**3GPP TSG RAN WG1 Meeting #109 R1-220xxxx**

**e-Meeting, May 9th – May 20th, 2022**

**Agenda Item: 9.12.2**

**Source: Moderator (Lenovo)**

**Title: Feature lead summary #1 on disabling of HARQ feedback for IoT NTN**

**Document for: Discussion and decision**

# Introduction

In the RAN#94 plenary meeting, an enhancement work item for Rel.18 IoT NTN was approved. One of the objectives is to specify the following HARQ enhancements to IoT NTN.

*This work considers Rel-17 IoT-NTN as baseline as well as Rel-17 NR-NTN outcome and the further IoT-NTN performance enhancements objectives are listed below:*

*-* ***Disabling of HARQ feedback to mitigate impact of HARQ stalling on UE data rates [RAN1,RAN2]***

*- Study and specify, if needed, improved GNSS operations for a new position fix for UE pre-compensation during long connection times and for reduced power consumption [RAN1]*

This document provides the proposals and summary of discussions on following aspects with detailed proposals from each company listed in appendix according to the inputs [3-22].

* Necessity of disabling HARQ feedback in IoT NTN
* Scenarios/cases to support disabling HARQ feedback
* Indication/configuration of disabling HARQ feedback in IoT NTN
* SPS PDSCH
* (N)PDSCH/(N)PDCCH scheduling restriction
* Performance enhancement for disabling HARQ feedback
* Others

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

[109-e-R18-NTN-02] Email discussion on disabling of HARQ feedback for IoT NTN by May 20 – Zhi (Lenovo)

* Check points: May 16, May 20

Since we have first check point on May 16, during this round of the email discussion, please comment on the issues before May 13, Friday, UTC 23:59.

# [ACTIVE] Issue-1 Necessity of disabling HARQ feedback in IoT NTN

## Background

IoT NTN disabling HARQ feedback for downlink transmission was discussed in Rel.17 study item phase[1]. The observation was captured in TR36.763. The main motivation of disabling HARQ feedback in Rel.18 WI is to solve the problem of mitigating impact of HARQ stalling on UE data rates.

In this meeting, most companies mention that the benefits can be achieved for IoT NTN by disabling HARQ feedback. As mentioned by [Huawei, ZTE, Spreadtrum, MTK, Sony, CATT, Xiaomi, Nokia, Samsung, Apple, CMCC, Lenovo, Sharp], disabling HARQ feedback for downlink transmission can mitigate HARQ stalling and improve the downlink throughput, while as highlighted by [Huawei, Spreadtrum, MTK, CATT, Xiaomi, Nokia, Samsung, Lenovo, Sharp], disabling HARQ feedback for a DL transmission can benefit UE power consumption/latency.

However, some companies have concern on supporting disabling HARQ feedback for some cases/scenarios. As mentioned by [Spreadtrum, Xiaomi, Nokia, Apple, CMCC, Lenovo], disabling HARQ feedback can degrade the L1 reliability of the downlink transmission and impact link adaptation due to the lack of feedback information.

Additionally, [Huawei, ZTE] mention that for IoT repetition scenario especially for NBIoT with worst cases, due to the long duration of NPDCCH and NPDSCH transmission, the performance improvement by disabling HARQ feedback is small. [Ericsson] considers not disabling HARQ feedback at least for LEO satellites since non-negligible data rates are achievable. [Mavenir] has negative view on supporting of disabling HARQ feedback since transmitting PDSCH with NDI toggling can be regarded as “standard transparent” HARQ disabling and allows the network to achieve reasonable DL throughput.

Moreover, [Sony] mentions that RAN1 does not need to consider disabling UL HARQ feedback in IoT-NTN.

## Company views

According to the above summary, majority of companies are supportive to disable HARQ feedback for downlink transmission in Rel.18 NTN IoT as in WID, and the detail supported cases/scenarios need further study.

**[Conclusion 1-1a]: Disabling HARQ feedback for downlink transmission is supported, and the detail supported cases/scenarios need further study.**

Please provide your views and justifications.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Ericsson | There is a variety of possible IoT NTN scenarios when we consider that there are different satellites with different orbit altitudes, different coverage levels, etc. Thus, we think IoT NTN should not adopt disabling HARQ feedback as a general unique approach, since there are use-cases where HARQ feedback can be kept enabled without incurring into the so called “stalling” issue. Having said that, a conclusion that better reflects the different scenarios/use-cases that will be faced by IoT NTN deployments is as follows:**[Conclusion 1-1a]: For IoT NTN, enabling and disabling HARQ feedback for downlink transmissions is supported.**The part about “**and the detail supported cases/scenarios need further study**” seems to be covered by other sections of this FLS. |
| Ligado | We agree with Sony & Mavenir that HARQ feedback can effectively be disabled using an in-standard solution via NDI bit.  |
| OPPO | We are fine with the proposal.  |

## Summary of 1st round discussions

# [ACTIVE] Issue-2 Scenarios/cases to support disabling HARQ feedback

## Background

In this meeting, some companies have concerns on support disabling HARQ feedback for IoT NTN considering the drawback of the features for some certain cases. So, from moderator’s perspective, scenarios/cases applied with the disabling HARQ feedback for downlink transmission in IoT NTN should be further discussed.

**LEO and GEO scenarios**

The main reason for considering disabling HARQ feedback for IoT NTN is due to the large roundtrip delay between the UE and the eNB. Obviously, RTD for LEO and GEO are different (e.g., the maximal RTD on the radio interface between the eNB and UE is 541.46ms for GEO and 25.77ms for LEO-600 respectively as analyzed in [1]).

