3GPP TSG RAN WG1 #105e R1-210xxxx

e-Meeting, May 10th – 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 Restriction on HARQ feedback disabling
* Performance enhancement

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

In RAN1#103e, following agreement has 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

Then, in this meeting, ***views on following options are summarized as:***

* Option 1: Slot index as the MSB
	+ Supported by [Huawei,QC,OPPO, Sony, Lenovo, Xiaomi]
	+ Objected by [Nokia]
* Option 1-a: Slot index as the LSB is supported by
	+ Supported by [OPPO, Sony, Xiaomi]
	+ Objected by [Nokia]
* Option 2: Reusing one bit from other bit field is supported by
	+ Supported by [Huawei,vivo, Spreadtrum, CATT, MTK, Apple, ZTE]

More specifically, [vivo, Apple] prefer to take this option for DCI 0-0/1-0 and DCI 0-1/1-1. And w.r.t detailed bit field, following are preferred:

* MCS field [Huawei]
* Bits for the second block [CATT]
* RV bit field [Apple, ZTE]
	+ Objected by
		- [Ericsson], which highlights that indication of 32 HARQ processes via Option 2 and it can easily cause confusion and complications in the specification
* Option 3: Extending the HARQ process ID field up to 5 bits is supported by
	+ Supported by [vivo, CMCC, CAICT, Ericsson, Nokia, Apple, Lenovo, Samsung, NEC, LG, Panasonic, InterDigital, ITRI]

More specifically, [Apple, Lenovo] highlight that this solution is applied for DCI 0-2/1-2.

* + Objected by
		- Huawei, which prefer to keep the DCI size unchanged as a unified solution

In addition, except for the options above, [vivo] also prefer to use some dedicated RNTIs or extend the number of scrambled CRC bits to indicate the extension of HARQ process ID for DCI 0-0/1-0.

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]. W.r.t DCI 0-0/1-0, [MTK, Ericsson, NEC, LG] proposes that the maximum HARQ process should be assumed as 16, but [CMCC, CAICT] propose to extend HARQ bit field to 5 bits also for this format. [Nokia] highlight that one additional bit (as MSB) can be added for HARQ ID indication (only applicable for NTN) for DCI 0-0/1-0.

According to the above summary, from moderator perspective, w.r.t the directly extension of bit field of HARQ process number, it may be only applicable for DCI 0-2/1-2 if supported according to the similar design principle. For other DCI format, e.g., DCI 0-1/1-1, other solutions, e.g., Option-2, can be considered. Then following proposals can be considered:

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

Enhancement on the HARQ process indication is supported as:

* For DCI 0-1/1-1,
	+ Option 2: Reusing one bit from other bit field
* For DCI 0-2/1-2:
	+ Option 3: Extending the HARQ process ID field up to 5 bits
* For DCI 0-0/1-0, one of following is considered
	+ Option 2: Reusing one bit from other bit field
	+ Option 3: Extending the HARQ process ID field up to 5 bits

Since this topic has already been discussed for several meetings, please directly provide your views below and detailed preference on each DCI format/option.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Solutions | Option-1 | Option 1-a | Option 2 | Option 3 |
| 1st preference | DCI 0-0/1-0 | OPPO |  |  |  |
| DCI 0-1/1-1 | OPPO |  |  | APT, Panasonic |
| DCI 0-2/1-2 |  |  |  | APT, Panasonic |
| 2nd preference | DCI 0-0/1-0 |  | OPPO |  |  |
| DCI 0-1/1-1 |  | OPPO |  |  |
| DCI 0-2/1-2 |  |  |  |  |
| Strong concern |  |  | APT , OPPO | OPPO |

# **Issue-2 HARQ codebook enhancements**

In RAN1#103e and RAN1#104e, following agreement has 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

Then, in this meeting, ***further views are summarized as:***:

1. W.r.t the Type-1 Codebook (Semi-static codebook):
	* Option-1: No enhancement
* Supported by [Spreadtrum, CATT, CMCC, OPPO, Nokia, CEWIT, Apple, ZTE, Lenovo, Xiaomi,Panasonic, ITRI]
	+ As pointed by [Spreadtrum], for Type-1 codebook with semi-static size, the needs for enhancement is limited. And the legacy behavior for codebook construction should be kept for Type-1 [CMCC]
	+ Option-2: Report NACK on disabled process
		- Supported by [MTK,ITRI]
		- Objected by [Huawei]
	+ Option-3: Reduce codebook size with criteria
		- Supported by [Huawei, vivo Qualcomm, Ericsson, Sony, Samsung, NEC], more specifically, the detailed criteria can be :
		- Skipping the feedback of PDSCH occasions from disabled HARQ processes [Huawei]
		- 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]
		- Codebook design for the limit of PDSCH transmissions less than candidate occasions for HARQ processes with feedback enabled [Qualcomm]
		- 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 [Ericsson].
		- Support configuration to a UE of a bitmap that indicates slots where the UE should generate HARQ-ACK information [Samsung]

Moreover, restriction on the scheduling can be consider to reduce the codebook size [Sony]

1. W.r.t Type-3 Codebook:
	1. Supportive to enhancement: Huawei, vivo, Spreadtrum, Ericsson, CEWiT, ZTE
		1. Solution 1: No feedback for HARQ process with disabled feedback
	2. Negative to enhancement: CATT, OPPO, Nokia, Lenovo, Samsung

As pointed by [CATT, OPPO], supports on Type-3 codebook is not needed.

For the Type-2 Codebook (Dynamic codebook), based on the previous agreement, w.r.t the C-DAI and T-DAI counting, following details are listed:

1. Alt-1: C-DAI and T-DAI count only PDSCH with feedback-enabled HARQ processes, more specifically,
	* For the DCI of PDSCH with feedback-enabled HARQ processes:
		1. Option-1: the C-DAI and T-DAI are given their true values (i.e., the count of feedback-enabled processes) : [Huawei, vivo, CATT, QC, Ericsson, Nokia, CEWiT, Apple, Sony, OPPO, ZTE, Lenovo, Samsung]
	* For the DCI of PDSCH with feedback-disabled HARQ processes,
		1. Option-1: The C-DAI and T-DAI are given their true values (i.e., the count of feedback-enabled processes), despite they are not incremented [CATT, Ericsson, Nokia, Lenovo]
		2. Option-2: The C-DAI and T-DAI are given a reserved value that can be ignored by the UE [CMCC, CEWiT, Apple]

As proposed by [CMCC], this value can also be removed or re-interpreted by [CMCC].

