**3GPP TSG RAN WG1 Meeting #110 R1-220xxxx**

**Toulouse, France, August 22nd – 26th, 2022**

**Agenda Item: 9.12.3**

**Source: Moderator (Lenovo)**

**Title: FLS#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]*

The following agreements on disabling of HARQ feedback for IoT NTN were achieved:

RAN1-109e

***Agreement***

*For IoT NTN, to configure/indicate enabling/disabling on HARQ feedback for downlink transmission, one or more of the following options can be considered:*

* *Option 1: per HARQ process via UE specific RRC signaling*
* *Option 2: per HARQ process via SIB signaling*
* *Option 3: explicitly indicated by DCI (e.g., new field or reusing existing field)*
* *Option 4: implicitly determined by existing configured/indicated parameter(s) (e.g., repetition number, TBS)*
* *Option 5: per HARQ process via MAC CE*
* *Other options or combinations are not excluded*

*Note: Option(s) for eMTC and NBIoT can be separately discussed.*

***Agreement***

*For IoT NTN, further study the potential issues due to enabling/disabling on HARQ feedback for downlink transmission*

* *Issue A: SPS PDSCH*
* *Issue B: (N)PDSCH/(N)PDCCH scheduling restriction*
* *Issue C: HARQ feedback for scheduling multiple TB*
* *Issue D: HARQ bundling for eMTC HD-FDD*
* *Issue F: NPRACH capacity*
* *Issue G: Serving cell/satellite change during data transfer (FFS: for eMTC and/or NB-IoT)*
* *Other issues are not excluded*

*Note: The “Issues” in common for eMTC and NB-IoT can be separately discussed.*

This document provides the proposals and summary of discussions with detailed proposals from each company listed in appendix according to the inputs[4]~[24]. Companies are encouraged to provide the inputs on Issue 1-9 in the discussion.

# Issue-1 Scenarios/cases to support disabling HARQ feedback

## 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 last RAN1 meeting, scenarios/cases applied with disabling HARQ feedback for downlink transmission in IoT NTN were discussed. In this meeting, companies have evaluated and analyzed on support disabling HARQ feedback for IoT NTN considering the necessity/drawback of the features for some certain cases.

**LEO and GEO scenarios**

The main reason for considering disabling HARQ feedback for IoT NTN is due to the large roundtrip delay between UE and eNB. Obviously, RTD for LEO and GEO are different (e.g., the maximal RTD on the radio interface between 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 the impact on peak data rate and latency with/without the support of HARQ disabling.

* As evaluated by [Huawei], HARQ disabling can improve DL throughput in all evaluated satellite scenarios (e.g., GEO, LEO-1200, LEO-600) for both UE with single HARQ process and two HARQ processes (e.g., data rate gain with HARQ disabled ranges from 119% to 900% in GEO scenarios, and from 40% to 163% for LEO-600 scenarios respectively)
* As evaluated by [MTK], with consideration of repetitions, the impact of satellite RTD on the NB-IoT data rates in GEO due to HARQ stalling is obvious (e.g., 60+% data rate reduction); for LEO it is relatively small (e.g., ~10% data rate reduction). While no repetitions are considered, the impact of the satellite RTD on the NB-IoT data rates in GEO and LEO is significant (e.g., 80+% data rate reduction for GEO, and 20+% data rate reduction for LEO-600)
* As evaluated by [Qualcomm], 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 evaluated by [Nokia], disabling HARQ feedback for DL transmission can improve the downlink throughput for GEO and LEO scenarios (e.g., throughput gain 1.3%~588.3% for eMTC GEO, 9.1%-14% for eMTC LEO-600, 1034.2%~2733.3% for NBIoT GEO, 101.8%~133.4% for NBIoT LEO-600 respectively).
* As evaluated by [Lockheed Martin], the disablement of HARQ feedback is mainly beneficial for GEO scenarios and even leads to throughput loss (e.g., ~3 dB throughput loss for QPSK) in LEO-600 scnearios.

As analyzed by [SONY], the benefits of supporting disabling of HARQ feedback apply in all scenarios and the alternative of defining specific scenarios under which HARQ feedback disabling is supported would lead to increased specification impact for little benefit. Similarly, as mentioned by [OPPO], the WID description does not set enhancement in relation with any deployment scenario, RAN1 spec does not differentiate any deployment scenario and setting a deployment restriction for HARQ disabling will break the flexibility of system. [Mavenir, Lenovo] propose that scenarios/cases where HARQ-ACK feedback should be disabled can be left for eNB implementation/configuration.

**Disabling HARQ feedback for up to all processes**

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. Whether supporting disabling of all HARQ feedback or not, and it can be up to eNB configuration or implementation.

For IoT NTN, as highlighted by [ZTE, Samsung, Lenovo], it should give the network enough flexibility to disable all or some of the feedback according to the reliability requirements, the throughput performance, etc, which is up to eNB implementation.

**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 [OPPO], whether to support NBIoT disabling of HARQ feedback in case of single HARQ process needs further study since 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. As proposed by [Apple], for an NB-IoT UE with a single HARQ process, the HARQ feedback for downlink transmission is always enabled.

