**3GPP TSG-RAN WG1 Meeting #116R1-2400xxx**

**Athens, Greece, February 26th – March 1st, 2024**

**Agenda Item: 8.9**

**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.*

**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).*

**RAN1-110bis-e**

Agreement

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

Agreement

*For NB-IoT NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, down select* ***ONE*** *from the following options at RAN1#111:*

* *Option 6a-1: Support RRC signaling configured between Option 1 and Option 3*
* *Option 6a-4: Support Option 1 by default, and support Option 3 to override default configuration for corresponding transmission*

**RAN1-111**

***Working assumption***

*For NB-IoT NTN and eMTC NTN for CE Mode B, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission:*

* *Support Option 1 by default, and support Option 3 to override default configuration for corresponding transmission*
	+ *Additional RRC signaling to enable Option 3*
	+ *If the bitmap for option 1 is not present and if option 3 is configured then the DCI directly indicates HARQ enable/disable. Option 3 can also be configured when the bitmap for option 1 is configured.*
	+ *FFS #1: Option 3 DCI-based overridden mechanism is applied to both semi-statically HARQ enabled and disabled processes or only applied to semi-statically HARQ disabled processes or only applied to semi-statically HARQ enabled processes.*
	+ *FFS #2: whether/how to support Option 3 overriding default configuration for corresponding transmission for multiple TBs scheduled by single DCI*

*For eMTC NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, take Option 1 for CE Mode A.*

**RAN1-112**

*Conclusion*

*For eMTC HD-FDD single TB scheduled by single DCI, UE is not expected to receive a DCI with “HARQ-ACK bundling flag” field set to 1 in case the corresponding HARQ process is configured with HARQ feedback disabled by RRC signaling.*

*Agreement*

*For a DL HARQ process with disabled HARQ feedback in eMTC, UE is not expected to receive another MPDCCH carrying a DCI scheduling a PDSCH for a given HARQ process or to receive another PDSCH without corresponding MPDCCH for the given HARQ process that starts at a BL/CE DL subframe until X=3 (ms) have passed after the end of the reception of the last PDSCH for that HARQ process.*

*Agreement*

*For HARQ feedback for eMTC SPS PDSCH, at least the following is supported: 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.*

*Conclusion*

*For DCI indicating SPS PDSCH release, HARQ-ACK report is performed as legacy in eMTC, regardless of HARQ feedback enabled/disabled configuration.*

*Agreement*

*For DCI-based overridden mechanism/indication in single TB scheduled by DCI, down select one of the following alternatives based on the criteria DCI overhead, PDCCH monitoring/power consumption, HARQ timer, impact on scheduling flexibility, UE implementation complexity*

* *Alternative 1: applies to both semi-statically HARQ enabled and disabled processes*
* *Alternative 2: only applied to semi-statically HARQ disabled processes*
* *Alternative 3: only applied to semi-statically HARQ enabled processes*

*Agreement*

*Confirm the following working assumption with the following update:*

*Working assumption*

*For NB-IoT NTN and eMTC NTN for CE Mode B, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission:*

* *Support Option 1 in case only per-HARQ process bitmap signaling is configured*
* *Support Option 3 DCI direct indication of HARQ feedback enable/disable in case only DCI solution enabling/disabling signaling is configured*
* *Support Option 3 DCI indication to override Option 1 configuration for corresponding transmission in case both per-HARQ process bitmap and DCI solution enabling/disabling signaling are configured*
	+ *FFS #1: Option 3 DCI-based overridden mechanism is applied to both semi-statically HARQ feedback enabled and disabled processes or only applied to semi-statically HARQ feedback disabled processes or only applied to semi-statically HARQ feedback enabled processes.*
	+ *FFS #2: whether/how to support Option 3 overriding Option 1 configuration for corresponding transmission for multiple TBs scheduled by single DCI*
	+ *FFS#3：Option 3 DCI-based overridden mechanism is DCI signaling to reverse the HARQ feedback enable/disable for the corresponding transmission from per-HARQ process RRC configuration or DCI signaling to directly indicate the HARQ feedback enable/disable for the corresponding transmission regardless of per-HARQ process RRC configuration.*

