**3GPP TSG RAN WG1 Meeting #110b-e R1-22xxxx**

**e-Meeting, Oct 10th – 19th, 2022**

**Agenda Item: 9.11.3**

**Source: Moderator (Lenovo)**

**Title: FLS#2 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.*

**RAN1-110**

Agreement

*For eMTC NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, down select one or more from the following options:*

* *Option 1: per HARQ process via UE specific RRC signaling.*
* *Option 3: explicitly indicated by DCI (e.g., new field or reusing existing field).*
* *Option 4: implicitly indicated by existing configured/indicated/combined parameter(s) in the DCI (e.g., repetition number, TBS)*
* *Option 6: combinations of some options above.*

Agreement

*For NB-IoT NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, down select one or more from the following options:*

* *Option 1: per HARQ process via UE specific RRC signaling*
* *Option 3: explicitly indicated by DCI (e.g., new field or reusing existing field)*
* *Option 4: implicitly indicated by existing configured/indicated/combined parameter(s) in the DCI (e.g., repetition number, TBS)*
* *Option 6: combinations of some options above*

Agreement

*For a DL HARQ process with disabled HARQ feedback in NB-IoT, 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.* 
  + *X =12*
* *Option 2: UE is not required to monitor NPDCCH in a period of Y(ms) from the end of reception of the last NPDSCH*
  + *Y=12*

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

This document provides the proposals and summary of discussions with detailed proposals from each company listed in appendix according to the inputs [4]-[22]. Companies are encouraged to provide the inputs on Issue 1-8 in the discussion.

# [Active]Issue-1 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.

***downlinkHARQ-FeedbackDisabled***

Used to disable the DL HARQ feedback, sent in the uplink, per HARQ process ID. The first/leftmost bit corresponds to HARQ process ID 0, the next bit to HARQ process ID 1 and so on. Bits corresponding to HARQ process IDs that are not configured shall be ignored. The bit(s) set to one identify HARQ processes with disabled DL HARQ feedback and the bit(s) set to zero identify HARQ processes with enabled DL HARQ feedback.

Regarding indication/configuration of disabling HARQ feedback for downlink transmission for IoT NTN, several options were discussed in last RAN1 meeting. The following table lists/summarizes 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. [MTK, Huawei, 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 (e.g., TAC), resulting in significant overhead signaling and degrading the system performance [Huawei, NEC, Mavenir, Nokia]  🡪UE that only supports the Control Plane CIoT EPS optimization or the Control Plane CIoT 5GS optimization, RRC reconfiguration is not applicable. It is impossible for a UE to further switch on/off the HARQ-ACK feedback through RRC reconfiguration once it is configured during RRC connection setup in TS36.300 Sec. 7.3a. [Huawei]  🡪For **eMTC**, CE Mode A and CE Mode B support different number of HARQ processes, thus the RRC solution may not be agnostic if there are two RRC fields, one for CE Mode A and another one for CE Mode B.[Ericsson] |
| Option 3:  explicitly indicated by DCI (e.g., new field or reusing existing field) | 🡪Provides a more flexible HARQ feedback configuration for IoT devices. [OPPO]  🡪 For NBIoT, with dynamic HARQ disabling, the issues on NPRACH capacity starvation and lack of reference for open loop link adaptation can be alleviated by eNB implementation. [Huawei]  🡪Dynamic signaling will allow adapting faster to changes/variations in the IoT-NTN scenarios. [Ericsson] | 🡪 more spec efforts [OPPO]  🡪additional bit overhead for DCI and increase complexity in PDCCH detection. [Huawei, NEC]  🡪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. [Lenovo]  🡪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]  🡪 For NBIoT, with dynamic HARQ disabling, the issues on NPRACH capacity starvation and lack of reference for open loop link adaptation can be alleviated by eNB implementation. [Huawei]  🡪whether to disable HARQ feedback can be determined by repetition number. [CATT] | 🡪determine the appropriate repetition threshold based on the simulations. [CATT]  🡪HARQ feedback disabling should not be applied to HARQ-ACK for PDSCH including MAC CE command. MAC CE command is attached by MAC entity in any TB (i.e., any TBS, any repetition) [Sharp]  🡪 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] |

In this meeting, preference options from companies are summarized as follow:

**eMTC**

For eMTC NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, down select one or more from the following options

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

Supported by: MTK, Huawei, Spreadtrum, ZTE, OPPO(1st), CATT, Nordic, Nokia, CMCC, Apple, InterDigital, Mavenir, Samsung, Sharp, Qualcomm, Lenovo

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

Supported by: NEC, Ericsson

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

Supported by:

* Option 6: combination

Supported by:

**NBIoT**

For NB-IoT NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, down select one or more from the following options:

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

Supported by: MTK, Spreadtrum, ZTE, OPPO(1st), CATT(1st), CMCC, Apple, InterDigital, Mavenir, Samsung, Sharp, Qualcomm, Lenovo

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

Supported by: OPPO (2nd), CATT (2nd), NEC, Nordic, Nokia(1st), Xiaomi, Apple, InterDigital, Mavenir, Ericsson

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

Supported by: Huawei, CATT (2nd), Nokia(2nd),

* Option 6: combination

Supported by: InterDigital, Mavenir

Along with RAN1 discussion, in RAN2-119 meeting, the following agreement has been achieved that from RAN2 perspective, at least eMTC, enabling/disabling HARQ feedback can be configured per DL HARQ process at least via UE specific RRC signaling. FFS for NB-IoT (and especially for CP solution for NB-IOT).

Agreements:

1. Disabling DL HARQ feedback is supported for NB-IoT and eMTC NTN. FFS on UE capability.
2. For UL HARQ operation, introduce two HARQ modes, i.e., HARQ mode A and HARQ mode B in IoT NTN (both NB-IoT and eMTC NTN), similarly to NR NTN.
3. From RAN2 perspective, at least for eMTC, enabling/disabling HARQ feedback can be configured per DL HARQ process at least via UE specific RRC signalling. FFS for NB-IoT (and especially for CP solution for NB-IOT).

## 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.

For eMTC, as RAN2 has agreed to take Option 1 as the baseline solution, in order to align the understanding with RAN2, the following proposals are listed as majority views:

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

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 3 (e.g., explicitly indicated by DCI).
* FFS: Criteria on switching of different options

For NBIoT, companies still have concerns that 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, NBIoT with large repetition number). Regarding Option 6a and Option 6b, two options (e.g., one by RRC signaling, one by DCI based) are considered to overcome the potential drawback of single solution if any, and the corresponding switching mechanism should be further discussed if supported.