Regarding the HARQ stalling issue for GEO and LEO scenarios, some companies evaluate and analyze the impact on peak data rate and latency.

[QC] observes that for GEO Set 1 deployments, lack of feedback disabled HARQ process(es) results in a throughput/latency penalty of > 11x for UEs with one HARQ process and > 5.5x for UEs with two HARQ processes. As analyzed by [Huawei, MTK], as least for NB-IoT with small repetition number,HARQ stalling reduces data rates by approximately [95%] and [49%] for GEO and LEO respectively without disabling of HARQ feedback. As highlighted by [Nokia] that the throughput gain in GEO scenarios is mainly due to elimination of HARQ stalling, while in LEO 600 km scenarios the gain is from more scheduling uplink opportunities due to the omitted ACK/NACK transmission. [Lenovo] mentions that although LEO scenarios with smaller RTT will mitigate the impact of HARQ stalling, the HARQ stalling issue can’t be solved essentially especially for the case with small repetition number.

However, some companies have concerns on support HARQ disabling on all types of NTN scenarios, especially for LEO. As highlighted by [Lockheed Martin], the disablement of HARQ feedback is mainly beneficial for GEO scenarios. [Ericsson] considers not disabling the HARQ feedback at least for LEO satellites, since non-negligible data rates are achievable by new features introduced in Rel.17 NBIoT/eMTC.

**eMTC/NBIoT disabling of all HARQ feedback**

Disabling of HARQ feedback for all HARQ feedback was discussed in R17 NR NTN WI. For ensuring the efficiency and reliability of transmission carrying some critical signaling, e.g., RRC configuration, at least one HARQ process with feedback enabled should be kept for NR NTN. However, till the discussion of RAN1-108 NR NTN, there is no consensus on the HARQ enabling/disabling configuration restriction regarding whether supporting disabling of all HARQ feedback or not, and it can be up to eNB configuration or implementation.

Similarly, highlighted by [Lockheed Martin], semi-static disablement of HARQ feedback through RRC signaling should be supported for at least a single process for IoT NTN (NB-IoT and eMTC). As highlighted by [Sony], regarding whether to support disabling all HARQ feedback, it is necessary to check whether there are any Rel-17 eMTC or NB-IoT MAC CEs that rely on HARQ feedback for activation, for example a TAC MAC CE or indication of UE-specific K\_offset.

**NBIoT disabling of HARQ feedback in case of single HARQ process**

Similar to the issue on disabling of all HARQ feedback, w.r.t NBIoT with single HARQ process, as highlighted by [Sony, CATT, Samsung, OPPO], whether to support NBIoT disabling of HARQ feedback in case of single HARQ process needs further study. The reason is that at least MAC CE relies on HARQ feedback for activation. Disabling HARQ process for these “important” PDSCH will impact the system operation based on the current specification.

However, as mentioned/illustrated by [MTK, Xiaomi, QC], HARQ stalling issue is obvious and severe even for UE configured with only single HARQ process, [Xiaomi] further proposes that the HARQ disabling can be supported at least for the IoT UE that is only configured/capable of single HARQ process.

**eMTC/NBIoT with large repetition number and small repetition number**

As highlighted by [Huawei], for NBIoT repetition scenario, due to the long duration of NPDCCH and NPDSCH transmission, the performance improvement by HARQ feedback disabling is small. Similarly, ZTE observes that the HARQ stalling will not happen if more than one HARQ process are applied, and repetition number is very large. Hence, whether to disable HARQ feedback can be determined by repetition number.

## Company views

According to the above summary, the following proposals are listed as majority views:

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

Disabling HARQ feedback for downlink transmission in IoT NTN is supported for GEO scenarios.

* FFS: NGEO scenarios

**[Conclusion 2-2a]:**

For eMTC NTN, whether to support disabling all HARQ process feedbacks for downlink transmission can wait for NR NTN conclusion if any.

For NBIoT NTN with 2 HARQ process, whether to support disabling all HARQ process feedbacks for downlink transmission can wait for NR NTN conclusion if any.

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

For NBIoT NTN with single HARQ process, disabling HARQ feedback for downlink transmission is supported.

**[Conclusion 2-4a]:**

Further study on support of disabling HARQ feedback for downlink transmission for large repetition number.

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Ericsson | At this point it seems that we are not ready to agree on “**[Proposal 2-1a], [Conclusion 2-2a], [Proposal 2-3a], [Conclusion 2-4a]**” For example, on “**[Conclusion 2-2a]**” we think that before re-using whatever was agreed for NR, we should discuss NB-IoT/LTE-MTC specific frameworks which may make the NR agreements not equally applicable.For the other proposals and conclusion, we need to have a common basis/framework to analyze/evaluate its feasibility, implications (drawbacks) and what it will provide as benefit (e.g., data rate).Thus, at this point it is probably better to list fundamental aspects to be considered when analyzing scenarios with HARQ feedback enabled and disabled, for example:* LEO satellites and GEO satellites.
* No repetitions and use of repetitions.
* Use of one or more HARQ processes.
* LTE-MTC framework up to the date as per Rel-17.
* NB-IoT framework up to the date as per Rel-17.
 |
| OPPO | Proposal 2-1a: supportConclusion 2-2a: as far as our understanding, there is no clear plan for further discussion on NR-NTN for restriction on the HARQ disabling for all HARQ process. Thus, this conclusion might lag the WI progress. Proposal 2-3a: we have a different opinion. We think that single HARQ process case in NB-IoT is not a data-rate harvest case. Thus the throughput enhancement is not as important as two HARQ process case. Conclusion 2-4a: in our opinion, when the transmission duration is smaller than the RTT, the HARQ stalling issue occurs. Thus, the HARQ disabling feature can be applied in this situation.  |

## Summary of 1st round discussions

# [ACTIVE] Issue-3 Indication/configuration of disabling HARQ feedback

## Background

In NR NTN, disabling HARQ feedback for downlink transmission is semi-static configured by RRC signaling. The configuration is indicated per HARQ process index by a bitmap manner, e.g., 32bit bitmap if the configured HARQ process number is 32.