However, as mentioned/illustrated by [Huawei, Xiaomi, Qualcomm, Nokia], HARQ stalling issue is obvious and severe even for UE configured with only single HARQ process, HARQ disabling can improve DL throughput in all evaluated satellite scenarios for UE with single HARQ process (e.g., data rate gain with HARQ feedback disabled about 181%~900% in GEO and from 50%~163% for single HARQ process [4], lack of feedback disabled HARQ process(es) results in a throughput/latency penalty of > 11x for UEs with one HARQ process [19]). [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. [Qualcomm] further proposes to support two additional feedback-disabled HARQ process for NB-IoT over NTN.

**Disabling HARQ feedback taking into account the 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. As mentioned by [Lenovo], although the performance improvement by HARQ feedback disabling is “small” in large repetition number, the HARQ feedback disabling can be configured by higher layer and whether to configure the feature to achieve the “small” benefit for larger repetition number is up to eNB implementation.

## Company views

According to the above summary, we take the potential conclusion achieved in the last meeting as the starting point. The following proposals are listed as:

**[Proposal 1-1a]**

For IoT NTN, how to support enabling and disabling HARQ feedback for downlink transmissions in the following can be considered including:

-       NGEO and GEO scenarios

-       Disabling HARQ feedback for up to all processes

* Disabling HARQ feedback for NBIoT with single HARQ process

-       Disabling HARQ feedback taking into account the repetition number

-       Other scenarios/cases are not excluded

Note: eMTC and NBIoT can be separately discussed.

Please provide your views and comments.

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| **Company** | **Comments and Views** |
| Ericsson | If we take decisions scenario-by-scenario we may end-up overlooking relevant scenarios or in a dead-end. Thus, we should just agree on the signaling type that will be used for enabling/disabling HARQ Feedback, and thus it will be up to eNodeB to apply one or the other approach on the scenario that is deemed necessary. |
| OPPO | We are fine with the proposal |
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# Issue-2 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, several options were discussed in last RAN1 meeting. In this meeting, preference options from companies are summarized as follow:

* Option 1: per HARQ process via UE specific RRC signaling

Supported by: Lockheed, Spreadtrum, ZTE, MTK, CATT, Samsung, Nordic(eMTC), CMCC, Mavenir, Sharp, Qualcomm, Nokia(eMTC), Lenovo, Apple

* Option 2: per HARQ process via SIB signaling

Supported by: Sony(?)

* Option 3: explicitly indicated by DCI (e.g., new field or reusing existing field)

Supported by: NEC, Xiaomi (NBIoT), Nordic (NBIoT), Mavenir, Sharp (NBIoT), Nokia(NBIoT)

* Option 4: implicitly determined by existing configured/indicated parameter(s) (e.g., repetition number, TBS)

Supported by: Huawei (NBIoT)

* Option 5: per HARQ process via MAC CE

Supported by:

The following table lists the pros and cros for different options from technical aspect.

|  |  |  |
| --- | --- | --- |
| Options | Advantage | Disadvantage |
| Option 1:  per HARQ process via UE specific RRC signaling | 🡪reuse HARQ feedback enabling/disabling configuration agreed in NR-NTN and facilitate/ease the discussion and standard effort. [Lockheed, Huawei, MTK, CATT, Samsung, Nordic, CMCC, Sharp, Apple]  🡪ensure network flexibility in HARQ feedback enabling/disabling scheduling [ZTE] | 🡪May not be applicable for NBIoT with single process since MAC CE relies on HARQ feedback for activation and NW may frequently reconfigure the HARQ feedback configuration, resulting in significant overhead signaling and degrading the system performance [Huawei, NEC, Mavenir, Nokia]  🡪Configure differently to different UEs and not clear what criteria would be used to determine that one UE would have HARQ feedback disabled and other would have HARQ feedback enabled [Sony] |
| Option 2:  per HARQ process via SIB signaling | 🡪 all UEs would have the same configuration for HARQ feedback disabling per HARQ process, which would reduce signaling load. [Huawei, Sony] | 🡪 cell specific configuration but is inflexible. [Huawei, CATT]  🡪configuration via SIB signaling does not consider UE-specific circumstances (e.g. channel quality, transmission reliability). [Interdigital]  🡪If configuration changes, UE behavior during SI modification period is unclear. [Interdigital] |
| Option 3:  explicitly indicated by DCI (e.g., new field or reusing existing field) | 🡪provides a more flexible HARQ feedback configuration for IoT devices. e.g., enabling HARQ feedback when there are many users such that stalling is not such a serious issue at the cell level even when the eNB (re-)schedules based on HARQ feedback [Sony, NEC]  🡪 more flexibility when using new field, and minimum specification change when reusing existing field [CATT]  🡪Dynamic signaling will allow adapting faster to changes/variations in the IoT-NTN scenarios. [Ericsson] | 🡪additional bit overhead for DCI and increase complexity in PDCCH detection. [Huawei, NEC]  🡪require DCI re-design which often complicates the standardization process. [Sony]  🡪causes additional scheduling latency and UE power consumption due to incorrect DRX configuration. [Interdigital]  🡪may not easily be adopted in eMTC SPS or multiple TB scheduling scenarios, may need additional SPS configuration for HARQ enabling/disabling. [Ericsson]  🡪the channel condition in IoT-NTN is more stable than NR-NTN since most of UEs are stationary. Introducing new dynamic configuration method for HARQ feedback disabling is not needed. [ZTE] |
| Option 4:  implicitly determined by existing configured/indicated parameter(s) (e.g., repetition number, TBS) | 🡪dynamic HARQ feedback enabling/disabling is based on MCS and allocated resource for transmission(s) as there is no impact on the existing DCI format N1. [Huawei]  🡪whether to disable HARQ feedback can be determined by repetition number. [CATT] | 🡪determine the appropriate repetition threshold based on the simulations. [CATT]  🡪This option assumes that HARQ feedback disabling is only applicable in certain coverage situations, the benefits of HARQ disabling are applicable in all coverage conditions. [Sony]  🡪 Relying on implicit indication via other configurations can limit network flexibility when configuring other parameters (e.g. repetition number) to ensure the correct DL HARQ feedback behavior. [Interdigital] |
| Option 5:  per HARQ process via MAC CE |  | 🡪require cross-working group coordination, which would increase specification work. [Sony, Interdigital] |