*RAN1 strives to have a common design (in terms of DCI design, PDCCH monitoring, etc.) for “Option 3” and “Option 3 + Option 1”.*

*For eMTC NTN, to configure/indicate enabling/disabling of HARQ feedback for downlink transmission, take Option 1 for CE Mode A.*

*Agreement*

*For DCI-based overridden/direct indication, down select one of the following based on the criteria DCI overhead, PDCCH monitoring behavior, impact on scheduling flexibility, UE implementation complexity, etc*

* *Option 1: Indication by adding one field in DCI*
* *Option 2: Indication by reusing/reinterpreting existing field in DCI*

**RAN1-112bis-e**

*Agreement*

*For Option 3 DCI indication:*

* *Option A: when both per-HARQ process bitmap and DCI solution enabling/disabling signaling are configured*
	+ *DCI-based overridden mechanism is DCI signaling to reverse the HARQ feedback enable/disable for the corresponding transmission from per-HARQ process RRC configuration*
		- *For single TB scheduled by DCI, the DCI based overridden indication is applied to one of the following options (to be down-selected):*
			* *Option A-1: only applied to semi-statically HARQ disabled processes*
			* *Option A-4: applied to both semi-statically HARQ disabled and enabled processes*
		- *FFS for multiple TBs scheduled by single DCI*
* *Option B: DCI-based HARQ enabling/disabling direct indication in case DCI solution enabling/disabling signaling is configured and per-HARQ process bitmap signaling is not configured (i.e. no bitmap is configured)*
	+ *DCI-based mechanism is DCI signaling to directly indicate the HARQ feedback enable/disable for the corresponding transmission*
		- *For single TB scheduled by DCI, DCI-based direct indication is applied to the scheduled TB*
		- *FFS for multiple TBs scheduled by single DCI*

*Agreement*

*For single TB scheduled by DCI, for DCI-based direct indication, down select one of the following based on the criteria DCI overhead, PDCCH monitoring behavior, impact on scheduling flexibility, UE implementation complexity, etc*

* *Option 1: Indication by adding one field in DCI (e.g., 1-bit)*
	+ *Note: Other fields in DCI are the same as legacy.*
* *Option 2: Indication by reusing/reinterpreting existing field in DCI*
	+ *Option 2A: HARQ-ACK related field*
		- *For eMTC CE mode B, one state of “HARQ-ACK resource offset” field in DCI format 6-1B is used for indication of HARQ feedback disabled, other states are used for indication of HARQ feedback enabled and corresponding HARQ-ACK resource.*
			* *FFS: detailed state*
		- *For NBIoT, one state of “HARQ-ACK resource” field in DCI format N1 is used for indication of HARQ feedback disabled, other states are used for indication of HARQ feedback enabled and corresponding HARQ-ACK resource.*
			* *FFS: detailed state*
	+ *Option 2B: MCS or repetition number field*
		- *Reduce 1bit of legacy MCS or repetition number field and add 1bit new field in DCI format 6-1B and N1 to indicate the HARQ feedback enabled/disabled*
			* *FFS: detailed for interpreting of the reduced MCS or repetition number field*
	+ *Option 2C: HARQ-ACK related field v2*
		- *For eMTC CE mode B, reduce 1bit of legacy “HARQ-ACK resource offset” field and add 1bit new field in DCI format 6-1B to indicate the HARQ feedback enabled/disabled*
			* *FFS: detailed for interpreting of the reduced “HARQ-ACK resource offset” field*
		- *For NBIoT, reduce 1bit of legacy “HARQ-ACK resource” field and add 1bit new field in DCI format N1 to indicate the HARQ feedback enabled/disabled*
			* *FFS: detailed for interpreting of the reduced “HARQ-ACK resource” field*
	+ *Option 2D: Other indication by reusing/reinterpreting existing field*

