release.

Proposal 8:* For DCI indicating SCell dormancy without scheduling a PDSCH reception, HARQ-ACK report is as in Rel-16.

Proposal 9:* 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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| R1-2112215 QC | Proposal 1: For Type-2 codebook generation, the UE assumes that the C-DAI and T-DAI of the DCI of PDSCH with feedback-disabled process is the same as the C\_DAI and T-DAI of the ost recently transmitted DCI of PDSCH with feedback-enabled process by gNB. Proposal 2: 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 3: For Type-1 codebook, UE reports a NACK for a bit corresponding to a PDSCH/TB of HARQ process with feedback disabled.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 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.  |
| R1-2112335 ITL | Proposal 1. For both type-1 and type-3 HARQ-ACK codebook, it is supported for UE to skip the HARQ-ACK feedback associated with PDSCH occasions if only DCI carrying feedback-disabled HARQ process is detected by UE.Proposal 2. 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 3. It is proposed to support explicit DCI signaling for skipping HARQ-ACK feedback by reusing PUCCH resource indication field in the DCI.Proposal 4. 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  |
|  |  |