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 1-2a]:**

For NB-IoT NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, down select **ONE** from the following options in [RAN1-110b-e, RAN1-111]:

* Option 1: per HARQ process via UE specific RRC signaling
* Option 3: explicitly indicated by DCI (e.g., new field or reusing existing field)
* Option 4: implicitly indicated by existing configured/indicated/combined parameter(s) in the DCI (e.g., repetition number, TBS)
* Option 6a: Option 1+ Option 3
  + FFS: Criteria on switching of different options
* Option 6b: Option 1+ Option 4
  + FFS: Criteria on switching of different options

Please provide your views and comments.

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| --- | --- |
| **Company** | **Comments and Views** |
| Qualcomm | Agree for eMTC (1-1a). Don’t see why similar cannot be adopted for NB-IoT (1-2a). |
| ZTE | For 1-1a, support  For 1-2a, we support option 1. As summarized by FL, companies supporting options other than option 1 mainly have concerns on single HARQ case. For the cases of more than one HARQ process, option 1 can be agreed by the majority. Hence, we can first achieve an agreement that option 1 is applied for the cases of more than one HARQ process. The single HARQ case can be FFS. |
| Xiaomi | We don’t think further discussion on the switching is needed. Anyway, it is up to the eNB’s choice. |
| Ericsson | Today we have the possibility of increasing/decreasing the number of HARQ processes dynamically via DCI (e.g., to adjust to the radio conditions).  Consistently, it would be beneficial enabling/disabling HARQ feedback dynamically using DCI. Otherwise, to change the HARQ feedback approach it will be needed to transmit an RRC-reconfiguration message along with a Higher-Layer ACK which will take time and won’t be timely or suitable in all scenarios.  RAN1 should discuss pros and cons of a DCI-based switching and an RRC-based switching as to select the one that will benefit IoT-NTN the most. We think that the down-selection (based on technical reasons) should be between Option3 and Option 1 for both LTE-MTC and NB-IoT. |
| Huawei, HiSilicon | As for NB-IoT, we prefer option 4 but can accept option 3 as 2nd preference.  Considering the totally different capability and implementation of NBIoT from NR (e.g. number of HARQ processes, support of RRC reconfiguration and etc.), simply inheriting semi-static HARQ disabling by RRC signaling does not help NBIoT to achieve the tradeoff between throughput, reliability and scheduling flexibility.  As for the combination of option 1+3 or 1+4, we do not see the necessity. From the functionality, option 3 can achieve same effect as option 1. There is no need to specify two mechanisms and one only achieves subset of the objective. From the perspective of UE capability, if dynamic disabling can be supported by low end UE (with single HARQ process), it should be no problem to implement such feature in high end UE (with two HARQ processes). For UE report the capability of two HARQ processes, eNB is still possible to configure to operate with single HARQ process, and dynamic HARQ disabling scheme is still necessary.  We expect the choice of HARQ disabling mechanism for eMTC and NBIoT can be agreed as a whole package with reduced options considering the limited TU.  **Proposal:**   * For eMTC NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, Option 1 (e.g., per HARQ process via UE specific RRC signaling) is supported * For NB-IoT NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, option 3 is supported, i.e. explicitly indicated by DCI (e.g., new field or reusing existing field) |
| Nokia, NSB | Proposal 1-1a: we think no need to consider option 3 and option 4 for eMTC considering no special requirement found on dynamic scheduling, considering the number of HARQ process supported by eMTC UE is not small.  For Proposal 1-2a: We do not think it is already clear to do this down selection ONE from the options. Especially for option 3 and option 4, it is still not clear which one has more benefit in all the possible scenarios from all companies in RAN1.  If would like to have down selection in this meeting, we think there should be one additional option as  Option 6c: Option 1+Option 3+Option 4.  Additionally, when dynamic DCI disabling can work, then maybe no need for RRC signaling for NB-IoT, then there should be another option as  Option 6d: Option 3+Option 4. |
| OPPO | Fine with Proposal 1-1a, and we share similar view with Qualcomm that similar proposal can be adopted for NB-IoT. |
| MediaTek | **[Proposal 1-2a]:** SupportOption 1: per HARQ process via UE specific RRC signaling for NB-IoT, as proposed by the moderator for eMTC NTN. |
| CMCC | We are fine with Proposal 1-1a.  For NB-IoT NTN, we prefer Option 1. |
| Nordic | We are OK with Proposal 1-1a. For NB-IoT we prefer Option 3 for both single and two HARQ processes case. A DCI-based switching provides much more flexible and faster adaption to changed channel conditions and to different type of messages (regular data versus MAC-CE or RRC-message) than RRC-based switching. |
| Apple | For Proposal 1-1a, we support the proposal and think the mechanism for NR NTN could be reused for eMTC NTN. We do not think the two FFS in the proposal are needed.  For Proposal 1-2a, we do not think it is quite different from what was agreed in RAN1 #110-e meeting. Overall, we are fine with Option 6a where Option 3 is used only when a UE has a single HARQ process. |
| InterDigital | We support Proposal 1-1a.  For Proposal 1-2a, not sure if we can down-select one option at this point. As similar to the last meeting, we can narrow down options which have the smallest number of companies support (i.e., Option 4, Option 6b) |
| Spreadtrum | For 1-1a, support  For 1-2a, we prefer option 1. |
| NEC | We are fine with Proposal 1-1a.  For NB-IoT NTN, we prefer Option 3. |

## Company views(2nd)

As some of the features depend on the configuration/indication scheme and companies’ positions are still there from the first meeting, the moderator hopes we can **do the down-selection this meeting** and move forward the following discussion.

Regarding the eMTC, as majority of companies prefer option 1 as baseline, and in order to align the understanding with RAN2, the proposal 1-1b is proposed (almost the same as RAN2)

**[Proposal 1-1b]:**

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 3 (e.g., explicitly indicated by DCI).~~
* ~~FFS: Criteria on switching of different options~~

Please provide your views and comments.

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| --- | --- | --- |
| Companies | Support or not (Mandatory) | Comment (Optional) |
| Ericsson | No | We do not want to end-up with LTE-MTC and NB-IoT having different enabling/disabling mechanisms, because there is no reason for it.  The legitim concern I have is that the “RRC-based switching” has two elements that will take a lot of time (even without using repetitions): The RRC re-configuration message *per-se* plus the HL-ACK that follows the RRC re-configuration message (I think is transmitted using SR). How long time does the above semi-static switching take even without repetitions? I just want to know whether the “RRC-based switching” is truly suitable or not, or if having it will basically mean (i.e., in reality) that it won’t be timely in many IoT-NTN scenarios.  If the “RRC-based switching” is proven to be timely enough, then it can be adopted for both LTE-MTC and NB-IoT. If not, then either we adopt a “DCI-based switching” or as a way-forward we adopt both a semi-static “RRC-based” switching and a dynamic “DCI-based” switching where the network can choose one or the other using RRC signaling. |
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Regarding NBIoT, the situation is a little different. Almost half of companies hope to consider the DCI based solution. The main concern of directly adopting option 1 to NBIoT are MAC CE activation relying on the HARQ feedback and significant overhead signalling of reconfiguration of HARQ feedback.