Regarding indication/configuration of disabling HARQ feedback for downlink transmission for IoT NTN, [ZTE, Spreadtrum, Lockheed, MTK, Nordic, Nokia, Samsung, OPPO, Apple, CMCC, Lenovo, Sharp] mention to reuse the HARQ feedback enabling/disabling configuration agreed in NR-NTN for Rel.18 IoT NTN, i.e., enabling/disabling on HARQ feedback for downlink transmission is configurable per HARQ process via UE specific RRC signaling.

However, some companies have different views considering the IoT coverage enhancement requirement and supported HARQ process number. [ZTE] mentions the enabling/disabling HARQ feedback in IoT-NTN can be based on repetition number for each transmission. [Sony, Xiaomi, Nokia, NEC] propose that DL HARQ feedback could be enabled / disabled either semi-statically or dynamically since dynamic enabling/disabling would provide more scheduling flexibility by the eNB. [NEC] further proposes to use one new bit field or existing fields (e.g., TPC command or HARQ-ACK resource offset field) in DCI to indicate HARQ feedback enabling/disabling if additional signal enabled.

## Company views

In summary, from moderator’s perspective, NR NTN disabling HARQ feedback configuration can be a starting point for IoT NTN, especially for eMTC with more than one HARQ processes, which is also the majority companies’ view. For NBIoT with single HARQ process, if disabling HARQ feedback for single HARQ process is supported in section 2 and it is disabled by RRC configuration, the issue related to any impact on the MAC CEs activation and overhead of RRC configuration/reconfiguration back-and-forth needs further study.

Based on that, potential solutions are listed for further study based on IoT specific feature (e.g., NBIoT support single HARQ process case, eMTC/NBIoT with large repetition number).

Note: NBIoT with single HARQ process, NBIoT with more than one HARQ process and eMTC HARQ feedback enabling/disabling indication/configuration are separately discussed although unified solution is encouraged if necessary/possible.

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

For eMTC, enabling/disabling of HARQ feedback for downlink transmission is at least configurable per HARQ process via UE specific RRC signaling.

* FFS: [if additional signal enabled,] explicitly/implicitly indicated by DCI.

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

For NBIoT with more than one HARQ process, enabling/disabling of HARQ feedback for downlink transmission is indicated/configured by [one of] following option(s):

* Option 1: per HARQ process via UE specific RRC signaling
* Option 2: explicitly indicated by DCI (e.g., new field or reusing existing field)
* Option 3: implicitly determined by existing configured/indicated parameter(s) (e.g., repetition number)

**[Proposal 3-3a]:**

For NBIoT with single HARQ process, enabling/disabling on HARQ feedback for downlink transmission is indicated/configured by [one of] following option(s):

* Option 1: per HARQ process via UE specific RRC signaling
* Option 2: explicitly indicated by DCI (e.g., new field or reusing existing field)
* Option 3: implicitly determined by existing configured/indicated parameter(s) (e.g., repetition number)

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Ericsson | Similarly, at this point it does not seem to be possible to agree on detailed proposals such as “**[Proposal 3-1a], [Proposal 3-2a], [Proposal 3-3a]**”.Perhaps we can list a set of alternatives to be studied, for example:For the indication of enabling/disabling of HARQ feedback for downlink transmission in IoT NTN, the following alternatives are considered for further study:* Using semi-static or dynamic signaling:
	+ - UE specific RRC signaling
		- Indication via DCI
* The enabling/disabling indication applies:
	+ - Per HARQ process
		- To more than one HARQ process
		- To all HARQ processes
 |
| OPPO | Support |

## Summary of 1st round discussions

# [ACTIVE] Issue-4 SPS PDSCH

## Background

In NR NTN, it was agreed that for HARQ feedback of each PDSCH, UE follows the per-process HARQ feedback enabled/disabled configuration for the associated HARQ process except for the first SPS PDSCH after activation if additionally enabled, where ACK/NACK is always reported by UE for the first SPS PDSCH.

For IoT NTN, As highlighted by [ZTE, Sony, Apple, Lenovo] that the same mechanism for NR NTN could be applied to IoT NTN. UE follows the per-process HARQ feedback enabled/disabled configuration for the associated HARQ process except for the first SPS PDSCH after activation. For SPS PDSCH, ACK/NACK is reported by UE for the first SPS PDSCH regardless of network configuration of enabled/disabled for this HARQ process if additional signal indicated. As highlighted by [Apple, Lenovo], for DCI indicating SPS PDSCH release, HARQ-ACK report is performed as legacy.

## Company views

From moderator’s perspective, if the indication/configuration of disabling HARQ feedback in eMTC follows that of NR NTN in section 3, the NR configuration of HARQ feedback enabling/disabling for SPS PDSCH can be the starting point for eMTC NTN.

According to the above summary, the following proposals are listed as majority views:

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

For HARQ feedback for eMTC SPS PDSCH, UE follows the per-process HARQ feedback enabled/disabled configuration for the associated HARQ process, except for the first SPS PDSCH after activation if HARQ feedback for SPS activation is additionally enabled.