* + 1. Option-3: The C-DAI/T-DAI are given their true values (i.e., the count of feedback-disabled processes) [OPPO, ZTE]
1. Alt 2: C-DAI and T-DAI count both PDSCH with feedback-enabled HARQ processes and PDSCH with feedback-disabled HARQ processes [Xiaomi]
2. Alt 3: T-DAI field in the DCI that schedules feedback-disabled process indicates the total DAI value while C-DAI field is reserved [Panasonic]

As other alternative as pointed by [APT], reusing Rel-16 DCI format 1\_2 with 0-bit DAI field to support reducing codebook size with Type-2 HARQ-ACK CB since a UE does not expect to multiplex HARQ-ACK information in a Type-2 HARQ-ACK codebook that is in response to a detection of a DCI format that does not include a counter DAI field. And the applicability should be checked

To further improve the performance of feedback, as pointed by [Qualcomm], spatial bundling of all feedback bits in a codebook is preferred.

For the SPS issue, [vivo] also prefer to keep the counting for SPS without changes, but [CAICT] propose to enable/disable HARQ feedback for DL SPS CG is configured per configuration and corresponding study is also interested by [Apple] for SPS PDSCH. More specifically, the following detailed views are shown by [Sony]:

* For the SPS PDSCH activation:
	+ UE reports HARQ feedback information for the SPS PDSCH activation when the related SPS PDSCH is HARQ feedback disabled.
	+ 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.
* For the SPS PDSCH release:
	+ The UE reports HARQ feedback information for the SPS PDSCH release, either the related SPS PDSCH is HARQ feedback disabled or enabled.
	+ 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.

According to the above summary, from moderator’s perspective, w.r.t the Type-1 codebook, it seems that majority does not prefer to introduce complicated solution, but the optimization for some specific case with minimized the codebook overhead is preferred. For the Type-3 codebook, the solution is clear and but some companies have concerns on necessity for Type-3 in NR-NTN. Then, the following proposals:

**[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

**[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：

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| APT | Support [Initial Proposal 2-1]Support [Initial Proposal 2-2]Considering MAC may not indicate PHY to generate HARQ-ACK, UE may only know HARQ PIDs configured with HARQ feedbacks. |
| OPPO | For initial proposal 2-1: we don’t support this proposal as we still think no enhancement is needed. If the gNB wants to reduce the PUCCH overhead, it should configure type 2 CB instead of type 1. Given that there is already solution for PUCCH overhead reduction, we don’t need another one achieving a similar goal.For initial proposal 2-2: we don’t support this proposal. As presented in our Tdoc, we think that there is no need to support type 3 CB. But if majority companies want to support type 3 CB, we can compromise. But we are against further enhancement. The type 3 CB should be reused as is. Regarding codebook size reduction, as we already have type 2 CB enhancement, we don’t need another size reduction enhancement for other codebook.  |
| Panasonic | Generally agree with proposal 2-1, but we would propose the following modification because UE can not know if only feedback-disabled HARQ processes is actually associated with PDSCH occasions.**Modified proposal 2-1: For Type-1 HARQ codebook in NTN, the UE may skip the codebook feedback if UE is scheduled with only feedback-disabled HARQ processes associated with PDSCH occasions.** Generally agree with proposal 2-2, but we would propose the following modification for more clarity. **Modified proposal 2-2: For Type-3 HARQ codebook in NTN, the UE should skip the HARQ-ACK for feedback-disabled HARQ processes in the HARQ codebook**.  |
|  |  |

For the Type-2 codebook, w.r.t the remaining issue on the counting of C-DAI and T-DAI, companies’ views on feedback-enabled HARQ process are converged and different points are shared on how to process the disabled case. Moreover, as pointed by [APT], for DCI format 1\_2, the solution with 0-bit DAI field to support reducing codebook size with Type-2 HARQ-ACK CB is more straightforward without specific effort since a UE does not expect to multiplex HARQ-ACK information in a Type-2 HARQ-ACK codebook that is in response to a detection of a DCI format that does not include a counter DAI field, but the applicability of DCI 1-2 in NTN should be checked. Then, from operation perspective, following can be taken in the proposal:

**[Initial Proposal 2-3]:**

For Type-2 HARQ codebook in NTN,

* + For the DCI of PDSCH with feedback-enabled HARQ processes, the C-DAI and T-DAI are given their true values (i.e., the count of feedback-enabled processes)
	+ For the DCI of PDSCH with feedback-disabled HARQ process, down-selection following options:
		- Option-1: The C-DAI and T-DAI are given their true values (i.e., the count of feedback-enabled processes), despite they are not incremented
		- Option-2: The C-DAI and T-DAI are given a reserved value that can be ignored by the UE
		- Option-3: The C-DAI/T-DAI are given their true values (i.e., the count of feedback-disabled processes)
	+ FFS: at least DCI for SPS release/SPS PDSCH
	+ FFS: DCI 1-2

Please provide your views below：

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| APT | Support Initial Proposal 2-3 |
| OPPO | In Rel-15/16 NR, C-DAI/T-DAI are designed to solve the case that at most 3 consecutive DCI are missing. If the last DCI or the last consecutive DCIs are missing, it can be fixed by gNB blind detection of HARQ codebook with different candidate codebook sizes. This mechanism has already existed in R15/R16. Take the following figure as example, assuming gNB expects that the HARQ codebook size is 6, it may try size 6, 5, 4 for the codebook detection and may still correctly detect the codebook with size 4.On the other hand, in R15/R16, from UE point of view, the UE may have a full knowledge of the number of missed DCIs in the legacy mechanism, and this information can be used to adjust CQI reporting by UE implementation. This information should be available also to the UE in R17 NR-NTN. **For Option-1**: The C-DAI and T-DAI are given their true values (i.e., the count of feedback-enabled processes), despite they are not incremented. We may consider the following two cases as shown in the following figure:* Case 1: Disabled HARQ processes are scheduled no earlier than enabled HARQ processes in a total number of PDCCH monitoring occasions corresponding to a Type-2 HARQ codebook.
* Case 2: Disabled HARQ processes are scheduled earlier than enhabled HARQ processes in a total number of PDCCH monitoring occasions corresponding to a Type-2 HARQ codebook.