In order to make majority accept the proposal, Option 6 is proposed to compromise if possible.  I know each company has its own position, there is a need to compromise to move forward now, so second preference is needed in your position. (e.g., may select several potential options for GTW discussion)

For option 6a-1, some companies believe either option 1 or option 3 can work well individually, in that sense, we can give the network the flexibility. This mechanism is widely used when we need compromise/down-selection.

For option 6a-2, if option 1 is configured, adopt option 1, otherwise adopt option 3.

For option 6a-3, some companies have concern to adopt option 1 for single HARQ process, so support option 3 for single HARQ process.

For option 6a-4, take option 1 as baseline solution, eNB can flexibly/additionally and dynamically indicate HARQ enabling to override the HARQ disabling configuration to address the concern of option 1(e.g., with existing DCI field(s))

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

For NB-IoT NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, down select **ONE** from the following options in [RAN1-110b-e]:

* Option 1: per HARQ process via UE specific RRC signaling
* Option 3: explicitly indicated by DCI (e.g., new field or reusing existing field)
* Option 6a-1: Support RRC signaling configured between Option 1 and Option 3
* Option 6a-2: Support Option 1 if RRC signaling configured, Option 3 otherwise
* Option 6a-3: Support Option 3 for UE with single HARQ process and Option 1 for UE with multiple HARQ processes
* Option 6a-4: Support Option 1 by default, and support Option 3 to override default configuration

Please provide your views and comments.

|  |  |  |  |
| --- | --- | --- | --- |
| Companies | 1st preference (Mandatory) | 2nd preference (Mandatory) | Comment (Optional) |
| Ericsson | Either Option 1 (*Iff* proven to be timely) or Option 3 | Option 6a-1 | We do not want to end-up with LTE-MTC and NB-IoT having different enabling/disabling mechanisms, because there is no reason for it.  See Ericsson’s comment in the previous proposal (i.e., comment under “**[Proposal 1-1b]**”). |
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# [Active]Issue-2 SPS PDSCH

## Background

Since SPS is only supported in CE mode A and the corresponding SPS period can be configured from 10ms to 640ms. While the reference value of RTT for LEO and GEO are 25.77ms and 541.46ms respectively. The HARQ stalling issue is not obvious in LEO scenario but do exist in GEO scenarios. Based on that, it is beneficial to configure HARQ disabling at least for GEO scenarios in eMTC. Similarly, for NR NTN SPS, the SPS period can also be configured from 10ms to 640ms, and the supported HARQ process is even larger than that of eMTC, the SPS HARQ disabling was introduced in Rel.17 NR NTN.

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 [Spreadtrum, ZTE, OPPO, CATT, Nokia, Xiaomi, CMCC, Apple, Qualcomm, 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. However, As proposed by [Nokia, NEC], HARQ feedback should be always enabled for the first SPS PDSCH after activation to avoid the repetition resource wasted, [NEC] further propose that HARQ feedback enabled/disabled for the first SPS PDSCH after activation is indicated by DCI. [Nokia] further propose that the configuration allows a process to report one HARQ-ACK for every n TBs received in SPS. 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.

As highlighted by [Spreadtrum, Lenovo, Apple], 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 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 2-1a]:**

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

* for the first SPS PDSCH after activation,
  + Option 1: 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, and follow per-process HARQ feedback enabled/disabled configuration otherwise.
  + Option 2: ACK/NACK is always reported by UE for the first SPS PDSCH after activation regardless of network configuration of enabled/disabled for this HARQ process.
  + Option 3: follow the per-process HARQ feedback enabled/disabled configuration for the associated HARQ process.

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

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** |
| ZTE | For 2-1a, support option 1, i.e., reusing the NR-NTN solution. There is no problem when reusing the NR-NTN solution. Hence, no need to define a new solution.  For 2-2a, fine with the proposal. |
| Xiaomi | 2-1a, option 1 is preferred to follow the NR-NTN design.  2-2a, agree. |
| Ericsson | There are more fundamental issues of the “disabling” approach that should be settled first for it to work properly (e.g., no-monitoring time of the so called “scheduling restriction”, avoiding a Tx/Rx issue, etc). Thus, the potential support of other features should be discussed with lower priority. |
| Nokia, NSB | Proposal 2-1a: We think these 3 options are not enough. Actually, considering SPS will last for some long time, in TN, there is HARQ feedback for each SPS transmission and network can know whether the scheduling is suitable for the related channel status of UE. Then eNB can reschedule the SPS if needed e.g. the SPS transmission is always ACK or always NACK or with a large probability as ACK or NACK. But from NTN, when we disabled the HARQ feedback for SPS, then even if UE feedback for the first SPS transmission, it only mention whether it is ok for channel of first transmission. E.g. if there is an HARQ NACK, then what the eNB should do, to continue the SPS transmission then there may be risk that all the SPS may be not successfully received but with some probability that it may be received successfully.  Proposal 2-2a: we are ok for this. |
| OPPO | Fine with Proposal 2-1a and 2-2a. For 2-1a, our preference is reusing NR-NTN method, i.e., Option 1. |
| CMCC | For Proposal 2-1a, we prefer Option 1 to reuse the agreed configuration of SPS PDSCH in Rel-17 NR NTN.  For Proposal 2-2a, we are fine with the proposal. |
| Apple | We support Option 1 in Proposal 2-1a, as it reuses the design of NR NTN.  We support Proposal 2-2a, as it follows the design of NR NTN. |
| InterDigital | Proposal 2-1a: we support Option 1  Proposal 2-2a: support the proposal |
| Spreadtrum | For Proposal 2-1a: we support Option 1  For Proposal 2-2a: we are fine with the proposal |
| NEC | For Proposal 2-1a: we support Option 1.  For Proposal 2-2a: we are fine with the proposal. |

## Company views(2nd)

In the last round email discussion, **[Proposal 2-1a] and [Proposal 2-2a]** were discussed:

W.r.t the **Proposal 2-1a** in section 2.2, in the 1st round discussion, [10] companies are provided views:

* Up to 8 companies (ZTE, Xiaomi, OPPO, CMCC, Apple, InterDigital, Spreadtrum, NEC) are fine with the proposal
* Up to 2 companies (Ericsson, Nokia) have concerns on it.