* If HARQ feedback for SPS activation is additionally enabled., ACK/NACK is reported by UE for the first SPS PDSCH after activation regardless of network configuration of enabled/disabled for this HARQ process.

**[Proposal 4-2a]:**

For DCI indicating SPS PDSCH release, HARQ-ACK report is performed as legacy in eMTC.

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Ericsson | Before moving to have agreements touching upon specific features such as SPS as in “[**Proposal 4-1a], [Proposal 4-1b]**”, we need to reach agreements on more fundamental aspects addressed in previous sections of the FLS.  |
|  |  |

## Summary of 1st round discussions

# [ACTIVE] Issue-5 (N)PDSCH/(N)PDCCH scheduling restriction

## Background

In NR NTN, additional gap is considered to avoid the continuous reception of PDSCH with same HARQ process at UE side as specified in TS38.214.

As highlighted by [Huawei, ZTE, QC, Nordic, Lenovo] that eNB can schedule new TB after [12ms or UE reported value] from the ending of NPDSCH transmission to improve the throughput for NBIoT and after [2, 4] millisecond from the end of PDSCH transmission for eMTC over the same feedback disabled HARQ process.

However, as highlighted by [MTK] when HARQ feedback for the HARQ process ID is disabled, if a NB-IoT UE receives a NPDSCH transmission ending in subframe n, the UE is not required to monitor NPDCCH in any subframe starting from subframe n+1 to subframe n+12. [Lenovo] mentions similar PDCCH scheduling restriction behavior for UE with single HARQ process.

Another issue related to the monitoring of a PDCCH which indicates the ACK/NACK after transmission of a PDSCH is raised up by companies. As highlighted by [ZTE, Spreadtrum], when HARQ feedback for a HARQ process is enabled, the UE is not expected to receive another NPDCCH/MPDCCH carrying a DCI scheduling a NPDSCH/PDSCH scheduled for the given HARQ process that starts until round trip propagation delay after the end of the transmit of HARQ-ACK. From the moderator’s view, the issue is the enhancement/reduction of PDCCH/NPDCCH monitoring for HARQ feedback enabling case, not related to the HARQ disabling and corresponding standard impact, so it is preferred to move to Al.9.12.4 Others for further discussion

## Company views

According to the above summary, reusing NR PDSCH scheduling restriction can be a starting point at least for eMTC. For NBIoT, considering the UE complexity and power saving, whether new UE behavior (different from NR NTN UE behavior) will be introduced needs further discussion. The following proposals are listed as majority views:

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

For a DL HARQ process with disabled HARQ feedback in eMTC, UE is not expected to receive another PDCCH carrying a DCI scheduling a PDSCH for a given HARQ process or to receive another PDSCH without corresponding PDCCH for the given HARQ process that starts until X (ms) after the end of the reception of the last PDSCH for that HARQ process.

* FFS: X =2, 4.

**[Proposal 5-2a]:**

For a DL HARQ process with disabled HARQ feedback in NBIoT, [one of] the following UE behavior(s) can be supported:

* Option 1: UE is not expected to receive another NPDCCH carrying a DCI scheduling a NPDSCH for a given HARQ process that starts until X(ms) after the end of the reception of the last NPDSCH for that HARQ process.
	+ FFS: X =12 or X is determined by UE reported capability.
* Option 2: UE is not required to monitor NPDCCH in a period of Y(ms) from the end of reception of the last NPDSCH
	+ FFS: Y=12 or Y is determined by UE reported capability.

**[Conclusion 5-3a]:**

Discussion on issues related to restriction of PDCCH monitoring for a PDSCH with enabled HARQ feedback is moved to AI 9.12.4.

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Ericsson | Similar comment, it seems that before treating detailed proposals as in “**[Proposal 5-1a], [Proposal 5-2a], [Conclusion 5-3a]**”, we need to have agreements on more fundamental aspects. Without having a common framework on which the disabling of HARQ feedback will apply, it is not possible to know the suitability of the numbers in the above cited proposals/conclusion. |
| OPPO | we think the value of X should be properly defined, which avoid to be too large or too short. From our understanding, the X value should involve the K\_mac delay which might not be a deterministic value but rather a configurable value provided by the network.  |

## Summary of 1st round discussions

# [ACTIVE] Issue-6 Performance enhancement for disabling HARQ feedback

## Background

For enhancing transmission performance, different solutions including potential parameter configurations are proposed by companies. Following aspects are categorized according to the views from each company:

* Enhancements on transmission repetition
	+ [CMCC] proposes that different configurations on aggregation factor for HARQ processes with/without feedback. However, [Spreadtrum] mentions that the existing repeated transmission mechanism can ensure the reliability of downlink transmission
* Blind retransmission
	+ [Nokia] proposes to consider blind PDSCH (re)transmission of the same packet by MAC scheduling without waiting for the transmission of the HARQ feedback.
* Enhancements on CQI/MCS table with new BLER
	+ [CMCC] mentions that the block error rate target only depends on network implementation without specification impact, and one MCS table may be sufficient, since network can schedule proper MCS value via DCI for HARQ process with/without feedback
* UCI/UE assistant information
	+ As highlighted in [Nokia, Samsung, Nordic], in case of scheduling with disabled HARQ feedback, additional new UCI feedback can be considered to improve the scheduling configuration from eNB side. e.g., to report the decoding statistic or reporting DL transmission disruption and/or requesting DL scheduling changes [Nokia], a new CSI reporting method or a one-bit feedback to suggest an increase or decrease in MCS or repetition value of NPDSCH[Nordic], reporting buffer status for HARQ operation, explicit indication to request enabling/disabling HARQ feedback [Samsung].