## 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 and it is disabled by RRC configuration, the issue related to any impact on the MAC CE 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 2-1a]:**

For eMTC NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, at least Option 1 (e.g., per HARQ process via UE specific RRC signaling) is supported.

* FFS: Option 2 (e.g., per HARQ process via SIB signaling) and Option 3 (e.g., explicitly indicated by DCI).
* FFS: Criteria on switching of different options

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

For NBIoT NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, down select from the following options:

* Option 1: per HARQ process via UE specific RRC signaling
* Option 2: per HARQ process via SIB signaling
* Option 3: explicitly indicated by DCI (e.g., new field or reusing existing field)
* Option 4: implicitly determined by existing configured/indicated parameter(s) (e.g., repetition number, TBS)

Note 1: NBIoT with single HARQ process and multiple HARQ processes can be separately discussed.

Note 2: Option combinations are not excluded.

Please provide your views and comments.

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| **Company** | **Comments and Views** |
| Ericsson | We should perform a down-selection and adopt only one Option.  Perhaps an initial step could consist in down-selecting between two or three options.  For example, we could down-select between:  Option1 (RRC-based switching) and Option3/4 (DCI-based switching)  Moreover, it seems possible to select one option that can be common for LTE-MTC and NB-IoT. |
| OPPO | As captured in the FL summary, for NB-IOT with single HARQ process, RRC-based disabling configuration may not work. Thus, whether the proposal suggests a unified solution to be used for both single HARQ to multiple HARQ or not? If not the case, it is better to make it clear. |
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# Issue-3 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, CATT, Xiaomi, CMCC, Qualcomm, Lenovo, Apple], 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 [Lenovo, Apple], for DCI indicating SPS PDSCH release, HARQ-ACK report is performed as legacy.

However, as mentioned by [Samsung], for IoT NTN, the considered scenarios are not latency sensitive. the gNB can activate at a time where the first SPS PDSCH has a HARQ process with enabled HARQ-ACK report, so the additional HARQ feedback for SPS activation is not needed.

## Company views

From moderator’s perspective, if the indication/configuration of disabling HARQ feedback in eMTC follows that of NR NTN in previous section, 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 3-1a]:**

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

* FFS: for the first SPS PDSCH after activation.

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

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

Please provide your views and comments.

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| **Company** | **Comments and Views** |
| Ericsson | Before discussing how to support certain feature that will result in a specification impact, we think we should discuss what is the motivation around it. For example, what are the gains foreseen from supporting SPS in IoT-NTN, will it be a typical use-case to use SPS in IoT-NTN? |
| OPPO | We are fine to clarify the motivation of SPS in IoT-NTN |

# Issue-4 (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 proposed by [ZTE, Nordic, CMCC, Qualcomm(eMTC), Lenovo(eMTC), Apple(eMTC)], following NR PDSCH/PDCCH scheduling restriction, the similar mechanism should be introduced to eMTC/NBIoT NTN. For a DL HARQ process with disabled HARQ feedback, 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. [ZTE, CMCC, Nordic, Qualcomm] further propose X=[1,3,4] for eMTC and X=[12 or configurable] for NBIoT.

However, as highlighted by [Huawei, MTK, Mavenir, Qualcomm, Lenovo, Ericsson], for NBIoT, legacy mechanism of PDCCH/PDSCH scheduling restriction for NPDSCH without HARQ feedback should be followed. For a DL HARQ process with disabled HARQ feedback in NBIoT, UE is not required to monitor NPDCCH in a period of Y(ms)=[12] from the end of reception of the last NPDSCH. This restriction is usually applied for NPDSCH carrying SIB, RAR and MBS. [Lenovo] further mentions the NPDCCH scheduling restriction behavior is imposed to NBIoT UE with single HARQ process.

## 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 4-1a]:**

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 =1, 3, 4.

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

For a DL HARQ process with disabled HARQ feedback in NBIoT, at least the following UE behavior(s) can be considered:

* 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.