Regarding the comments from Nokia, that the configuration allows a process to report one HARQ-ACK for every n TBs received in SPS. From moderator’s understanding, the HARQ process number is determined by subframe index for SPS, so whether to report HARQ-ACK or not can be implemented by proper SPS configuration and HARQ enabling/disabling configuration. The solution adopted in NR can be the baseline that the HARQ feedback for SPS PDSCH follow the per-process HARQ feedback enabled/disabled configuration. We are still open to consider Nokia proposed solution for further study to check the benefit of reporting HARQ-ACK every n TB instead of following NR solution, so the proposal is updated as follow

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

For HARQ feedback for eMTC SPS PDSCH, UE at least follows the per-process HARQ feedback enabled/disabled configuration for the associated HARQ process except for the first SPS PDSCH after activation

* for the first SPS PDSCH after activation,
  + Option 1: 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, and follow per-process HARQ feedback enabled/disabled configuration otherwise.
  + Option 2: ACK/NACK is always reported by UE for the first SPS PDSCH after activation regardless of network configuration of enabled/disabled for this HARQ process.
  + Option 3: follow the per-process HARQ feedback enabled/disabled configuration for the associated HARQ process.

W.r.t the **Proposal 2-2a** in section 2.2, in the 1st round discussion, [10] companies are provided views:

* Up to 10 companies (ZTE, Xiaomi, Ericsson, Nokia, OPPO, CMCC, Apple, InterDigital, Spreadtrum, NEC) are fine with the proposal

The following proposal is recommended:

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

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 | We have not even completed the fundamentals of the “Disabling” approach (e.g., we have not finalized yet the scheduling restriction, handling mixed enabled/disabled scenarios, etc). We should finalize first the design of the “Disabling” approach before discussing the potential support of other features. |

# [Active]Issue-3 (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.

**TS38.214 Section 5.1**

When HARQ feedback for the HARQ process ID is disabled, the UE is not expected to receive another PDCCH carrying a DCI scheduling a PDSCH or set of slot-aggregated PDSCH scheduled for the given HARQ process or to receive another PDSCH without corresponding PDCCH for the given HARQ process that starts until Tproc,1 after the end of the reception of the last PDSCH or slot-aggregated PDSCH for that HARQ process.

For eMTC, as proposed by [ZTE, CATT, Nordic, Apple, Qualcomm, Lenovo], following NR PDSCH/PDCCH scheduling restriction, the similar mechanism should be introduced to eMTC NTN. However, as mentioned by [Ericsson] that there is a delay between the “MPDCCH and the scheduled PDSCH”, afterwards there is at least a 3 ms delay between the end of PDSCH and the start of PUCCH which accounts for sufficient PDSCH decoding time at the devices, and further propose that UE is not required to monitor PDCCH in a period of Y(ms) from the end of reception of the last PDSCH.

The minimum gap between the end of PDSCH and the start of corresponding HARQ-ACK is 3ms for eMTC defined in 36.213, which accounts for PDSCH decoding time and corresponding uplink data preparation at the devices. Furthermore, eMTC UE has the ability to decode MPDCCH and PDSCH in the same subframe and there is NO MPDCCH monitoring restriction in legacy eMTC shown in Figure 1 (e.g., UE has the ability to decode PDSCH and monitor/decode MPDCCH simultanously even for the PDSCH with HARQ enabling/disabling, as subframe #2 in Figure 1).





Figure 1 Minimal gap between PDSCH and PUSCH

**TS36.213 Section 10.2**

For FDD, a BL/CE UE shall upon detection of a PDSCH intended for the UE and for which an HARQ-ACK shall be provided, transmit the HARQ-ACK response using the same  derived according to Clause 10.1.2.1 in subframe(s) *n+ki* with *i =0,1, …, N-1*, where

- subframe *n-k-K*offset is the last subframe in which the PDSCH is transmitted, where

- if the UE is in half-duplex FDD operation and is not configured with higher layer parameter *ce-PDSCH-14HARQ-Config* and is configured with CEModeA and higher layer parameter *ce-HARQ-AckBundling* and the 'HARQ-ACK bundling flag' in the corresponding DCI is set to 1, or if the UE is configured with higher layer parameter *ce-SchedulingEnhancement*

- is given by the 'HARQ-ACK delay' field in the corresponding DCI, and the HARQ-ACK delay value is determined based on the higher layer parameters according to Table 7.3.1-2;

- if the UE is in half-duplex FDD operation and is configured with higher layer parameter *ce-PDSCH-14HARQ-Config* and is configured with CEModeA, and 'PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ' field is present in the corresponding DCI,

- is given by the HARQ-ACK delay value as defined in [4], in the corresponding DCI,

- otherwise

-

*- 0≤k0<k1<…,kN-1* and the value of and  is provided by higher layer parameter *pucch-NumRepetitionCE-format1,* if configured, otherwise it is provided by higher layer parameter *pucch-NumRepetitionCE*-*Msg4-Level0-r13, pucch-NumRepetitionCE-Msg4-Level1-r13, pucch-NumRepetitionCE-Msg4-Level2-r13* or *pucch-NumRepetitionCE-Msg4-Level3-r13* depending on whether the most recent PRACH coverage enhancement level for the UE is 0, 1, 2 or 3, respectively; and

For NBIoT, as highlighted by [MTK, Huawei, Xiaomi, Apple, Mavenir, Qualcomm, Ericsson], 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. [Huawei] further mentions that NBIoT UE is usually not capable of decoding NPDSCH and NPDCCH in parallel. The 12 ms scheduling restriction is reserved for UE to decode NPDSCH, and eNB is not expected to transmit a DCI scheduling NPDSCH with any HARQ process. [Lenovo] further mentions the NPDCCH scheduling restriction behavior is imposed to NBIoT UE with single HARQ process.

However, as proposed by [ZTE, OPPO, Nordic, CMCC, Lenovo], following NR PDSCH/PDCCH scheduling restriction, the similar mechanism should be introduced to NBIoT NTN. [ZTE] mentions that option 2 seems to prohibit all PDCCH monitoring. As a result, for a UE with multiple HARQ processes, if one HARQ process is decoding a PDSCH/NPDSCH, the other free HARQ process scheduling data cannot work either, which seems not reasonable and may decrease system data rate because of the missed detection of the other free HARQ process data.[OPPO] proposes that the original motivation of introducing option 2 is to specify the behavior when UE receives a NPDSCH carrying RAR grant, paging, or Rel-14 SC-PTM. Note that those DL transmissions are broadcast transmissions and not associated with a DL HARQ process for retransmission. It is different from a DL HARQ process with disabled HARQ feedback, which is used for unicast transmission. [Ericsson] mentions that to avoid incurring in an Rx/Tx issue, the NPDCCH monitoring restriction duration can optionally add the legacy variable that accounts for NPUSCH Format 2 repetitions and the RU length that depends on the configured SCS, plus 1ms for UL-to-DL switching.