It is obvious that in Case 2, Option-1 doesn’t bring any benefits.For Case 1, with Option-1 UE may determine a correct codebook size if it misses the last DCI for enable HARQ process but detects a later DCI for disable HARQ process. But this should not be a problem because the gNB can always fix the codebook size misunderstanding issue by blindly detect the codebook with different candidate sizes, as Rel-15/16 did. The benefit of Option-1 in Case 1 is very limited. Secondly, UE is required to read the C-DAI/T-DAI in the DCI scheduling disabled HARQ processes to generate a Type-2 HARQ codebook for the enabled HARQ process, which is quite different from the existing HARQ-ACK codebook generation principle. Thirdly, the information of the total missed DCI number which can be derived according to Rel-15/16 mechanism, is completely missing with Option-1. For the above reasons, we don’t support Option-1. Our preference is Option 3.  |
| Panasonic | Regarding the DCI of PDSCH with feedback-disabled HARQ process, indication of both C-DAI and T-DAI would not be useful. T-DAI would be more useful to avoid mis-alignment of the codebook size between gNB and UE when the last DCI is missed. In this situation to inform C-DAI in DCI for feedback-disabled process is not useful. Therefore, we would like to add the following option for down-selection.**Option-4**: The C-DAI is given a reserved value that can be ignored by the UE and T-DAI is given the true value (i.e., the count of feedback-enabled processes) despite it not incremented.  |

# **Issue-3 PDSCH/PUSCH scheduling restriction**

In RAN1#104e, following agreement has been achieved:

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

Then, in this meeting, ***further views are summarized as:***

1. Option-1: Confirming the working assumption as X = T\_proc,1 [vivo, CATT, CMCC, OPPO, Ericsson, Nokia, CEWiT, Apple, ZTE, Samsung,LG, Xiaomi,ITRI,APT]
2. Option-2: Revise the WA by X = max(T\_proc,1, K1) where K1 is the minimum k1 if it is configured, otherwise k1 = 0 [QC]

In addition, [OPPO] propose to clarify PDSCH reception constraint for a given enabled DL HARQ process and [Ericsson] proposed to clarify the PDSCH reception restriction once the HARQ feedback is disabled.

[LG] propose that PDSCH scheduling restriction if two PDSCHs are associated with different HARQ process id and one of two PDSCHs is HARQ feedback disabled.

Moreover, [Ericsson] propose to further clarify the intention of previous agreement as below:

* Definition 1: 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 DCI scheduling another PDSCH or set of slot-aggregated PDSCH for the given HARQ process.
* Definition 2: 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 another PDSCH or set of slot-aggregated PDSCH for the given HARQ process.

Among these two Definitions, [Ericsson, Nokia] prefer to take the Definition 1.

Based on the above analysis, w.r.t WA on X, according to the majority’s views, following proposal is provided:

**[Initial Proposal 3-1]:**

Confirming following WA assumption that X = T\_proc,1;

Furthermore, w.r.t the two definitions w.r.t the previous agreement, the main difference is to restrict whether the DCI to scheduling another PDSCH or set of slot-aggregated PDSCH for the given HARQ process can be set before the transmission of the 1st PDSCH. From moderator perspective, it seems that there is such restriction for the legacy system that a PDSCH is not expected to be transmitted for the same HARQ process until after the HARQ-ACK has been transmitted, which is beneficial on dynamic scheduling to simplify implementation and testing by precluding the transmission of the 2nd DCI scheduling the latter PDSCH before the 1st PDSCH.

Based on the above analysis, w.r.t the interpretation on previous agreement, according to the majority’s views, following proposal is provided:

**[Initial Proposal 3-2]:**

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 DCI scheduling another PDSCH or set of slot-aggregated PDSCH for the given HARQ process.

Please provide your views below：

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| APT | Support [Initial Proposal 3-1]Support [Initial Proposal 3-2]. The intention is to minimize the spec impact on the PDSCH processing time. Therefore, it is enough if NW ensures X=T\_proc,1 after a PDSCH reception used as the PDSCH processing time. See TS 38.214 V16.5.0, clause 5.3. |
| OPPO | We agree with initial proposal 3-1. We agree with initial proposal 3-2.  |
| Panasonic | Support both proposal 3-1 and proposal 3-2.  |

Moreover, according to the recommendation in the FL summary is last meeting, [Qualcomm] propose 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] propose to define a minimum gap between two PUSCHs of a HARQ process, for example, T\_proc,2. However, as proposed by [CATT], the existing scheduling rule should be kept for PUSCH. Moreover, [OPPO] proposed to clarify the PUSCH transmission constraint for a given enabled UL HARQ process

From moderator perspective:

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

*Agreement:*

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

Agreement from RAN2#112e:

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

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

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

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

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

Then, based on the above analysis, it’s clear that for enabling the consecutive transmission with same HARQ process, e.g., retransmission, no additional enhancement for the PUSCH scheduling is needed comparing to terrestrial network. Companies are encourage to justify the necessity.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| APT | Agree with moderator. It can be discussed in the future releases.  |
| OPPO | If in NR-NTN a same existing R15/R16 NR timeline is assumed, then with the above clarified conclusion, we think that there is no need for further enhancement. But we are open to consider a NTN new timeline.  |
| Panasonic | Agree with above conclusion.  |

# **Issue-4 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. In this meeting, ***following views are summarized:***

1. Option 1: UE expects that at least one HARQ process for DL scheduling is configured for the scheduling of MAC-CE.[CATT, MTK, CMCC, Nokia, Sony, InterDigital]
2. Option 2: Up to gNB’s implementation for scheduling [NEC, Panasonic]

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

According to the above summary, it’s clear that resolving the potential mismatch between UE’s and gNB’s behavior due to the introduction of feedback disabling is needed along with the discussion in previous meeting. Then, from moderator perspective, Option-1 can be taken with following proposal:

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

For the PDSCH carrying MAC CE, UE expects that at least one HARQ process is configured with HARQ feedback.