Note: it may be different UE behaviors for different UE categories (e.g., UE with single/multiple HARQ processes)

Please provide your views and comments.

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| **Company** | **Comments and Views** |
| Ericsson | Legacy processing delays are an important part of what makes the IoT technologies having a low complexity and a low cost, thus in our view any design to “disabling the HARQ feedback” should aim at keeping the legacy “legacy processing delays” unmodified.  NB-IoT:  In line with the above, for NB-IoT the earliest the DL monitoring should start is at the subframe at which NPUSCH Format 2 would be otherwise transmitted (i.e., preserving for sufficient NPDSCH decoding time as per legacy, where there is at least a 12 ms delay (or gap) between the end of NPDSCH and the start of the DL monitoring).  LTE-MTC:  For LTE-MTC, the earliest the DL monitoring should start is at the subframe at which PUCCH would be otherwise transmitted (i.e., preserving for sufficient PDSCH decoding time as per legacy, where there is at least a 3 ms delay (or gap) between the end of PDSCH and the start of the DL monitoring)  Any proposal on shortening those delays will require RAN4 studies |
| OPPO | Option 2 is preferred as it refers better to the UE monitoring behavior. |
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# Issue-5 HARQ feedback for scheduling multiple TB

## Background

eMTC/NBIoT multiple TB scheduling with single DCI is introduced in Rel.16. In HARQ feedback disabling for downlink transmission, 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.

For NR NTN HARQ disabling, two types of HARQ codebook are enhanced as:

* For Type-1 HARQ codebook in NR NTN, the UE will consistently report NACK-only for the feedback-disabled HARQ process regardless of decoding results of corresponding PDSCH.
* 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
* For the DCI of PDSCH with feedback-enabled HARQ processes, the C-DAI and T-DAI are the count of only feedback-enabled processes

Similar as enhancement of NR NTN HARQ codebook Type-1, as proposed by [ZTE, CATT], ACK is assumed for a feedback-disabled HARQ process in the HARQ feedback for scheduling multiple TB scenario. While similar as enhancement of NR NTN HARQ codebook Type-2, as proposed by [Xiaomi], UE only reports the HARQ information for the HARQ enabled process, corresponding UE behavior and timing relationship as shown in Figure 1. Specially for NBIoT, as proposed by [Huawei], HARQ feedback are assumed enabled for both of the scheduled TBs if the two TBs have different HARQ feedback assumptions for multiple TB scheduling with single DCI.



Figure 1 HARQ disabling in multiple TB scheduling

## Company views

According to the above summary, similar as discussion in NR HARQ codebook Type 1, Type 2 enhancement, before we conclude the impact of multiple TB scheduling with HARQ disabling, we should firstly achieve the high-level UE behavior for the downlink transmission with the HARQ process disabled and the following proposals are listed as majority views:

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

For multiple TB scheduling with single DCI, the following UE behaviors are considered for the downlink transmission with HARQ process disabled：

* Option 1: ACK is assumed/reported for the downlink transmission with HARQ process disabled regardless of decoding results of corresponding transmission
* Option 2: HARQ feedback is reported only for downlink transmission with HARQ process enabled (e.g., HARQ feedback is not reported for downlink transmission with HARQ process disabled)
* Other options are not excluded

Note: eMTC and NB-IoT can be separately discussed

Please provide your views and comments.

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| **Company** | **Comments and Views** |
| Ericsson | Before discussing how to support certain feature that will result in a specification impact, we should discuss what is the motivation around it. It is worth noting that Multi-TB grant is outperformed in terms of achievable data by Single-TB grant when the latter is used with nine or more HARQ processes. |
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| OPPO | Option 2 is preferred due to the high transmission efficiency. |

# Issue-6 HARQ bundling for eMTC HD-FDD

## Background

eMTC HD-FDD HARQ bundling is introduced in Rel.14 and enhanced in Rel.17. 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. Similar as enhancement of NR NTN HARQ codebook Type-1, [ZTE, CATT, Apple] proposes that ACK is assumed for a feedback-disabled HARQ process in the logical AND operation. Similar as enhancement of NR NTN HARQ codebook Type-2, [Qualcomm] proposes UE only report the HARQ feedback for HARQ process enabled as shown in Figure 2.



Figure 2 HARQ disabling in HARQ bundling for eMTC HD-FDD

## Company views

According to the above summary, similar as discussion for scheduling multiple TB, before we conclude the impact of HD-FDD HARQ bundling with HARQ disabling, we should firstly achieve the high-level UE behavior for the downlink transmission with the HARQ process disabled and the following proposals are listed as majority views:

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

For eMTC HD-FDD HARQ bundling, the following UE behaviors are considered for the downlink transmission with HARQ process disabled:

* Option 1: ACK is assumed/reported for the downlink transmission with HARQ process disabled regardless of decoding results of corresponding transmission
* Option 2: HARQ feedback is reported only for downlink transmission with HARQ process enabled (e.g., HARQ feedback is not reported for downlink transmission with HARQ process disabled)
* Other options are not excluded

Please provide your views and comments.