**TS36.213 Section 16.6**

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*.

In this meeting, preference options from companies are summarized as follow:

For a DL HARQ process with disabled HARQ feedback in NB-IoT, 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=12(ms) after the end of the reception of the last NPDSCH for that HARQ process.

Supported by: ZTE, OPPO, Nordic, CMCC, Lenovo

* Option 2: UE is not required to monitor NPDCCH in a period of Y=12(ms) from the end of reception of the last NPDSCH

Supported by: MTK, Huawei, Xiaomi, Apple, Mavenir, Qualcomm, Ericsson

The main difference between Option 1 and Option 2 is that for option 1, UE needs to monitor NPDCCH after the reception of previous PDSCH, but UE is not expected to be scheduled with new PDSCH of the same HARQ process within a period, while for option 2, UE is not required to monitor NPDCCH at all for a period of 12ms as shown in Figure 2.



Figure 2 PDSCH/NPDCCH scheduling restriction

## Company views

According to the above summary, reusing NR PDSCH scheduling restriction can be a starting point at least for eMTC. For eMTC, regarding the value of X, as the minimum gap is defined as 3ms, the PDSCH scheduling restriction duration should be 3ms. For NBIoT, considering the UE complexity and power saving, the moderator recommends taking NBIoT legacy Option 2 to NPDCCH monitoring restriction in HARQ disabling scenarios, which is a relative conservative and safe way to NBIoT UE and is aligned with slight majorities.

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

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=[3] (ms) after the end of the reception of the last PDSCH for that HARQ process.

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

For a DL HARQ process with disabled HARQ feedback in NBIoT, UE is not required to monitor NPDCCH in a period of Y=12(ms) from the end of reception of the NPDSCH.

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Qualcomm | Agree with both above. |
| ZTE | For 3-1a, support.  For 3-2a, OK with the proposal if it is preferred by majority. |
| Xiaomi | Agree |
| Ericsson | LTE-MTC:  **[Proposal 3-1a]** seems to result in an issue due that LTE-MTC can support more than two HARQ processes (e.g., If we follow the wording of “**[Proposal 3-1a]**”, the subsequent MPDCCH transmission of HARQ processes#0 would be transmitted in subframe#6, however if there are seven or more HARQ processes in use, subframe#6 would be used to transmit the first MPDCCH of HARQ process#7). Thus, to avoid the above-mentioned issue, what was called “Option 2” for NB-IoT should also be adopted for LTE-MTC, that is:  ­ UE is not required to monitor MPDCCH in a period of Y(ms) from the end of reception of the last PDSCH  ­ Y=3  NB-IoT:  We are ok with **[Proposal 3-2a].**  PS: It is worth noting that those “constant no-monitoring periods” of 12ms in NB-IoT/3ms in LTE-MTC respectively, only work when all HARQ processes have HARQ feedback disabled.  In a mixed scenario, the no-monitoring period (12ms in NB-IoT/3ms in LTE-MTC) must account for the characteristics of the UL transmission as to avoid a Tx/Rx issue. |
| Huawei, HiSilicon | We support proposal 3-2a |
| Nokia, NSB | Proposal 3-1a: to keep it simple, we prefer to reuse same delay between PDSCH and PUCCH.  Proposal 3-2a: OK to reuse legacy specification. |
| OPPO | Fine with Proposal 3-1a.  Regarding Proposal 3-2a, we still prefer Option 1 in last meeting, i.e., UE is not expected to receive another NPDCCH carrying a DCI scheduling a NPDSCH for a given HARQ process that starts until X=12(ms) after the end of the reception of the last NPDSCH for that HARQ process. |
| MediaTek | **[Proposal 3-2a]:** support. |
| CMCC | For Proposal 3-1a, we are fine with the proposal.  For Proposal 3-2a, if majority companies support the legacy mechanism of NPDCCH/NPDSCH scheduling restriction, we are fine with the proposal. |
| Nordic | Support both proposals |
| Apple | We support both proposals. For Proposal 3-2a, we could simply rely on the legacy processing time restriction and no specification change is needed. |
| InterDigital | Support both proposals |
| Spreadtrum | Support |
| NEC | Agree with above two proposals. |

## Company views(2nd)

In the last round email discussion, **[Proposal 3-1a]** and **[Proposal 3-2a]** were discussed:

W.r.t the **Proposal 3-1a** and **Proposal 3-2a** in section 3.2, in the 1st round discussion, [14] companies are provided views:

* Up to 12 companies (Qualcomm, ZTE, Xiaomi, Huawei, Nokia, MediaTek, CMCC, Nordic, Apple, InterDigital, Spreadtrum, NEC) are fine with the proposals
* Up to 2 companies (Ericsson, OPPO) have concerns on it.

Regarding the comment from Ericsson, from moderator understanding, for eMTC, there is no need to make the restriction for MPDCCH monitoring but only PDSCH scheduling restriction for particular HARQ process number, and regarding the comment from OPPO, considering the UE complexity and power saving, the moderator recommends taking NBIoT legacy Option 2 to NPDCCH monitoring restriction in HARQ disabling scenarios, which is a relative conservative and safe way to NBIoT UE and is aligned with slight majorities.

Based on that, the original proposal is kept for further comments.

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

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=[3] (ms) after the end of the reception of the last PDSCH for that HARQ process.

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

For a DL HARQ process with disabled HARQ feedback in NBIoT, UE is not required to monitor NPDCCH in a period of Y=12(ms) from the end of reception of the NPDSCH.

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Ericsson | LTE-MTC:  As explained in our previous comment, **[Proposal 3-1a]** results in an issue that the eNodeB will have to handle. Basically, it will overlap the ongoing scheduling cycle with the subsequent one and the eNodeB will have to prioritize one over the other, which will make even more complicated to handle a mixed enabling/disabling scenario (and the avoidance of a Tx/Rx issue) that we have not discussed yet.  The proposal for NB-IoT is cleaner because it lets finishing the first scheduling cycle and as early as possible it allows to start the subsequent one. So, both LTE-MTC and NB-IoT can use the same solution. Thus, to avoid the above-mentioned issue, what was called “Option 2” for NB-IoT should also be adopted for LTE-MTC, that is:  ­ UE is not required to monitor MPDCCH in a period of Y(ms) from the end of reception of the last PDSCH  ­ Y=3  NB-IoT:  We are ok with **[Proposal 3-2a].**  PS: It is worth noting that those “constant no-monitoring periods” of 12ms in NB-IoT/3ms in LTE-MTC respectively, only work when all HARQ processes have HARQ feedback disabled.  In a mixed scenario, the no-monitoring period (12ms in NB-IoT/3ms in LTE-MTC) must account for the characteristics of the UL transmission as to avoid a Tx/Rx issue. |
|  |  |

# [Closed]Issue-4 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 [Spreadtrum, 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, Huawei], UE only reports the HARQ information for the HARQ enabled process, corresponding UE behavior and timing relationship as shown in Figure 3. Specially for NBIoT, as proposed by [Huawei], UE do not feedback HARQ-ACK if two TBs are scheduled by single DCI and HARQ feedback is disabled for both processes, and 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. As proposed by [NEC], HARQ feedback enabling/disabling is indicated by NDI field of DCI or a new DCI field. Optionally, the indication of new DCI field can be applied to all scheduled TBs, the first scheduled TB, the last scheduled TB or the middle-scheduled TB.