## Company views

According to the above summary, the following proposals are listed as majority views:

**[Proposal 6-1a]:**

Further study the following performance enhancement schemes for disabled HARQ feedback:

* Enhancements on transmission repetition
* Blind retransmission
* Enhancements on CQI/MCS table with new BLER
* UCI/UE assistant information

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Ericsson | What has been listed under “**[Proposal 6-1a]:**” refers to what can be considered as potential optimizations on the disabling scheme. As mentioned earlier, there are more fundamental aspects to be discussed first. The proposal requires knowing how the disabling of HARQ feedback will look like on the LTE-MTC and NB-IoT frameworks, as to know first what is achievable from it (e.g., in terms of achievable data rate). Once we know that, we can try to conclude whether some additional enhancements for the disabling HARQ feedback are needed or not, pondering what are the implications in terms of complexity and spec impacts. |
| OPPO | These aspects are not the high priority at this stage |

## Summary of 1st round discussions

# [ACTIVE] Others

## Background

NOTE: The issues in this section identified by companies are related to HARQ disabling and corresponding standard impact/enhancement. Since the views from companies are still diverged and the necessity for corresponding enhancement is not fully justified. Then, from moderator’s perspective, it is better to discuss these issues more. Companies are encouraged to give comments on these issues and show views in this meeting and even next meeting contributions.

**Disabling HARQ feedback impact on HARQ bundling for eMTC H-FDD**

eMTC H-FDD HARQ bundling is introduced in Rel.14 and enhanced in Rel.17. [Sony, Apple] mention the design of disablement of HARQ feedback should handle the case where HARQ feedback is bundled, and HARQ feedback is enabled for some HARQ processes and is disabled for others. [Apple] further proposes that ACK is assumed for a feedback-disabled HARQ process in the logical AND operation.

**Disabling HARQ feedback impact on HARQ feedback for scheduling multiple TB**

Similar as issue of HARQ bundling, as highlighted by [Qualcomm], solutions should be designed for the case of transmitting HARQ feedback for a multi-TB block where some TBs (or TB bundles) have feedback enabled, while some others have feedback disabled.

**Disabling HARQ feedback impact on NPRACH capacity**

With the support of disabling HARQ feedback, NPRACH capacity issue is raised up by [Nokia] that if HARQ feedback is disabled, NB-IoT UE will need to transmit the SR on NPRACH, while if HARQ feedback is always enabled in legacy, NB-IoT UE can transmit the SR piggyback with HARQ feedback. The impact of NB-IoT scheduling request when HARQ feedback is disabled needs further study.

**Disabling HARQ feedback impact on HARQ codebook generation**

Similar as the discussion of NR NTN HARQ codebook enhancement, as highlighted by [Apple, CMCC], for HARQ-ACK codebook construction for PUCCH format 3, 4 or 5, the HARQ codebook does not include the ACK/NACK bits from feedback-disabled HARQ processes and UE ignores the DAI field in the DCI scheduling feedback-disabled HARQ process. [CMCC] further propose that UE can consistently report NACK-only for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH.

However, from moderator’s perspective, PUCCH format 3, 4 or 5 is not supported in eMTC FDD, and eMTC TDD is not in the scope of IoT NTN, the issue related to HARQ codebook generation with disabled HARQ feedback needs further study.

**Serving cell change during data transfer**

Due to the large number of repetitions, an UL/DL transmission in IoT can be longer than the time interval needed by the UE for cell reselection or handover. [Nokia] proposes to address the issue of repetition continuation for a HARQ process between two NTN cells. From the moderator’s view, the issue is related to combining between two NTN cells and not related to the HARQ disabling and corresponding enhancement. And if necessary, the issue is moved to Al.9.12.4 Others for further discussion

## Company views

According to the above summary, the following proposals are listed as majority views:

**[Proposal 7-1a]:**

Study and justify the issue of disabling HARQ feedback impact on HARQ bundling for eMTC H-FDD.

**[Proposal 7-2a]:**

Study and justify the issue of disabling HARQ feedback impact on HARQ feedback for scheduling multiple TB.

**[Proposal 7-3a]:**

Study and justify the issue of disabling HARQ feedback impact on NPRACH capacity.

**[Proposal 7-4a]:**

Study and justify the issue of disabling HARQ feedback impact on HARQ codebook generation.

**[Conclusion 7-5a]:**

Move the discussion of benefits and impact on Serving cell change during data transfer to Al.9.12.4

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Ericsson | Similarly, what has been listed under “**[Proposal 7-1a]:**” are part of the frameworks that can be studied. In section 4, “SPS” has been categorized separately but it might as well have been listed here. At this point, all features are equally important until they have been analyzed, being perhaps “single TB scheduling with one or more HARQ processes” the most fundamental framework that can be used as starting point. |
| OPPO | Suggest to focus on issue 1-5 first.  |

## Summary of 1st round discussions

# Proposals for discussion at GTW sessions

# Contact information

In order to facilitate the contact among the chairman, moderator and delegates, please feel free to add your company/responsible delegates/email information in the following table.

|  |  |  |
| --- | --- | --- |
| **Company** | **Delegate(s) name** **(Given name, Family name)** | **Email** |
| Ericsson | Gerardo Agni, Medina Acosta | gerardo.agni.medina.acosta@ericsson.com |
|  |  |  |