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| **Company** | **Comments and Views** |
| Ericsson | As a preliminary view, Option 1 seems to be safest approach as to avoid running into the risk of ending-up in DL monitoring issues. |
| OPPO | Option 1 is preferred |
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# Issue-7 NPRACH capacity

## Background

With the support of disabling HARQ feedback, NPRACH capacity issue is raised up by [CATT, 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. [Nokia] further proposes that when HARQ feedback is disabled, NPUSCH format 2 resources can be allocated for SR and ACK/NACK transmission to reduce the load requirement on PRACH.

However, as highlighted by [Sony], the impact on PRACH capacity can be managed by eNB implementation. Similarly, as mentioned by [MTK], considering the data capacity is much smaller than RACH capacity, that data capacity will fail before RACH capacity for many UEs. Unless all HARQ processes are disabled and all UEs transmit RACH at the same time, there will be some HARQ feedback to piggyback SR and no RACH capacity issue happens.

## Company views

According to the above summary, further studies are needed for companies.

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

Further study the issue and potential solution of disabling HARQ feedback impact on NPRACH capacity.

Please provide your views and comments.

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| **Company** | **Comments and Views** |
| Ericsson | For not having to perform any major specification impact, in our opinion the possibility of enabling/disabling HARQ feedback can help to alleviate this issue. For example, in scenarios where the disabling approach is used, from time to time the eNodeB can enable the HARQ feedback as to create the opportunity for the UE to incorporate a SR as part of the ACK/NACK response. |
| OPPO | This topic can be discussed later when the HARQ disabling configuration is nailed down and then we can come back to check if the issue is still here. |
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# Issue-8 Serving cell change during data transfer

## Background

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, and further proposes eNB to maintain the soft bit information, from one cell to another internally in the eNB, and inform the UE to continue the transmission in the next (intra-satellite) cell using the same HARQ process.

## Company views

According to the above summary, further studies are needed for companies.

**[Proposal 8-1a]:**

Further Study the issue and potential solution on Serving cell change during data.

Please provide your views and comments.

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| **Company** | **Comments and Views** |
| Ericsson | We think that having the possibility of enabling/disabling HARQ feedback can help to alleviate this issue at least in some scenarios. Beyond that, probably this is a topic that should be handled/discussed in RAN2. |
| OPPO | Agree with Ericsson’s comment |
|  |  |

# 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.

Performance enhancement for disabling HARQ feedback

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, As mentioned by [Spreadtrum], the existing repeat transmission mechanism can ensure the reliability of downlink transmission. Additional performance enhancement schemes for disabled HARQ feedback are not needed.
* 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, further studies are needed for companies.

**[Proposal 9-1a]:**

Further study the issue and potential solution on performance enhancement for disabling HARQ feedback.

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Ericsson | N/A |
|  |  |
|  |  |