Figure 3 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 no matter what kinds of indication are adopted and the following proposals are listed as majority views:

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

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)
* Option 3: HARQ feedback is reported or not depending on the other TBs HARQ-enabled/HARQ-disabling scheduled by single DCI
* Other options are not excluded

Note 1: eMTC and NB-IoT can be separately discussed

Note 2: HARQ feedback bundling and non-bundling can be separately discussed

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Qualcomm | We think Option 1 should be excluded as it defeats the purpose of HARQ disabling if we must transmit the ACK anyway. This wastes UE power, as well as overall throughput due to the needless ACK transmission.  For Option 2, which seems sensible, we need to further discuss the “timeline” for the HARQ-ACK transmission of the TBs with feedback-enabled. Per our understanding, the current specs assume a “back-to-back” transmission of ACKs for the scheduled TBs, “if each TB has feedback associated with it”. This may create “holes” in the timeline, which may also be inefficient. We can discuss further on this. We could add an FFS saying “HARQ-ACK transmission timeline details”.  We don’t quite understand the motivation for Option 3, wither. |
| ZTE | Option 1 is preferred, which is similar to type-1 HARQ codebook in NR-NTN. With this option, the spec impact is minimized since there is no need to additionally consider the timing relationship issue or the HARQ feedback bundling case. Although the overhead of HARQ-ACK transmission is not saved, the main target to mitigate HARQ stalling issue can still be achieved. |
| Xiaomi | Option 2 is preferred. |
| Ericsson | None of the options resolve the issue, for example assuming “ACK” for the HARQ processes with HARQ feedback disable is NOT enough to keep the disabling approach ongoing, since the no-monitoring period (12ms in NB-IoT/3ms in LTE-MTC) must account for the characteristics of the UL transmission as to avoid a Tx/Rx issue.   * In NB-IoT: The RU length of NPUSCH Format 2, the number of repetitions, and one subframe to perform UL-to-DL switching. * In LTE-MTC: The number of PUCCHs and their location, number of PUCCH repetitions and one subframe to perform UL-to-DL switching.   Moreover, how to handle a scenario “*where some TBs have feedback enabled, while some others have feedback disabled*” is not a Multi-TB grant related issue, the issue is more fundamental since it happens even with a conventional Single-TB grant. Thus, we shall address the fundamentals (i.e., single-TB grant) of the disabling approach before starting any discussion on other features (e.g., Multi-TB grant). |
| Huawei, HiSilicon | We would suggest to split the proposals for NBIoT and eMTC due to different method of HARQ CB generation.  For NBIoT, HARQ-ACK is not feedback if HARQ is disabled for both TBs scheduled by a DCI format. The HARQ-ACK for both TBs should be feedback if HARQ-ACK feedback is enabled for at least one of the TBs scheduled by the DCI format. |
| Nokia, NSB | Support for further consideration |
| OPPO | For multiple TB scheduling with single DCI, we prefer to discuss non-bundling case first, bundling case can be discussed later, e.g.,  For multiple TB scheduling with single DCI and without HARQ-ACK bundling, the following UE behaviors are considered for the downlink transmission with HARQ process disabled： |
| CMCC | We prefer Option 1. |
| Nordic | Option 2 is preferred by us |
| Apple | We are fine with the proposal, and prefer Option 1 for its simplicity. Note that in NR NTN, the size of type-1 HARQ codebook is fixed, even if all HARQ processes are feedback disabled. |
| Spreadtrum | We prefer Option 1. |
| NEC | Option 2 is preferred by us. |
| FL | W.r.t the **Proposal 4-1a**, in section 4.2, in the 1st round discussion, some of companies propose that the issue needs further study after fundamental issues in section 1-3 are stable, while some of companies propose to differential the discussion for eMTC and NBIoT. Due to time limited this meeting, companies are encouraged to input the views next meeting, the section is closed this meeting. |

# [Active]Issue-5 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, [Speadtrum, ZTE, OPPO, CATT, Apple] proposes that ACK is assumed for a feedback-disabled HARQ process in the logical AND operation. However, [Lenovo]mentions due to PDSCH number restriction (e.g., 10 PDSCH for each scheduling cycle) and PUCCH feedback resource restriction for each scheduling cycle (e.g., 3 for PUCCH resource for each scheduling cycle), if ACK is assumed for HARQ disabling scenarios (e.g., this HARQ feedback of ACK will occupy a PDSCH number and a PUCCH resource of HARQ bundling), there is no available PDSCH and corresponding PUCCH resource in the scheduling cycle and it is equivalent that HARQ disabling feature is not supported in HD-FDD HARQ bundling.

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 4, and further mentions that the legacy HARQ bundling only includes the bundling of HARQ enabled process in legacy TS36.213.

[NEC] proposes that ACK is assumed for the disabled HARQ process when performing a logical AND operation if not all the bundled TB is disabled HARQ feedback, and if all the bundled TB is disabled HARQ feedback, then HARQ bundling function will not apply even it is configured. As mentioned by [Sharp] that the UE will ignore HARQ feedback for disabled HARQ processes when performing HARQ bundling.



Figure 4 HARQ disabling in HARQ bundling for eMTC HD-FDD

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## 10.2 Uplink HARQ-ACK timing

[……]

For FDD, a BL/CE UE shall upon detection of a PDSCH intended for the UE and for which an HARQ-ACK shall be provided, transmit the HARQ-ACK response using the same  derived according to Clause 10.1.2.1 in subframe(s) *n+ki* with *i =0,1, …, N-1*, where

- subframe *n-k**-**K*offset is the last subframe in which the PDSCH is transmitted, where

- if the UE is in half-duplex FDD operation and is not configured with higher layer parameter *ce-PDSCH-14HARQ-Config* and is configured with CEModeA and higher layer parameter *ce-HARQ-AckBundling* and the 'HARQ-ACK bundling flag' in the corresponding DCI is set to 1, or if the UE is configured with higher layer parameter *ce-SchedulingEnhancement*

- is given by the 'HARQ-ACK delay' field in the corresponding DCI, and the HARQ-ACK delay value is determined based on the higher layer parameters according to Table 7.3.1-2;

- if the UE is in half-duplex FDD operation and is configured with higher layer parameter *ce-PDSCH-14HARQ-Config* and is configured with CEModeA, and 'PDSCH scheduling delay and HARQ-ACK delay for 14 HARQ' field is present in the corresponding DCI,

- is given by the HARQ-ACK delay value as defined in [4], in the corresponding DCI,

- otherwise

-

[….]