Please provide your views below：

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| APT | Support Initial Proposal 4-1 |
| OPPO | We disagree with this proposal. This topic has been extensively discussed in RAN1#104-e, the necessity of this restriction is quite low and the argument is not convincing. It is naturally up to network implementation without any further enhancement. |
| Panasonic | Disagree with proposal 4-1. This is unnecessary restriction and it should be purely gNB implementation matter. Furthermore, as we mentioned in the email discussion last meeting, it causes a significant delay of MAC CE delivery in some scenarios. For example, for an operation with SCS=120kHz and RTT=42ms (max RTT for LEO 1200km), within the RTT period (42ms=335 slots) only up to 32 slots are available for feedback-enabled transmissions. gNB would easily run out of all feedback-enabled processes and would have to use feedback-disabled processes until (re)transmission of one of the feedback-enabled process is completed (i.e. ACK is received) although it is not efficient due to the low MCS transmission to achieve lower BLER. When MAC CE is generated, gNB has to wait the MAC CE transmission until a feedback-enabled process becomes available if the MAC CE transmission is restricted to feedback-enabled process. This might create significant delay for MAC CE transmission. On the other hand, it is possible for gNB to override an ongoing feedback-enabled process for the MAC CE transmission. But in this case RLC retransmission is triggered when the “stolen” HARQ process is NACK. This further increase the delay of the TB. |

# **Issue-5 Performance enhancement**

For enhancing the performance of transmission, in last meeting, different solutions including potential parameters configurations are proposed by companies. In this meeting, following aspects are categorized into following aspects according to the views from each company:

1. Enhancements on aggregated transmission (including repetition) [CMCC]
	* Larger aggregation factor:

As highlighted by [Spreadtrum, CATT, ETRI, Nokia, ZTE, Samsung], supports of the larger aggregation factor is beneficial for NTN.

* + Indication of aggregation factor:

[Huawei] prefer to indicate the value via DCI by reinterpreting the idle bits.

[OPPO, Ericsson, Apple, ETRI] prefer to introduce different configurations for the transmission via HARQ process with enabled or disabled feedback. But a unified configuration is preferred by Lenovo.

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

* + Transmission scheme:

Moreover, as results shown in [ZTE], performance gain can be achieved for the transmission with reduced DM-RS density. [Panasonic] proposes to introduce the scaling factor for TBS determination.

1. Enhancements on CQI/MCS table with new BLER

A new CQI table with larger BLER e.g., 1% is proposed by [Qualcomm, Interdigital]. But this part is not preferred by [CATT, Nokia] since similar performance can be achieved by implementation of scheduling.

1. Blind retransmission

As highlighted by [Magister, Spreadtrum, InterDigital], supports on blind PDSCH (re)transmission of the same packet by MAC scheduling without waiting for the transmission of the HARQ feedback can be considered with configuration per UE. However, as pointed by [Nokia], changing the existing processing timeline restrictions for scheduling is not preferred.

1. UCI

As highlighted in [Qualcomm, ETRI, LG, Xiaomi], in case of scheduling with disabled HARQ feedback, additional new UCI feedback, e.g., to report the decoding statistic or reporting DL transmission disruption and/or requesting DL scheduling changes, can be considered to improve the scheduling configuration from gNB side. However, this part is not preferred by [Nokia]

1. UE assistance information

As mentioned in [Samsung, Huawei], report for the assist information from UE side, e.g., the buffer situation in the DL HARQ procedure [Samsung] via reserved resource [Huawei], is beneficial for scheduling the decision for HARQ scheduling with enabled/disabled feedback. However, this is not preferred by [Nokia].

In addition, other solutions, e.g., priority order for transmission [CAICT], RV limitation for DL scheduling and different configuration on transmission parameters, e.g., PC, MCS, UCI [Qualcomm] is proposed by proponent.

Based on the above analysis, following proposal is provided according to majority view:

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

Study on following enhancements is prioritized:

* Enhancements on aggregated transmission (including repetition)

Please provide your views below：

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| APT | Support Initial Proposal 5-1 |
| OPPO | Fine with this proposal. |
| Panasonic | Support proposal 5-1 |

# **Conclusion**

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

# **Appendix**

|  |  |
| --- | --- |
| Contribution | Observation/Proposals |
| R1-2104257 Huawei | Observation 1: Slot index as MSB of HARQ process ID is more flexible for UE with supportable HARQ process number not lager than 16.Observation 2: Explicit Indication of HARQ process ID via reusing idle bits depends on DCI format design.Observation 3: UE can be configured to know whether the HARQ process feedback is disabled or enabled.Observation 4: For Type-1 HARQ-ACK codebook, skipping the feedback of PDSCH occasions from disabled HARQ process can largely reduce the overhead.Proposal 1: Extending HARQ process ID field shall be precluded.Proposal 2: Implicit indication of HARQ process ID via binding MSB of HARQ process ID with slot index is first preferred.Proposal 3: For Type-1 HARQ-ACK codebook, skip the feedback of PDSCH occasions from disabled HARQ processes.Proposal 4: For Type-3 HARQ-ACK codebook, skip the feedback of PDSCH occasions from disabled HARQ processes.Proposal 5: For Type-2 codebook, DAI is not count for scheduled PDSCH from disabled HARQ process.* 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) or SPS PDSCH release associated with the DCI formats with enabled HARQ 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) or SPS PDSCH release associated with the DCI formats with enabled HARQ up to the current serving cell and current PDCCH monitoring occasion.

Proposal 6: Aggregation/repetition transmission parameters can be configurable and indicated via DCI.Proposal 7: Reinterpret idle bits in DCI for indicating transmission parameters.Proposal 8: UE assistance information reporting in reserved resource can be considered for NTN. |
| R1-2104357vivo | Proposal 1：Support to indicate enhanced HARQ process ID by the following:* For DCI 0-1/1-1 and DCI 0-2/1-2, extend the HARQ process ID field to 5 bits.
* For DCI 0-0/1-0, the following options can be considered:
	+ Option 1: Re-interpret existing DCI field to indicate the extension of HARQ process ID.
	+ Option 2: Use some dedicated RNTIs or extend the number of scrambled CRC bits to indicate the extension of HARQ process ID.

Proposal 2: The functionality of enabling/disabling HARQ feedback per HARQ process can be semi-static configured and dynamically switched.Proposal 3：Support to enhance HARQ-ACK codebook as below:* For Type-1 HARQ-ACK codebook:
	+ If both enabled HARQ processes or SPS release and disabled HARQ processes are transmitted in the  occasions, there is no need to enhance.
	+ If only disabled HARQ processes are transmitted in the occasions, omit the HARQ-ACK report.
* For Type-2 HARQ-ACK codebook:
	+ HARQ-ACK codebook only includes HARQ-ACK of PDSCH with enabled HARQ processes and SPS release.
	+ 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.