# Proposals for discussion at Online 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.

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# Appendix

|  |  |
| --- | --- |
| Contribution | Observation/Proposals |
| R1-2205831  Lockheed Martin | Observation 1: Per-process HARQ-feedback disablement is agreed to for NR-NTN; HARQ-feedback-disablement for NR-NTN is not agreed.  Observation 2: It should be possible to semi-statically enable/disable HARQ feedback by RRC signaling.  Observation 3: The disablement of HARQ feedback is mainly beneficial for GEO scenarios.  Observation 4: As long as the maximum number of HARQ processes is greater than four RTTs, accounting for the round trip delay including feedback, HARQ provides a performance improvement.  Proposal: The disablement of HARQ should be supported. |
| R1-2205857  Huawei, HiSilicon | Observation 1: HARQ disabling can improve DL throughput in all evaluated satellite scenarios for both UE with single HARQ process and UE with two HARQ processes, when PDSCH repetition () is used and number of subframe for PDSCH is larger than one (). With the increase of time domain resource used for a PDSCH transmission (, the data rate gain from HARQ disabling reduces.  Observation 2: For IoT NTN, the NPDCCH monitoring restriction when UE is not required to transmit a corresponding NPUSCH format 2 can be applied to NPDSCH carrying unicast data with HARQ disabling.  Proposal 1: Support dynamic HARQ feedback enabling/disabling per HARQ process based on MCS and allocated resource for transmission(s) for NB-IoT (Option 4).  Proposal 2: For multiple TBs scheduled by one DCI and the two TBs have different HARQ feedback assumptions, i.e. one is disabled and the other is enabled, HARQ feedback are assumed enabled for both of the scheduled TBs. |
| R1-2206010  Spreadtrum Communications | 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: Additional performance enhancement schemes for disabled HARQ feedback are not needed.  Proposal 3: 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 4: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. |
| R1-2206022  ZTE | Proposal 1: 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, as option 1.  Proposal 2: The decision on whether and how many HARQ processes are disabled depends on network configuration.  Proposal 3: In eMTC HD-FDD scenario, for HARQ-ACK bundling with logical AND operation, ACK is assumed for a feedback-disabled HARQ process.  Proposal 4: In the HARQ feedback for scheduling multiple TB scenario, ACK is assumed to mitigate the impact of introducing feedback-less HARQ processes on multi-TB scheduling for eMTC and NB-IoT.  Proposal 5: For HARQ feedback of each SPS (N)PDSCH, UE follows the per-process configuration of HARQ feedback enabled/disabled for the associated HARQ process, except for the first SPS (N)PDSCH after activation if HARQ feedback for SPS activation is additionally enabled.  Proposal 6: When HARQ feedback for a HARQ process is disabled, the UE is not expected to receive another MPDCCH carrying a DCI scheduling a PDSCH scheduled for the given HARQ process that starts until 4 subframes after the end of the reception of the last PDSCH for eMTC.  Proposal 7: When HARQ feedback for a HARQ process is disabled, the UE is not expected to receive another NPDCCH carrying a DCI scheduling a NPDSCH scheduled for the given HARQ process that starts until 12 DL subframes after the end of the reception of the last NPDSCH for NB-IoT.  Proposal 8: 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. |
| R1-2206135  Sony | Observation 1: RAN1 does not need to discuss whether disabling HARQ feedback is supported in the Rel-18 specifications as this has already been decided in the WID.  Proposal 1: RAN1 defines mechanisms for disabling HARQ feedback that are applicable to all scenarios.  Observation 2: eNB implementation can enable or disable HARQ feedback on a scenario-by-scenario basis.  Proposal 2: HARQ feedback disabling can be supported on a per-HARQ process basis.  Proposal 3: RAN1 down-selects the options for configuration / indication of HARQ feedback disabling to the following 3 options:   * Option 1: per HARQ process via UE specific RRC signaling * Option 2: per HARQ process via SIB signaling * Option 3: explicitly indicated by DCI (e.g., new field or reusing existing field)   Proposal 4: The following potential issues can be further studied once the baseline operation of the HARQ feedback disabling feature is agreed:   * Issue A: SPS PDSCH * Issue B: (N)PDSCH/(N)PDCCH scheduling restriction * Issue C: HARQ feedback for scheduling multiple TB * Issue D: HARQ bundling for eMTC HD-FDD * Issue F: NPRACH capacity * Issue G: Serving cell/satellite change during data transfer (FFS: for eMTC and/or NB-IoT) |
| R1-2206139  MediaTek | Observation 1: For repetition scenario with enabling HARQ, peak data rate reduction in LEO compared with cellular is negligible.  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 is disabled, the legacy procedure in TS 36.213 Section 16.6 can be reused:   * if a NB-IoT UE receives a NPDSCH transmission ending in subframe n, and if the UE is not required to transmit a corresponding NPUSCH format 2, the UE is not required to monitor NPDCCH in any subframe starting from subframe n+1 to subframe n+12.   Observation 2: HARQ feedback enabling/disabling can be determined based on the enabling-disabling configuration of the HARQ process for the multi-TB.  Observation 3: For RACH capacity issue, considering the data capacity is much smaller than RACH capacity, that data capacity will fail before RACH capacity for many UEs.  Observation 4: High reliability can be ensured by RLC ARQ re-transmission.  Proposal 3: RAN2 can discuss fast RRC configuration for RLC ARQ for IoT NTN. |
| R1-2206312  OPPO | Observation 1: WID does not set any deployment condition for HARQ disabling enhancement  Observation 2: RAN1 spec does not differentiate from different deployment scenarios  Observation 3: introducing deployment limits for HARQ disabling will cause network flexibility reduction  Proposal 1: RAN1 should avoid further discussions on supporting HARQ disabling enhancement dependent of deployment scenario.  Proposal 2: RAN1 should firstly discuss whether to introduce disabling HARQ feedback for the UE configured with one HARQ process.  Proposal 3: For the UE with two (or more) HARQ process, disabling HARQ feedback can be configurable per HARQ process. |