# Appendix

|  |  |
| --- | --- |
| Contribution | Observation/Proposals |
| R1-2203160Huawei, HiSilicon | Observation 1: For IoT NTN with disabling HARQ mechanism, the peak rate for different scenarios can be greatly increased, and the data rate of LEOs is comparable with that of TN.Observation 2: When repetition is taken into consideration, the stalling issues may not exist when UE is configured with 2 HARQ processes and each HARQ process schedules one TB as the NPDSCH scheduling by the second HARQ process can fill the stalling of the NPDSCH scheduling by the first HARQ process.Observation 3: In IoT NTN, the maximum data rate can be greatly impacted in the case when large number of repetitions is used for link budget improvement.Observation 4: For repetition scenario, due to the long duration of NPDCCH and NPDSCH transmission, the performance improvement by HARQ disabling is small.Observation 5: For the cases that can meet service requirement, power consumption can be saved due to disabling of feedback.Observation 6: For the cases that cannot meet service requirement, with disabling HARQ mechanism, eNB can schedule new TB after 12ms from the ending of PDSCH transmission to improve the throughput. |
| R1-2203241ZTE | Proposal 1: Consider to reuse the HARQ feedback disabling solution agreed in Rel-17 NR-NTN, i.e., enabling/disabling on HARQ feedback for downlink transmission is configurable per HARQ process via UE specific RRC signaling. The enhancement on PDCCH monitoring and SPS activation may also be reused with minor necessary modification.Proposal 2: The enabling/disabling HARQ feedback in IoT-NTN based on repetition number for each transmission can also be supported.Proposal 3: When HARQ feedback for a HARQ process is enabled, the UE is not expected to receive another NPDCCH/MPDCCH carrying a DCI scheduling a NPDSCH/PDSCH scheduled for the given HARQ process that starts until round trip propagation delay after the end of the transmit of HARQ-ACK. |
| R1-2203351Spreadtrum | Proposal 1: Enabling/disabling on HARQ feedback for downlink transmission should be configurable per HARQ process via UE specific RRC signaling for IOT NTN.Proposal 2: For an NTN UE configured with one HARQ process, when HARQ feedback is enabled, the UE does not monitor PDCCH until the RTT time has elapsed from the end of the PUSCH.Proposal 3: For the number of configured HARQ processes is 2 (for NB-IoT in NTN) or larger than 1 (for eMTC in NTN), if HARQ processes is full before the RTT time has elapsed from the end of the PUSCH, UE does not monitor PDCCH until the RTT time has elapsed from the end of the PUSCH. |
| R1-2203390MTK | Observation 1: for IoT NTN, disabling of HARQ feedback is supported in Rel-18 IoT NTN WID. Observation 2: for NB-IoT, HARQ stalling reduces data rates by approximately 95% and 49% for GEO and LEO respectively without disabling of HARQ feedback. Observation 3: for NB-IoT, the maximum latency with 2 HARQ processes with up to 4 HARQ transmissions is 2264 ms. Observation 4: for NB-IoT, disabling of HARQ feedback avoids the issue of HARQ stalling and allows data rates consistent with cellular NB-IoT / eMTC. Observation 5: In case of disabling of HARQ feedback, it seems natural if eNB transmitter does not wait for ACK/NACK of current DL packet transmission before scheduling a new/retransmission since the UE does not anyway send ACK/NACK for the current NPDSCH/PDSCH for the corresponding HARQ process.Observation 6: High reliability can be ensured by RLC ARQ re-transmission.Observation 7: Impact on resource utilisation with lower BLER target for first transmission with HARQ feedback disabling can be further studied.Proposal 1: Enabling/disabling on HARQ feedback for downlink transmission is configurable per HARQ process via UE specific RRC signalling in IoT NTN.Proposal 2: When HARQ feedback for the HARQ process ID is disabled, if a NB-IoT UE receives a NPDSCH transmission ending in subframe n, the UE is not required to monitor NPDCCH in any subframe starting from subframe n+1 to subframe n+12.Proposal 3: RAN2 can discuss fast RRC configuration for RLC ARQ for IoT NTN. |
| R1-2203392Lockheed Martin | Proposal 1: Semi-Static disablement of HARQ feedback through RRC signaling should be supported for at least a single process for IoT NTN (NB-IoT and eMTC). Proposal 2: Whether the indication of disablement of HARQ feedback for IoT NTN (NB-IoT and eMTC) should be supported may be FFS. |
| R1-2203747Sony | Observation 1: RAN1 does not need to consider disabling UL HARQ feedback in IoT-NTN.Proposal 1:In the design of HARQ feedback disabling, RAN1 considers the following issues:* Whether HARQ feedback can be disabled for all HARQ processes
* Whether DL HARQ feedback is disabled per-cell, per-UE or per-HARQ process
* The protocol layer at which DL HARQ feedback is disabled (RRC, MAC or PHY)
* Whether DL HARQ feedback is disabled semi-statically or dynamically
* HARQ bundling when HARQ feedback is disabled for some HARQ processes but not for others
 |