Proposal 4：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 Tproc,1 after the end of the reception of the last PDSCH or slot-aggregated PDSCH for that HARQ process.* The TB of the two PDSCHs can be either same or different.
 |
| R1-2104402 Magister Solution Ltd | Observation 1: Without retransmissions, significant percentage of users are not receiving any throughput in challenging GEO use case.Observation 2: Blind retransmissions (slot aggregation) improve the residual BLER in challenging GEO use case with HARQ feedback disabled.Observation 3: Blind retransmissions (slot aggregation) waste a lot of resources if it is not enabled per UE in a dynamic way (on a need basis).Observation 4: Dynamic blind retransmissions (slot aggregation) improve the residual BLER for the users in challenging channel conditions, while aiming to minimize the effect on system throughput.Proposal 1: Allow to send blind PDSCH (re)transmission of the same packet by MAC scheduling without waiting for the transmission of the HARQ feedback.Proposal 2: Blind retransmissions should be possible to configure per UE. |
| R1-2104426Spreadtrum | Proposal 1: Reusing one bit from other bit field should be considered for HARQ process ID indication.Proposal 2: Blind retransmission and larger aggregation/repetition factor can be considered for enhancing the performance of transmission.Proposal 3: No enhancement is needed for the Type-1 codebook.Proposal 4: Enhancement for Type-3 HARQ codebook should be considered, if it is supported in NTN. |
| R1-2104518CATT | 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. No HARQ enhancement for DCI 0-2/1-2 is needed.
4. 32 processes can be supported based on UE capabilities.
5. No enhancement is needed for type 1 HARQ-ACK codebook.
6. 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.
7. For SPS case, the HARQ-ACK feedback for activation and release command can be enabled.
8. Type 3 HARQ-ACK codebook is not needed in NTN case.
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.
13. The minimum time gap between two neighboring disabled PDSCHs with same HARQ ID should be X = T\_proc,1.
14. There is no need to follow the legacy scheduling restriction of PUSCH in NTN.
 |
| R1-2104566MTK | Proposal 1: Support of 32 HARQ processes in the device is a UE capability in NR NTN.Proposal 2: The fallback DCI 0-0/1-0 I is used for UL and DL connections with a maximum of 16 HARQ processes.Proposal 3: Support Option 2 “Reusing one bit from other bit field” for DCI 0-1/1-1 and DCI 0-2/1-2Proposal 4: For Type-1 HARQ codebook, support report ACK/NACK on enabled processes and NACK on disabled processes.Proposal 5: 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 6: MAC CE are sent with HARQ feedback enabled even if activation/deactivation time is not coupled to the transmission time of the associated HARQ-ACK.  |
| R1-2104609 CMCC | Observation 1: If Type-1 HARQ codebook is constructed with reduced codebook size based on dynamic scheduling, additional ambiguity from both UE and gNB side may be introduced due to missing detection of DCI.* If any DCI of PDSCH with feedback-disabled HARQ process was miss-detected, miss understanding may occur on the bit size of the Type-1 HARQ-ACK codebook between the gNB and the UE.
* The position of ACK/NACK for PDSCH with feedback-enabled HARQ process in the reported Type-1 HARQ-ACK codebook are not fixed, and it depends on which one of the DCIs of PDSCH with feedback-disabled HARQ process was miss-detected.

Observation 2: If HARQ codebook is constructed with reduced codebook size based on semi-static scheduling, scheduling flexibility may be significantly reduced.Observation 3: If only disabled HARQ process are used for scheduling in $M\_{A,C}$ occasions, and if no HARQ-ACK feedback is expected at UE side, ambiguity due to missing detection of DCI will cause no issue.Observation 4: If only disabled HARQ process are used for scheduling in $M\_{A,C}$ occasions, and if no HARQ-ACK feedback is expected at UE side, PUCCH resource overhead may be significantly reduced if only DCIs of PDSCH with feedback-disabled HARQ processes are transmitted by the gNB.Observation 5: For type-2 HARQ-ACK codebook, even if the UE identified DCI miss detection event for PDSCH with feedback-disabled HARQ processes, the UE can NOT trigger RLC retransmission due to unknow the SN of the corresponding RLC PDU.Proposal 1: At least support extending the HARQ process ID field up to 5 bits for DCI 0-2/1-2 and DCI 0-1/1-1.Proposal 2: At least support extending the HARQ process ID field up to 5 bits for DCI 0-0/1-0.Proposal 3: For type-1 HARQ-ACK codebook construction, support the legacy behavior.Proposal 4: For type-1 HARQ-ACK codebook report, if only disabled HARQ process are used for scheduling in $M\_{A,C}$ occasions, no HARQ-ACK feedback is expected at UE side.Proposal 5: For type-2 HARQ-ACK codebook enhancement with reduced codebook size, the C-DAI field and T-DAI field in DCI of PDSCH with feedback-disabled HARQ processes is ignored by the UE.Proposal 6: For type-2 HARQ-ACK codebook enhancement with reduced codebook size, the C-DAI and T-DAI field in the DCI of PDSCH with feedback-disabled HARQ processes can be removed or reinterpreted.Proposal 7: For PDSCH/PUSCH scheduling restriction, confirm the working assumption of X = T\_proc,1.Proposal 8: 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 9: Support enhancement on the aggregated transmission for DL. |
| R1-2104669Qualcomm | 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: When 32 HARQ processes is configured, UE determines the HARQ ID as 16\*mod(n,2) +k where* n is the slot number during which the DCI was first transmitted
* k is indicated by the 4 HARQ process ID bits in DCI

Proposal 2: To amend an existing agreement as below: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 of dl-DataToUL-ACK ~~k1~~ if it is configured, otherwise K1 = 0
* ~~Note: The TB of the two PDSCHs can be either same or different~~

Proposal 3: Consider new CQI BLER targets for HARQ processes without feedbacks.Proposal 4: 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 5: For DL HARQ processes with HARQ feedback disabled, initial transmissions shall use RV 0 and retransmissions shall not use RV 0.Proposal 6: For Type-2 HARQ codebook* Only PDSCHs of HARQ processes with feedback enabled are counted in DAIs in DCI.