| R1-2206388  CATT | Observation 1: Disabling HARQ feedback mechansim of NR NTN can be reused for IoT NTN.  Observation 2: Different configuration for the different UE in the same serving cell is better.  Observation 3: Indicating HARQ disabling by DCI can be a good choice for different kind of services.  Observation 4: Disabling HARQ feedback based on repetition number can be considered.  Observation 5: The benefits of using MAC CE for configuration is unclear.  Proposal 1: Enabling/disabling of HARQ feedback for downlink transmission is at least configurable per HARQ process via UE specific RRC signaling.  Proposal 2: Whether to support more flexible configuration with DCI or MAC signalling on HARQ in IoT NTN needs further study.  Proposal 3: Reuse the SPS PDSCH mechanism of NR NTN for IoT NTN.  Proposal 4: ACK value is assumed for TB of the HARQ process with disabled HARQ-ACK information, when Multi-TB is scheduled and harq-AckBundling is configured.  Proposal 5: ACK value is assumed for TB of the HARQ process with disabled HARQ-ACK information for HARQ bundling in eMTC HD-FDD.  Proposal 6: Further study on the tradeoff of UE power and the HARQ feedback disabling is needed. |
| R1-2206480  NEC | Observation: Reuse the NR NTN agreement on HARQ feedback configuration without enhancements may introduce constraints to IoT NTN scenarios and degrade the NW performance.  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. |
| R1-2206632  Xiaomi | 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: No HARQ stalling issue 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.  Proposal 3: The HARQ design for SPS PDSCH in NR NTN can be reused in IoT NTN.  Proposal 4: UE only report the HARQ information for the HARQ enabled process in multi-TB scheduling scenario with different HARQ processes for NB-IoT. |
| R1- 2206850  Samsung | Proposal 1: For IoT NTN, enabling/disabling HARQ feedback for downlink transmission is configurable per HARQ process via UE-specific RRC signalling.  Proposal 2: For IoT NTN, enabling/disabling HARQ feedback for downlink transmission is supported for the case of single HARQ process and for multiple HARQ processes.  Proposal 3: Enhancements to HARQ procedure for SPS PDSCH are not needed when disabling HARQ feedback in NTN IoT.  Proposal 4: Further discuss to identify the issues that require specification efforts when HARQ feedback is disabled in NTN IoT.  Proposal 5: Further discuss the reporting of additional information by the UE. |
| R1-2206881  Nordic Semiconductor ASA | Proposal 1: For eMTC, enabling/disabling on HARQ feedback for downlink transmission should be configurable per HARQ process via UE specific RRC signalling.  Proposal 2: For NB-IoT, enabling/disabling on HARQ feedback for downlink transmission should be done dynamically via scheduling DCI.  Proposal 3: 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 4: 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 5: 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. |
| R1-2206933  CMCC | 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 impact of disabling HARQ feedback on power consumption, as well as whether disabling HARQ feedback is acceptable to large repetition in IoT NTN, need further study.  Proposal 2. UE expects that MAC-CEs are transmitted using HARQ processes with feedback enabled.  Proposal 3. Enabling/disabling on HARQ feedback can be configured per HARQ process via UE specific RRC signaling for IoT NTN.  Proposal 4. For a DL HARQ process with disabled HARQ feedback in NB IoT, UE is not expected to receive another NPDCCH carrying a DCI scheduling a NPDSCH for a given HARQ process that starts until 12 ms after the end of the reception of the last NPDSCH for that HARQ process.  Proposal 5. For HARQ feedback of each SPS PDSCH in IoT NTN, UE follows the per-process configuration of HARQ feedback enabled/disabled for the associated HARQ process, except for the first SPS PDSCH after activation if HARQ feedback for SPS activation is additionally enabled.  Proposal 6. Support different configuration on aggregation factor for HARQ process with/without feedback. |
| R1-2207080  Mavenir | Observation 1: Disabling HARQ-ACK feedback in IoT NTN can significantly improve the system throughput under certain conditions. Therefore, we support adding the option of disabling HARQ-ACK feedback of HARQ processes in NTN scenario.  Proposal 1: Scenarios/cases where HARQ-ACK feedback should be disabled can be left for eNB implementation/configuration.  Proposal 2: To configure/indicate HARQ feedback enabling/disabling, we support the use of UE specific RRC signalling along with explicit indication of HARQ-ACK transmission in DCI.  Proposal 3: For UE behaviour on NPDCCH restriction, the following two options need to be studied:  Option 1 (least spec impact): For the HARQ-feedback-disabled HARQ process in NTN, follow 12 ms NPDCCH monitoring restriction as already specified in the spec.  Option 2 (optimized approach): For the HARQ-feedback-disabled HARQ process in NTN, 12 ms NPDCCH monitoring restriction can be reduced based on UE capabilities. |
| R1-2207144  Sharp | Proposal 1: HARQ-ACK disabling by MAC CE command is not considered for Rel-18 IoT NTN.  Proposal 2: HARQ feedback disabling by SIB1 is not considered for Rel-18 IoT NTN.  Proposal 3: HARQ feedback disabling via existing configuration (e.g., TBS, repetition number) should not be considered for Rel-18 IoT NTN.  Proposal 4: HARQ feedback disabling per HARQ process via UE-specific RRC signaling is supported for Rel-18 IoT NTN. Further discuss if DCI based HARQ feedback disabling is necessary for 1 HARQ process UE.  Proposal 5: The UE assumes DTX for disabled HARQ processes when performing HARQ bundling for HD-FDD MTC UE. |
| R1-2207150  InterDigital | Observation 1: Proposal 1: Disabling DL HARQ feedback is UE-specific (i.e., Option 2: disabling DL HARQ feedback via SIB signalling is not supported).  Proposal 2: Disabling DL HARQ feedback is configured per HARQ process (i.e., Option 3: Indication per transmission via NDI bit in DCI is not supported).  Proposal 3: Disabling DL HARQ feedback is explicitly configured (i.e., Option 4: implicit determination by existing configuration is not supported).  Proposal 4: Disabling DL HARQ feedback is configured per HARQ process via RRC (i.e. support Option 1) same as in Rel-17 NR NTN. |