| R1-2203755Nordic | Proposal 1: At least for eMTC, enabling/disabling on HARQ feedback for downlink transmission should be configurable per HARQ process via UE specific RRC signallingProposal 2: In eMTC, for a DL HARQ process with disabled HARQ feedback, the UE is not expected to receive another PDSCH scheduled for the given HARQ process that starts until 1ms after the end of the reception of the last PDSCH for that HARQ process.Proposal 3: In NB-IoT single HARQ case, the gap from the end of the last subframe of NPDSCH to the beginning of NPDCCH is configurable by the UE-specific RRC-signalling and its value could be based on capability indicated by the UE.Proposal 4: In NB-IoT two HARQ case, the gap from the end of the last subframe of NPDSCH carrying the TB of the second HARQ process to the beginning of NPDCCH is fixed in specification.Observation 1: A new CSI reporting method or a one-bit feedback channel for UE to suggest an increase or decrease in MCS or repetition value of NPDSCH would be beneficial. |
| R1-2203758CATT | Proposal 1: Rel-17 IoT functionality on HARQ is recommended as the baseline for HARQ enhancement of IoT NTN.Proposal 2: Reuse disabling HARQ feedback mechansim of NR NTN for IoT NTN.Proposal 3: Further study on if HARQ disabling is needed for IoT UE that supports only one HARQ process. |
| R1-2203805Xiaomi | Observation 1: The main benefit to support HARQ disabling is to resolve the HARQ stalling issue.Observation 2: HARQ stalling issue happens when the IoT UEs are configured with only one HARQ process.Observation 3: Further check if HARQ stalling issue happens when the IoT UEs are configured with more than one HARQ process.Proposal 1: The HARQ disabling can be supported for at least for the IoT UE that is only configured/capable of single HARQ process.Proposal 2: Dynamic HARQ disabling can be supported at least for the IoT UE configured/capable of one HARQ process. |
| R1-2203840Nokia | Observation 1: Disabling HARQ feedback for DL transmission can improve the downlink throughput. Observation 2: Disabling HARQ feedback for DL transmission has some drawbacks, which include 1) network not getting acknowledgement of MAC CE or RRC signal, 2) more resource and higher latency with RLC retransmission, 3) network has no feedback for link adaptation.Observation 3: When HARQ feedback is disabled, scheduling request from NB-IoT UE may impact NPRACH capacity.Observation 4: When HARQ feedback is disabled for eMTC/NB-IoT DL transmission, more repetitions are required, which results in higher UE power consumption and higher latency.Observation 5: Disabling HARQ feedback may adversely impact the link adaptation operation for NB-IoT and eMTC.Proposal 1: RAN1 studies the impacts of HARQ feedback disabling in eMTC and NB-IoT over NTN, taking into consideration the characteristics of of IoT devices.Proposal 2: RRC configuration of HARQ feedback per HARQ process for DL transmission is used as a baseline for IoT NTN. Proposal 3: RAN1 studies switching of HARQ feedback enabling/disabling for IoT NTN.Proposal 4: RAN1 studies the impact of NB-IoT scheduling request when HARQ feedback is disabled. Proposal 5: RAN1 studies blind retransmission for UE power saving, spectral efficiency, or latency improvement when HARQ feedback is disabled.Proposal 6: When HARQ feedback is disabled, alternative long-term feedback can be considered to facilitate link adaptation for NB-IoT/eMTC in NTN. Proposal 7: RAN1 to discuss the issue of repetition continuation for a HARQ process between two NTN cells.  |
| R1-203930Samsung | Proposal 1: For IoT NTN, enabling/disabling HARQ feedback for downlink transmission should be at least configurable per HARQ process via UE-specific RRC signalling.Proposal 2: Further discuss whether to allow disabling of HARQ feedback for NB-IoT with a single HARQ process, and whether to allow disabling HARQ feedback for all HARQ processes when multiple HARQ processes are configured. Proposal 3: Further discuss the reporting of additional information by the UE. |
| R1-2203937NEC | Proposal 1 HARQ feedback could be configured via DCI for IoT devices.Proposal 2 HARQ feedback configuration mechanism in NR NTN could be applied as a baseline solution in IoT NTN.Proposal 3 RRC signalling indicates the function that whether the DCI will indicate the HARQ feedback configuration.Proposal 4 One or multiple HARQ process group can be triggered for HARQ feedback disabled by DCI.Proposal 5 A criteria for NW configuration enabled and disabled HARQ-ACK feedback switching could be specified. |
| R1-2204012OPPO | Proposal 1: RAN1 should firstly discuss whether to introduce disabling HARQ feedback for the UE configured with one HARQ process.Proposal 2: For the UE with two (or more) HARQ process, disabling HARQ feedback can be configurable per HARQ process. |
| R1-2204080Ericsson | Proposal 1 For LTE-MTC NTN, RAN1 should discuss and consider not disabling the HARQ feedback at least for LEO satellites, since non-negligible data rates in the order of hundreds of kbps are achievable using “ce-PDSCH-14HARQ-Config-r17” and “ce-PDSCH-maxTBS”.Proposal 2 For NB-IoT NTN, RAN1 should discuss and consider not disabling the HARQ feedback at least for LEO satellites, since non-negligible data rates in the order of hundreds of kbps are achievable using “npdsch-16QAM-Config-r17”. |
| R1-2204268Apple | Proposal 1: The disabling of HARQ feedback for downlink transmission is configurable per HARQ process via UE specific RRC signaling.Proposal 2: In HARQ-ACK codebook construction for PUCCH format 3, 4 or 5, the HARQ codebook does not include the ACK/NACK bits from feedback-disabled HARQ processes.* UE ignores the DAI field in the DCI scheduling feedback-disabled HARQ process.