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### 7.3.1 FDD HARQ-ACK reporting procedure

[….]

For a BL/CE UE in half-duplex FDD operation, if the UE is configured with CEModeA, and if the UE is configured with higher layer parameter *ce-HARQ-AckBundling* and the 'HARQ-ACK bundling flag' in the corresponding DCI is set to 1,

- for HARQ-ACK transmission in subframe *n*, the UE shall generate one HARQ-ACK bit by performing a logical AND operation of HARQ-ACKs across all  BL/CE DL subframes for which subframe *n* is the 'HARQ-ACK transmission subframe'.

- if subframe *n-k1* is the most recent subframe for which subframe *n* is the 'HARQ-ACK transmission subframe', and if the 'Transport blocks in a bundle' field in the corresponding DCI for PDSCH transmission in subframe *n-k1* indicates a number of transport blocks in a bundle other than , the UE shall generate a NACK for HARQ-ACK transmission in subframe *n*.

[…..]

## 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 no matter what kinds of indication are adopted and the following proposals are listed as majority views:

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

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)
* Option 3: HARQ feedback is reported or not depending on the other TBs HARQ-enabled/HARQ-disabling scheduled within a HARQ bundle
* Other options are not excluded

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Qualcomm | As we have highlighted multiple times before, the current specs for “single TB scheduling” (unlike multi-TB scheduling) clearly state that **Option 2 listed above is the “current UE behavior”**. We paste the relevant texts here again, below. We don’t see why we need to discuss this further.  *“For a BL/CE UE in half-duplex FDD operation, if the UE is configured with CEModeA, and if the UE is configured with higher layer parameter ce-HARQ-AckBundling and the 'HARQ-ACK bundling flag' in the corresponding DCI is set to 1.*  *- for HARQ-ACK transmission in subframe n, the UE shall generate one HARQ-ACK bit by performing a logical AND operation of HARQ-ACKs across all  BL/CE DL subframes for which subframe n is the 'HARQ-ACK transmission subframe'.”*  **Since a feedback-disabled HARQ process will set the ‘HARQ-ACK bundling flag’ in the corresponding DCI to 0, and there will be no ‘HARQ-ACK transmission subframe’, these HARQ processes will have no impact on the feedback bit to be generated. No change to the current specifications is required to handle this issue.** |
| ZTE | Option 1 is preferred. The legacy AND operation can be kept without any change. |
| Ericsson | For the HARQ processes with disabled HARQ feedback, regardless of whether an ACK or NACK were assumed by-default for them, they will start monitoring after a DL no-monitoring period from the last PDSCH, and such a DL monitoring period may be too close (as to do not allow for UL-to-DL switching) or even collide with the PUCCH transmission(s) associated to the HARQ processes with HARQ feedback enabled. Thus, the no-monitoring period (3ms in LTE-MTC) must account for the characteristics of the UL transmission as to avoid a Tx/Rx issue.   * In LTE-MTC: The number of PUCCHs and their location, number of PUCCH repetitions and one subframe to perform UL-to-DL switching. |
| Nokia, NSB | Support for further consideration. |
| OPPO | If this proposal targets for HARQ bundling for single TB scheduling with single DCI, we share similar view with Qualcomm. |
| Apple | We support Option 1 for this simplicity. Regarding Qualcomm’s comment on Option 1, we would like to clarify if the value (in Section 7.3.1 of TS36.331) is semi-statically configured or dynamically determined. If semi-statically configured, how to avoid the case where some HARQ processes in the bundle are feedback enabled while others are feedback disabled?  For Option 2 and Option 3, we think they do not cover the case where some HARQ process(es) in the HARQ bundling has HARQ feedback enabled, while other HARQ process(es) in the HARQ bundling has HARQ feedback disabled. If all the HARQ processes in the HARQ bundling have HARQ feedback disabled, then the “HARQ-ACK bundling flag” in DCI can be simply set to 0 to disable the HARQ feedback report. |
| Spreadtrum | We prefer Option 1. |
| NEC | Option 1 is preferred. |

## Company views(2nd)

W.r.t the **Proposal 5-1a** in section 5.2, in the 1st round discussion, [8] companies are provided views. The motivation of proposal 5-1 is to give companies way forward for next meeting discussion. So the moderator hopes to take **Proposal 5-1a** as agreement for the guideline/starting point of next meeting discussion.

Regarding the comments from Apple, from moderator understanding, the actual HARQ bundle size *M* is dynamically determined by DCI, only the HARQ feedback scheduled in the same subframe/PUCCH resource by DCIs can be bundled together. If Option 1 is supported, the ACK for the HARQ disabling process will be bundled with other HARQ-ACK for HARQ enabled process, and the ACK for HARQ disabling process will also occupy one of the *M* HARQ-ACK feedback.

Based on that, the original proposal is kept for further comments.

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

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)
* Option 3: HARQ feedback is reported or not depending on the other TBs HARQ-enabled/HARQ-disabling scheduled within a HARQ bundle
* Other options are not excluded

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Ericsson | Further discussion is needed since none of the options resolve the issue. Regardless of whether an ACK or NACK were assumed by-default for the “HARQ processes with HARQ feedback disabled”, they will start monitoring after a DL no-monitoring period from the last PDSCH, and such a DL monitoring period may be too close (as to do not allow for UL-to-DL switching) or even collide with the PUCCH transmission(s) associated to the HARQ processes with HARQ feedback enabled. Thus, the no-monitoring period (3ms in LTE-MTC) must account for the characteristics of the UL transmission as to avoid a Tx/Rx issue.   * In LTE-MTC: The number of PUCCHs and their location, number of PUCCH repetitions and one subframe to perform UL-to-DL switching. |
|  |  |

# [Closed]Issue-6 NPRACH capacity

## Background

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. [Nokia] observes that when SR is only indicated by NPRACH, the required NPRACH capacity may be very high for a NTN cell and 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 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. [Huawei] further mentions that with dynamic HARQ disabling, the issues on NPRACH capacity starvation and lack of reference for open loop link adaptation can be alleviated by eNB implementation.