| R1-2207257  Qualcomm | 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 NTN  Proposal 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 in the context of:   * A single DCI scheduling feedback-enabled and feedback-disabled TBs at the same time * HARQ-ACK transmission timeline when feedback-enabled and feedback-disabled TBs are scheduled by the same DCI * Determination of bundled HARQ ACK feedback when some TBs in a bundle have feedback enabled, while others have feedback disabled   Proposal 5: For IoT NTN, to configure/indicate enabling/disabling on HARQ feedback for downlink transmission, the following option is considered as the default:   * Option 1: per HARQ process via UE specific RRC signaling   Proposal 6: For IoT NTN, regarding the following potential issues due to enabling/disabling on HARQ feedback for downlink transmission, the viewpoints expressed herein are adopted—omit details |
| R1-2207291  Nokia, Nokia Shanghai Bell | Observation 1: Disabling HARQ feedback for DL transmission can improve the downlink throughput.  Observation 2: The degree of downlink throughput improvement can depend on the satellite type, orbit, and the UE location.  Observation 3: When SR is only indicated by NPRACH , the required NPRACH capacity may be very high for a NTN cell.  Observation 4: Disabling HARQ feedback may adversely impact the link adaptation operation for NB-IoT and eMTC, resulting an degraded/unacceptable perofrmance.  Observation 5: The available service time of a cell can be significantly shorter than the time required for a data transmission using repetitions.  Proposal 1: Disabling HARQ feedback is studied by taking into consideration the characteristics of of IoT devices and deployment scenarios.  Proposal 2: RRC configuration of HARQ feedback enabling/disabling per HARQ process for DL transmission is used as a baseline for IoT NTN.  Proposal 3: Explicitly indication of HARQ feedback enabling/disabling by DCI and implicitly determination by existing configured/indicated parameter need further study for IoT NTN.  Proposal 4: When HARQ feedback is disabled, NPUSCH format 2 resources can be allocated for SR and ACK/NACK transmission to reduce the load requirement on PRACH.  Proposal 5: RAN1 should discuss how to guarantee a workable link adaptation when HARQ feedback is disabled.  Proposal 6: When HARQ feedback is disabled, alternative long-term feedback should 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. |
| R1-2207295  Lenovo | Proposal 1: Disabling HARQ feedback for downlink transmission should be supported in Rel.18 NTN IoT as in WID.  Proposal 2: Supporting disabling HARQ feedback for downlink transmission in IoT NTN for the following scenarios/cases is up to eNB implementation:   * Disabling of HARQ feedback in case of single HARQ process and all HARQ feedback * LEO and GEO scenarios * Small repetition and large repetition cases   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.  Proposal 7: For eMTC HARQ-ACK bundling and disabling HARQ feedback configured, the UE behavior for the HARQ feedback and corresponding DCI fields for the disabling HARQ process need further study.  Proposal 8: For multiple TB scheduling and disabling HARQ feedback configured, the UE behavior for the HARQ feedback and corresponding DCI fields for the disabling HARQ process need further study. |
| R1-2207355  Apple | Proposal 1: The disabling HARQ feedback for downlink transmission is supported at least for GEO scenario.  Proposal 2: For an NB-IoT UE with a single HARQ process, the HARQ feedback for downlink transmission is always enabled.  Proposal 3: The disabling of HARQ feedback for downlink transmission is configurable per HARQ process via UE specific RRC signaling, for both eMTC and NB-IoT (except for the case of only one HARQ process).  Proposal 4: For a downlink HARQ process with disabled HARQ feedback for eMTC, UE is not expected to receive another PDCCH carrying a DCI scheduling a PDSCH for the 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.  Proposal 5: In HARQ-ACK bundling with logical AND operation, ACK is assumed for a feedback-disabled HARQ process.  Proposal 6: 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 7: For DCI indicating SPS PDSCH release, HARQ-ACK feedback is always enabled.  Proposal 8: 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. |
| R1-2207570  Ericsson | Proposal 1 For “LTE-MTC over NTN” to configure/indicate enabling/disabling on HARQ feedback for downlink transmission, RAN1 down-selects between “Option 1 (i.e., semi-static signalling via RRC)” and “Option 3 (i.e., dynamic signalling via DCI)”, FFS details.  Proposal 2 For “NB-IoT over NTN” to configure/indicate enabling/disabling on HARQ feedback for downlink transmission, RAN1 down-selects between “Option 1 (i.e., semi-static signalling via RRC)” and “Option 3 (i.e., dynamic signalling via DCI)”, FFS details.  Proposal 3 The support of disabling HARQ feedback for downlink transmission relies on not transmitting PUCCH and the ability to receive the subsequent MPDCCH scheduling data as soon as DL monitoring is allowed.  • The earliest the DL monitoring should start is at the subframe at which PUCCH would be otherwise transmitted (i.e., preserving for sufficient PDSCH decoding time, at least a 3 ms delay between the end of PDSCH and the start of the DL monitoring).  Proposal 4 The support disabling HARQ feedback for downlink transmission relies on not transmitting NPUSCH Format 2 and the ability to receive the subsequent NPDCCH scheduling data as soon as DL monitoring is allowed.  • The earliest the DL monitoring should start is at the subframe at which NPUSCH Format 2 would be otherwise transmitted (i.e., preserving for sufficient NPDSCH decoding time, at least a 12 ms delay between the end of NPDSCH and the start of the DL monitoring). |

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13. R1-2206632, Discussion on HARQ operation for IoT NTN Xiaomi
14. R1-2206850, Disabling of HARQ feedback for IoT NTN Samsung
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23. R1-2207355, HARQ Feedback Disabling for IoT NTN Apple
24. R1-2207570, On disabling HARQ feedback for IoT NTN Ericsson