Proposal 7: 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 8: 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 9: 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 10: 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 11: 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.  |
| [R1-2104723](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2104723.zip)CAICT | Proposal 1: Support option 3 for DCI 0-2/1-2, DCI 0-1/1-1. If 32 HARQ processes are also supported 0-0/1-0, also option 3 is supported.Proposal 2: Configure two subsets of HARQ processes for enabled HARQ processes and disabled HARQ processes respectively via RRC signaling. To decide the HARQ disable/enable state with HARQ process ID indication in the scheduling DCI.Proposal 3: HARQ-ACK feedback related bit fields are not included in the DCI with a feedback-disabled HARQ process.Proposal 4: Consider enhancements on DCI formats and corresponding PDCCH detection when DL HARQ process with feedback disabled and enabled are simultaneously supported for one UE.Proposal 5: Enabling/disabling of HARQ feedback for DL SPS/UL CG is configured per configuration.Proposal 6: Provide higher priority order for the HARQ disabled transmission than the priority order for HARQ enabled transmission. |
| R1-2104772 OPPO | 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, count C-DAI and T-DAI for scheduling of enable HARQ processes and disabled HARQ process independently. Proposal 4: Type-3 HARQ codebook is not supported in NR-NTN. Proposal 5: Confirm the working assumption that X = T\_proc,1. Proposal 6: PUSCH transmission constraint for a given disabled UL HARQ process should be considered. Proposal 7: 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 8: PUSCH processing time should be updated in NTN. Proposal 9: Option 1 or Option 1a should be supported for enhanced HARQ process ID indication. Proposal 10: PDSCH reception constraint for a given enabled DL HARQ process should be clarified in NTN. Proposal 11: PUSCH transmission constraint for a given enabled UL HARQ process should be clarified in NTN. Proposal 12: The size of the PDSCH-to-HARQ\_feedback timing indicator field in DCI should not be changed.  |
| R1-2104812Ericsson | [Observation 1 It is not necessary to schedule 32 HARQ processes using fallback DCI 0\_0/1\_0.](#_Toc71641852)[Observation 2 Adding an additional configurable bit in DCI 0\_1/1\_1 and/or 0\_2/1\_2 to support 32 HARQ processes minimizes the impacts on specification and scheduling.](#_Toc71641853)[Observation 3 Time window-based method (and its variations) for supporting 32 HARQ processes is not aligned with asynchronous NR HARQ design principle, introduces unnecessary scheduling restriction, and thus is against the RAN1 agreement of “minimizing the impacts on specification and scheduling.”](#_Toc71641854)[Observation 4 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.](#_Toc71641855)[Observation 5 If the reused bit is from a field that is not applicable when HARQ feedback is disabled, it will couple two features, i.e., 32 HARQ processes can only be used when HARQ feedback is disabled, which is highly undesirable.](#_Toc71641856)[Observation 6 The intention of disabling HARQ feedback for a downlink transmission is not to send HARQ feedback for the downlink transmission.](#_Toc71641857)[Observation 7 If the network schedules a PDSCH on a HARQ process with feedback disabled, it is clear that the network is not interested in receiving the feedback.](#_Toc71641858)[Observation 8 Sending feedback from UE for a HARQ process with disabled feedback leads to waste of radio resource and UE power consumption, as well as increased interference.](#_Toc71641859)[Observation 9 RAN1 already agreed that Type-3 HARQ codebook can be applied in licensed spectrum.](#_Toc71641860)[Observation 10 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.](#_Toc71641861)[Observation 11 There should not be some artificial restriction that Type-3 HARQ codebook is not applicable to NTN.](#_Toc71641862)[Observation 12 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.](#_Toc71641863)[Proposal 1 Whether 32 HARQ processes are used or not in the uplink can be configured by RRC.](#_Toc71641864)[Proposal 2 Whether 32 HARQ processes are used or not in the downlink can be configured by RRC.](#_Toc71641865)[Proposal 3 If 32 HARQ processes are configured, the size of the HARQ process ID field in DCI 0\_1/1\_1 is 5 bits.](#_Toc71641866)[Proposal 4 If 32 HARQ processes are configured, the size of the HARQ process ID field in DCI 0\_2/1\_2 is 5 bits.](#_Toc71641867)[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.](#_Toc71641868)[Proposal 6 In case of Type-1 HARQ codebook, when HARQ processes are enabled/disabled on a per HARQ process basis, the UE inserts NACKs in positions corresponding to PDSCHs associated with feedback disabled HARQ processes.](#_Toc71641869)[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.](#_Toc71641870)[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.](#_Toc71641871)[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.](#_Toc71641872)[Proposal 10 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 DCI scheduling another PDSCH or set of slot-aggregated PDSCH for the given HARQ process.](#_Toc71641873)[Proposal 11 Confirm the working assumption that X = T\_proc,1 when the PDSCH is scheduled on a HARQ process with feedback disabled.](#_Toc71641874)[Proposal 12 RAN1 to discuss the timing restriction for PDSCH scheduling when HARQ feedback is disabled.](#_Toc71641875) |
| R1-2104829Nokia | Observation 1: Using option 1 or option 1-a would create scheduling impacts due to the time-wise dependency of the HARQ process ID.Observation 2: Using option 1 or option 1-a may not be feasible if PDCCH is not monitored in all slots.Observation 3: 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: In the agreement from RAN1#104-e on PDSCH processing for a HARQ process with disabled HARQ feedback, the value of X should be according to the working assumption, that is, X = T\_proc,1.Proposal 2: For Type-2 HARQ codebook, C-DAI and T-DAI counting should exclude scheduled PDSCHs that are associated with feedback-disabled HARQ processes.Proposal 3: The UE uses HARQ process ID to determine whether or not HARQ feedback is disabled.Proposal 4: The UE determines the Type-2 HARQ codebook size based on the scheduled HARQ processes that has HARQ feedback enabled.Proposal 5: No enhancements 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 6: No enhancements 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 7: Do a down-selection of the options for indication of HARQ process ID such that only one option is specified. Proposal 8: Enhanced HARQ process ID indication is supported for DCI 0-2/1-2 and DCI 0-1/1-1 by extending the HARQ process ID field up to 5 bits when configured.Proposal 9: Assign one additional bit for indicating the MSB of the HARQ process ID for DCI format 0-0 and DCI format 1-0.Proposal 10: UEs supporting NTN should by default support the maximum number of HARQ processes to ensure network efficiency.Proposal 11: 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 12: Support slot aggregation for NR over NTN.Proposal 13: Do not support enhancements to the CQI tables or reporting mechanisms that are specific to NR over NTN. Proposal 14: No support for changing the existing processing timeline restrictions for scheduling.Proposal 15: No need for additional uplink control information is needed for supporting UEs with HARQ feedback disabled.Proposal 16: No need to introduce further UE assistance information specifically related to NR operation over NTN. |
| R1-2105054CEWiT | Proposal 1: Treat candidate occasion with PDSCH corresponding to feedback disabled HARQ process ID as unscheduledProposal 2: No enhancement is needed for the existing mechanism for semi-static codebook formationObservation 1: Enabling/disabling of feedback is indicated by DCI and the semi-static codebook should not be dependent on the DCI parameterObservation 2: Forming Type1 codebook based on HARQ enabled ID creates ambiguity in case of DCI failureProposal 3: Enabling dynamic codebook or codebook based on HARQ process ID at UE is supported in case feedback is disabled for majority of the HARQ process IDProposal 4: cDAI and tDAI should count only PDSCH with feedback enabled HARQ processes * In DCI scheduling PDSCH with feedback enabled HARQ processes, the cDAI and tDAI indicate the count of feedback-enabled processes
* In DCI scheduling PDSCH with feedback disabled HARQ processes, the cDAI and tDAI indicate a reserved value that can be ignored by the UE