## Company views

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

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

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

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Qualcomm | Not relevant or high priority. |
| ZTE | This issue can be deprioritized until the fundamental issues about HARQ disabling are resolved. |
| Ericsson | As we have stated before, 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. |
| Huawei, HiSilicon | If option 3 in section 1.2 is adopted, the starvation of NPRACH capacity can be resolved by implementation |
| Nokia, NSB | SR transmission due to HARQ disabling will increase the NPRACH transmission opportunities and need more NPRACH resources configuration (whether SR dedicated NPRACH or common NPRACH resources) which will decrease the capacity for data. Otherwise, the impact on normal NPRACH/other SR transmission will become serious, e.g., cause the failure of other NPRACH transmission. Additionally, NB-IoT UE only have 1 or 2 HARQ processes, which may be all feedback disabled or at least 1 HARQ process with feedback disabled, especially in GEO scenario, this will also cause much pressure on NPRACH capacity. So the solution to alleviate the SR transmission opportunities through NPRACH should be considered. |
| OPPO | OK. |
| MediaTek | This can be de-prioritized. |
| Apple | We think this topic can be deprioritized. |
| InterDigital | This issue can be deprioritized |
| Spreadtrum | Low priority |
| NEC | Low priority. |
| FL | W.r.t the **Proposal 6-1a**, in section 6.2, in the 1st round discussion, majority of companies propose that the issue needs further study as low priority after fundamental issues in section 1-3 are stable. Due to time limited this meeting, companies are encouraged to input the views next meeting, the section is closed this meeting. |

# [Closed]Issue-7 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 7-1a]:**

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

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| Qualcomm | Not relevant to the WID. |
| Xiaomi | Low priority |
| Ericsson | As we also stated before, 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. |
| Nokia, NSB | This issue is one typical and important issue in Rel18 considering long repetition of IoT UE in NTN. Considering the limited serving time of one NTN cell, the issue may happen with a high probability, especially when UE access into cell with a shorter remaining serving time.  Resource for NTN is valuable and we should not waste it. Also considering UE may waste much energy if the transmission and the access procedure is wasted without benefit when transmission is not possible to complete in one NTN cell, which is big issue in IoT UE.  We propose this issue should be solved in Rel18 or Rel18 may work with very low efficiency. |
| OPPO | OK. |
| MediaTek | This can be de-prioritized. |
| Apple | We think this topic can be deprioritized. |
| InterDigital | This issue can be deprioritized |
| Spreadtrum | Low priority |
| NEC | We support this proposal. And we think RAN1 can also further study this issue as eNB may need to inform the UE whether to continue the transmission. |
| FL | W.r.t the **Proposal 7-1a**, in section 7.2, in the 1st round discussion, majority of companies propose that the issue needs further study as low priority after fundamental issues in section 1-3 are stable. Due to time limited this meeting, companies are encouraged to input the views next meeting, the section is closed this meeting. |

# [Closed]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:

* UCI/UE assistant information
  + 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 8-1a]:**

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

Please provide your views and comments.

|  |  |
| --- | --- |
| **Company** | **Comments and Views** |
| ZTE | This issue can be deprioritized until the fundamental issues about HARQ disabling are resolved. |
| Ericsson | There are still many fundamental issues of the disabling approach that need to be resolved for it to work properly, thus any proposed enhancement should have a lower priority at least for the moment. |
| Nokia, NSB | When HARQ feedback is disabled, the link adaptation will be impacted, especially the impact is significant when number of HARQ process is small for NB-IOT UE.  With a low efficiency link adaptation, the scheduling will be with low efficiency, causing IoT UE to consume more power and also the IoT resource efficiency will be very low.  We propose this issue should be solved in Rel18 or Rel18 may work with very low efficiency. |
| OPPO | In our contribution (R1-2208836), if the gNB intends to transmit PDCCH carrying ACK information in eMTC system, we raised an issue on how to perform HARQ feedback for PUSCH associated with an UL HARQ mode B configuration. We propose to discuss this issue.  **[Proposal 8-2a]:**  Discuss enhancements on PDCCH carrying HARQ-ACK feedback when UE is configured with UL HARQ mode B. |
| FL | W.r.t the **Proposal 8-1a**, in section 8.2, in the 1st round discussion, majority of companies propose that the issue needs further study as low priority after fundamental issues in section 1-3 are stable. Due to time limited this meeting, companies are encouraged to input the views next meeting, the section is closed this meeting. |

# Proposals for discussion at Online sessions

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

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 3 (e.g., explicitly indicated by DCI).
* FFS: Criteria on switching of different options
* Option 1: per HARQ process via UE specific RRC signaling

Supported by: MTK, Huawei, Spreadtrum, ZTE, OPPO(1st), CATT, Nordic, Nokia, CMCC, Apple, InterDigital, Mavenir, Samsung, Sharp, Qualcomm, Lenovo

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

Supported by: NEC, Ericsson

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

For NB-IoT NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, down select **ONE** from the following options in [RAN1-110b-e, RAN1-111]:

* Option 1: per HARQ process via UE specific RRC signaling
* Option 3: explicitly indicated by DCI (e.g., new field or reusing existing field)
* Option 4: implicitly indicated by existing configured/indicated/combined parameter(s) in the DCI (e.g., repetition number, TBS)
* Option 6a: Option 1+ Option 3
  + FFS: Criteria on switching of different options
* Option 6b: Option 1+ Option 4
  + FFS: Criteria on switching of different options
* Option 1: per HARQ process via UE specific RRC signaling

Supported by: MTK, Spreadtrum, ZTE, OPPO(1st), CATT(1st), CMCC, Apple, InterDigital, Mavenir, Samsung, Sharp, Qualcomm, Lenovo

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

Supported by: OPPO (2nd), CATT (2nd), NEC, Nordic, Nokia(1st), Xiaomi, Apple, InterDigital, Mavenir, Ericsson

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

Supported by: Huawei, CATT (2nd), Nokia(2nd),

* Option 6: combination

Supported by: InterDigital, Mavenir

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

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

* for the first SPS PDSCH after activation,
  + Option 1: 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, and follow per-process HARQ feedback enabled/disabled configuration otherwise.
  + Option 2: ACK/NACK is always reported by UE for the first SPS PDSCH after activation regardless of network configuration of enabled/disabled for this HARQ process.
  + Option 3: follow the per-process HARQ feedback enabled/disabled configuration for the associated HARQ process.

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

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

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

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=[3] (ms) after the end of the reception of the last PDSCH for that HARQ process.

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

For a DL HARQ process with disabled HARQ feedback in NBIoT, UE is not required to monitor NPDCCH in a period of Y=12(ms) from the end of reception of the NPDSCH.

# 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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