Proposal 3: In HARQ-ACK bundling with logical AND operation, ACK is assumed for a feedback-disabled HARQ process.Proposal 4: For HARQ feedback of each SPS PDSCH, UE follows the per-process configuration of HARQ feedback enabled/disabled for the associated HARQ process. * The HARQ codebook does not include the ACK/NACK bits from feedback-disabled HARQ processes.

Proposal 5: For DCI indicating SPS PDSCH release, HARQ-ACK feedback is always enabled.Proposal 6: With additional RRC configuration of HARQ feedback for SPS PDSCH activation, UE reports ACK/NACK for the first SPS PDSCH after activation. Without additional RRC configuration of HARQ feedback for SPS PDSCH activation, UE follows the feedback configuration of the HARQ process for the first SPS PDSCH after activation. |
| R1-2204329CMCC | Observation 1: Disabling HARQ feedback is beneficial to throughput improvement and latency reduction with the cost of reduced reliability or increased power consumption.Proposal 1. The disabling of HARQ feedback should be supported for IoT NTN.Proposal 2. The impact of disabling HARQ feedback on power consumption, as well as whether reliability reduction is acceptable in IoT NTN, needs further study.Proposal 3. Enabling/disabling on HARQ feedback can be configured per HARQ process via UE specific RRC signaling for IoT NTN.Proposal 4. Support different configuration on aggregation factor for HARQ process with/without feedback.Proposal 5. For HARQ codebook in NB-IoT over NTN, the UE can consistently report NACK-only for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH.Proposal 6. For semi-persistent HARQ codebook in eMTC over NTN, the UE can consistently report NACK-only for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH.Proposal 7. For HARQ codebook depending on the DAI for eMTC over NTN, the C-DAI and T-DAI are the count of feedback-enabled processes. |
| R1-2204516Lenovo | Proposal 1: Disabling HARQ feedback for downlink transmission should be supported in Rel.18 NTN IoT as in WID.Proposal 2: Scenarios/cases applied with the disabling HARQ feedback for downlink transmission in IoT NTN should be further discussed.Proposal 3：Disabling HARQ feedback is configured by RRC signaling, and NR NTN configuration is the baseline solution.Proposal 4: For IoT NTN DL HARQ process with disabled HARQ feedback, (N)PDCCH/(N)PDSCH scheduling restriction should be imposed to allow enough time for UE decoding processing.Proposal 5: Configuration of HARQ enabling/disabling per HARQ process also applies to SPS PDSCH.Proposal 6: For SPS PDSCH, ACK/NACK is reported by UE for the first SPS PDSCH regardless of network configuration of enabled/disabled for this HARQ process if additional signal indicated. |
| R1-2204646Sharp | Proposal 1:Disabling HARQ feedback for IoT NTN is supported in Rel-18.Proposal 2:In IoT NTN, HARQ feedback disabling/enabling is configured per HARQ process via UE specific RRC signalling. |
|  R1-2204935Mavenir | Observations: * Subsequently transmitting PDSCH after k0 msec with NDI toggling can be regarded as “standard transparent” HARQ disabling, and allows the network to achieve reasonable DL throughput.
	+ Although HARQ feedback is not used for determining HARQ retransmission decision, the ACK/NACK is still useful for network’s link adaptation.
* Further studies are needed if any extra specification is necessary for HARQ disabling.
 |
| R1-2205059Qualcomm | Observation 1: For GEO Set 1 deployments, lack of feedback disabled HARQ process(es) results in a throughput/latency penalty of > 11x for UEs with one HARQ process and > 5.5x for UEs with two HARQ processes.Proposal 1: Specify feedback-disabled HARQ processes for eMTC and NB-IoT over NTNProposal 2: RAN1 to support two additional feedback-disabled HARQ process for NB-IoT over NTN, resulting in a total of up to four HARQ processes.* At most two out of these four HARQ processes will have HARQ feedback enabled, and the soft-buffer storage requirements for NB-IoT UEs will not be impacted.

Proposal 3: For eMTC over NTN, introduce a 4-millisecond gap between successive PDSCH transmissions over the same feedback disabled HARQ process.Proposal 4: RAN1 to discuss the impact of introducing feedback-less HARQ processes on multi-TB scheduling for eMTC and NB-IoT. |

# References

1. 3GPP TR 36.763 V1.0.0 (2021-06)
2. RP-213596, New WID on IoT NTN enhancements MediaTek Inc, RAN#94e
3. R1-2203160, Discussion on disabling of HARQ feedback for IoT NTN Huawei, HiSilicon
4. R1-2203241, Discussion on disabling of HARQ feedback for IoT-NTN ZTE
5. R1-2203351, Discussion on disabling of HARQ feedback for IoT NTN Spreadtrum Communications
6. R1-2203390, Disabling of HARQ for IoT NTN MediaTek Inc.
7. R1-2203392, Disabling of HARQ for IoT NTN Lockheed Martin
8. R1-2203747, On disabling HARQ feedback for IoT-NTN Sony
9. R1-2203755, Disabling of HARQ feedback for IoT NTN Nordic Semiconductor ASA
10. R1-2203758, HARQ feedback disabling for IoT NTN CATT
11. R1-2203805, Discussion on HARQ operation for IoT NTN xiaomi
12. R1-2203840, Disabling of HARQ feedback for NB-IoT/eMTC over NTN Nokia, Nokia Shanghai Bell
13. R1-2203930, Disabling of HARQ feedback for IoT NTN Samsung
14. R1-2203937, Disabling of HARQ feedback for IoT NTN NEC
15. R1-2204012, Discussion on disabling of HARQ feedback for IoT NTN OPPO
16. R1-2204080, On disabling HARQ feedback for IoT NTN Ericsson
17. R1-2204268, On disabling of HARQ feedback for IoT NTN Apple
18. R1-2204329, Discussion on disabling of HARQ feedback for IoT NTN CMCC
19. R1-2204516, Disabling of HARQ feedback for IoT NTN Lenovo
20. R1-2204646, Discussions on Disabling of HARQ feedback for IoT NTN Sharp
21. R1-2204935, On disabling HARQ feedback for IOT-NTN Mavenir
22. R1-2205059, Disabling HARQ Feedback for IoT-NTN Qualcomm Incorporated