Proposal 5: Reduce Type 3 codebook size by including ACK/NACK information for feedback enabled HARQ processesProposal 6: 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 $T\_{proc,1}$ after the end of the reception of the last PDSCH or slot-aggregated PDSCH for that HARQ process. |
| R1-2105103 Apple | Proposal 1: Enhanced HARQ process number indication is supported for DCI 0-2/1-2 by extending the HARQ process number field up to 5 bits.Proposal 2: 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 3: Support to have different configurations for HARQ processes with or without HARQ feedback. Proposal 4: In type-1 HARQ-ACK codebook construction, UE does not reduce the HARQ-ACK codebook size for HARQ processes with disabled HARQ feedback.Proposal 5: In type-2 HARQ-ACK codebook construction,* In DCI of PDSCH with feedback enabled HARQ processes, C-DAI and T-DAI are given their true values.
* In DCI of PDSCH with feedback disabled HARQ processes, T-DAI is given its true value and C-DAI is given a reserved value.

Proposal 6: 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 7: Confirm the working assumption of X=$T\_{proc,1}$, where X is the minimum time gap for a UE to receive two PDSCHs or set of slot-aggregated PDSCHs with the same HARQ process number with feedback disabled. |
| R1-2105166Sony | 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: Unified solution of HARQ process indication for all DCI formats, down select from following options:* Option 1: Slot index as the MSB
* Option 1-a: Slot index as the LSB

Proposal 2: 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 3: 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 one DCI are given the count value of {serving cell, PDCCH monitoring occasion}-pair(s) who’s associated PDSCH is HARQ feedback enabled.
	+ FFS whether DAI count for SPS release.

Proposal 4: UE reports HARQ feedback information for the 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 count for PDCCH indicating SPS PDSCH activation when the related SPS PDSCH is HARQ feedback disabled.Proposal 6: The UE reports HARQ feedback information for the SPS PDSCH release, either the related SPS PDSCH is HARQ feedback disabled or enabled.Proposal 7: 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. |
| R1-2105191ZTE | Proposal 1: Enhancement on the DCI to support enlarged HARQ process indication should be prioritized for DCI format 0-1/1-1.Proposal 2: Re-interpretation of bits in DCI should be considered as the baseline to support the HARQ process indication with extended maximum HARQ process number.Proposal 3: For Type-2 codebook, separately counting on the C/T-DAI for HARQ enabling and disabling case is preferred. Proposal 4: For Type-3 codebook, enhancement can be enabled by only allowing the ACK-NACK generation for HARQ process with enabled feedback.Proposal 5: Confirming the working assumption:* 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 Tpro,1 after the end of the reception of the last PDSCH or slot-aggregated PDSCH for that HARQ process.

Proposal 6: The link budget listed in 38.821 can be used to evaluate the UL performance for mobile UE with consideration on the potential enhancements introduced in coverage enhancement WI.Proposal 7: Enlarged aggregation factor and reduced DM-RS density should be supported to improve the performance for NTN.Proposal 8: Following enhancements are not needed to be supported:* + Blind re-transmission:
	+ CQI with new BLER target
	+ UCI including DL decoding Infor/MCS request
	+ Different parameters configuration
		1. MCS table
		2. Time domain resource allocation table
		3. Frequency resource allocation type 0 and type 1
		4. Block error rate target
		5. Physical resource block (PRB) bundling configuration
		6. PDSCH mapping type A and type B
 |
| R1-2105215Lenovo | Proposal 1: The HARQ process number is tied to SFN/slot index of PDCCH/PUSCH/PDSCH for DCI format 0-0/1-0 and DCI format 0-1/1-1 if UE is configured with HARQ process number of 32.Proposal 2: For DCI 0-2/1-2, the HARQ process number field in DCI is determined to higher layer parameter.Proposal 3: Different numbers of HARQ processes is configured based on UE capability.Proposal 4: UE assumes the HARQ feedback disabling where HARQ ID belongs to the RRC configured HARQ process disabling subset.Proposal 5: The multiple transmissions of same TBs in consecutive or interlaced slots can be considered when HARQ is disabledProposal 6: Repetition transmission number and interlace transmission interval can be indicated in corresponding DCI when HARQ process disabling.Proposal 7: A unified configuration should be considered for each HARQ process with/without feedback except aggregation factor if benefit identified.Proposal 8: For Type 1 HARQ-ACK codebook, no enhancement is needed for NR NTN.Proposal 9: For Type 2 HARQ-ACK codebook, HARQ-ACK codebook only includes HARQ-ACK of PDSCH with HARQ feedback enabled, and counter DAI and total DAI are not increased for a PDCCH with HARQ feedback disabled.Proposal 10: Type 3 HARQ-ACK codebook is not supported for NR NTN. |
| R1-2105222ETRI | 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 for achieving target BLER performance.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 via “UL feedback” as the one of the NTN’s transmission enhancement solutions for achieving 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
 |
| R1-2105308Samsung | Proposal 1: Enhanced Type-2 and Type-3 HARQ-ACK codebooks are not supported for NTN.Proposal 2: 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 3: When HARQ-ACK information for a HARQ process with disabled HARQ-ACK information is included in a HARQ-ACK codebook, the UE reports* A predetermined HARQ-ACK information value, such as a NACK, for the HARQ process when the UCI payload size is no more than 11 bits.
* HARQ-ACK information based on a reception outcome of a corresponding TB for the HARQ process when the UCI payload size is more than 11 bits.

Proposal 4: A Type-2 HARQ-ACK codebook only includes HARQ-ACK information for HARQ processes with enabled HARQ-ACK information report.* DAI values change only when a PDSCH includes TBs for HARQ processes with enabled HARQ-ACK information report.

Proposal 5: Support a larger number of repetitions for NTN* The number of repetitions is indicated by the DCI format as in Rel-16.
* Extend/modify the TDRA field or add a new field to indicate the number of repetitions.

Proposal 7: For the HARQ process ID indication in DCI formats 0\_1/1\_1/0\_2/1\_2, extend the HARQ process ID field to 5 bits when the number of HARQ processes is more than 16 (Option 3).Proposal 8: For the DL, the gNB can configure up to 32 HARQ processes. For the UL, the gNB can configure up to 32 HARQ processes if a UE indicates a capability. If the gNB does not configure 32 HARQ processes, the number of HARQ processes is 16 (as in Rel-15/16).Proposal 9: For the maximum number of HARQ processes, support the following options.* Option 1. gNB broadcasts the maximum TBS to be configured for the cell 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 constraint}.

Proposal 10: Support UE assistance information for HARQ to address support of larger number of HARQ processes than in Rel-16 without a large increase of the UE soft buffer size. |
| R1-2105411NEC | Proposal 1: 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 2: 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 3: If 32 HARQ processes are configured, scheduling is carried out with non-fallback DCI formats:* Support option 3 for HARQ process ID indication for non-fallback DCI 0-2/1-2 and DCI 0-1/1-1
* No enhancement is needed for DCI 0-0/1-0

Proposal 4: Whether to use HARQ enabled or disabled process for the transmission of MAC CE is left up to gNB implementation.  |
| R1-2105479LG | Proposal 1: For enhanced HARQ process id identification in NTN, support followings enhancement. * For non-fallback DCI (DCI format 0-2/1-2 and DCI format 0-1/1-1), increase the HARQ process ID field up to 5 bits
* For fallback DCI (DCI format 0-0/1-0), support no enhancement

Proposal 2. For transmission enhancement when HARQ feedback is disabled, consider following enhancement: * repetition factor is recommended by UE
* PDSCH decoding results or probability is reported by UE

Proposal 3. Confirm working assumption of X = T\_proc,1. Proposal 4. Discuss PDSCH scheduling restriction if two PDSCHs are associated with different HARQ process id and one of two PDSCHs is HARQ feedback disabled. Proposal 5. For Type-1 HARQ-ACK codebook enhancement, option 3 (reduced codebook size with criteria) is preferred. Proposal 6. For Type-2 HARQ-ACK codebook enhancement, the C-DAI and T-DAI are given their true values (i.e., the count of feedback-enabled processes) in the DCI of PDSCH with enabled/disabled HARQ processes.Proposal 7. Support enhancements on Type-3 HARQ-ACK codebook by including enabled HARQ processes only. Proposal 8. UE feedbacks acknowledgement for the reception of SPS activation DCI, if the first PDSCH after reception of the SPS activation DCI is with disabled HARQ process.  |
| R1-2105561Xiaomi | Proposal 1: The number of supported HARQ processes is subject to the UE’s capability.Proposal 2: Slot index as MSB or LSB can be taken as additional indication to support more than 16 HARQ processes.Proposal 3: The enhancement on the type 1 codebook design is not desired.Proposal 4: C-DAI and T-DAI count both PDSCH with feedback-enabled HARQ processes and PDSCH with feedback-disabled HARQ processes.Proposal 5: Confirm the working assumption that X = T\_proc,1.Proposal 6: Dynamic HARQ enabling/disabling is not supported.Proposal 7: Enhancement on the UCI reporting such as the data decoding statistics should be introduced. |
| [R1-2105620](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_105%5CDocs%5CR1-2105620.zip)Panasonic | Proposal 1: 1 bit is added for HARQ process ID indication in DCI format 0\_1, 1\_1 and 0\_2, 1\_2.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 that schedules feedback-disabled HARQ process indicates the total DAI value while C-DAI field is reserved. Proposal 5: Whether to use feedback-disabled process or enabled process for SPS PDSCH is up to network implementation.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. Proposal 7: Enhancement of PDSCH/PUSCH transmission to improve user throughput without further increasing the number of HARQ processes should be discussed.Proposal 8: 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.  |
| R1-2105669InterDigital | 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: a CQI table with a new target BLER (e.g., 1%) is considered when HARQ feedback is disabledProposal-2: blind retransmission is considered when HARQ feedback is disabledProposal-3: support extending the HARQ process ID field up to 5 bits (i.e., Option 3)Proposal-4: the PDSCH carrying MAC-CE command is transmitted in the HARQ process with HARQ feedback enabled |
| R1-2105757ITRI | Enhanced HARQ process ID indication* For enhanced HARQ process ID indication is supported for DCI 0-2/1-2 and DCI 0-1/1-1, extending the HARQ process ID field up to 5 bits (option 3) can be supported

HARQ codebook enhancement* For Type-1 HARQ codebook, both option 1 (no enhancement) and option 2 (reporting NACK on disabled process) can be considered.

Restriction on HARQ feedback disabling* For the transmission of MAC CE and SPS release, UE expects that MAC CE and SPS release information is scheduled via one HARQ process configured with HARQ feedback (Option 2).
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| R1-2105822APT | [Observation 1 In Rel-15 NR, for some cases, even if the TB is correctly decoded in the physical layer of a UE, the UE may not generate any HARQ-ACK information.](#_Toc71202276)[Proposal 1 Conform the working assumption: X = T\_proc,1.](#_Toc71202278)[Proposal 2 Reuse Rel-16 DCI format 1\_2 with 0-bit DAI field to support reducing codebook size with Type-2 HARQ-ACK CB only including HARQ-ACK of PDSCH with feedback-enabled HARQ processes.](#_Toc71202279)[Proposal 3 The applicability of DCI format 1\_2 to NR NTN shall be concluded in RAN1.](#_Toc71202280)[Proposal 4 Whether to enhance HARQ-ACK CB in RAN1 shall be discussed, regarding TS 38.321 may capture when a UE does not generate HARQ-ACK information.](#_Toc71202281) |