**RAN1-113**

***Working assumption***

*For DCI-based direct indication in single TB scheduled by DCI,*

* *Indication by reusing/reinterpreting HARQ-ACK related field in DCI*
	+ - *For eMTC CE mode B, one state of “HARQ-ACK resource offset” field in DCI format 6-1B is used for indication of HARQ feedback disabled, other states are used for indication of HARQ feedback enabled and corresponding HARQ-ACK resource.*
			* *FFS: detailed state, and whether this state is different across different UEs*
		- *For NBIoT, one state of “HARQ-ACK resource” field in DCI format N1 is used for indication of HARQ feedback disabled, other states are used for indication of HARQ feedback enabled and corresponding HARQ-ACK resource.*
			* *FFS: detailed state, and whether this state is different across different UEs*
* *If reusing/reinterpreting HARQ-ACK related field in DCI is also used for DCI overriding scheme, the interpretation of the state can be different than for DCI-based direct indication.*

***Agreement***

*For single TB scheduled by DCI,*

* *Working assumption 1 DCI based overridden indication is applied to both semi-statically HARQ disabled and enabled processes*
	+ *For DCI based overridden indication, adopt indication by reusing/reinterpreting HARQ-ACK related field in DCI*
		- *For eMTC CE mode B, “HARQ-ACK resource offset” field in DCI format 6-1B is used for indication of maintaining/reversing the HARQ feedback enable/disable for the corresponding transmission from per-HARQ process RRC configuration and corresponding HARQ-ACK resource in case of indication of HARQ feedback enabled.*
			* *HARQ feedback disabled is reversed to enabled in case of any states other than state A in “HARQ-ACK resource offset”, otherwise is maintained as disabled.*
			* *HARQ feedback enabled is maintained in case of any states other than state A in “HARQ-ACK resource offset”, otherwise is reversed to disabled.*
				+ *FFS: detailed state A, and whether this state A is different across different UEs*
		- *For NBIoT, “HARQ-ACK resource” field in DCI format N1 is used for indication of maintaining/reversing the HARQ feedback enable/disable for the corresponding transmission from per-HARQ process RRC configuration and corresponding HARQ-ACK resource in case of indication of HARQ feedback enabled.*
			* *The same DCI indication functionality as eMTC is adopted.*
* *Working assumption 2 For Option 1 + Option 3 DCI based overridden mechanism, for a HARQ process configured as HARQ feedback disabled by per-HARQ process bitmap signaling and further reversed to HARQ feedback enabled by DCI, the NBIoT UE does not wait for an RTT+3ms (i.e., till subframe n+Kmac+3 in TS36.213 section 16.6) before monitoring NPDCCH for the same HARQ process (or monitoring any NPDCCH for the case of single HARQ process configuration).*
* *Send an LS to RAN2 with the following contents:*
	+ *RAN1 respectfully ask RAN2 for the feasibility of Working assumption 2 (taking into account potential RAN2 spec impact).*

***Agreement***

*The draft LS in R1-2306205 is endorsed. Final LS in R1-2306245.*

***Agreement***

*For the RRC configuration of DCI solution enabling/disabling of HARQ feedback for NB-IoT and LTE-MTC in CE Mode B, the RRC configuration is UE-specific.*

***Agreement***

*for NB-IoT and LTE-MTC in CE Mode B, if multiple TBs is configured, for DCI-based HARQ enabling/disabling direct indication in multiple TBs scheduled by single DCI, the same indication is applied to all scheduled TBs, i.e. HARQ is enabled or disabled for all TBs.*

**RAN1-114**

*Agreement*

*Confirm the following working assumption:*

*Working assumption*

*For DCI-based direct indication in single TB scheduled by DCI,*

* *Indication by reusing/reinterpreting HARQ-ACK related field in DCI*
	+ - *For eMTC CE mode B, one state of “HARQ-ACK resource offset” field in DCI format 6-1B is used for indication of HARQ feedback disabled, other states are used for indication of HARQ feedback enabled and corresponding HARQ-ACK resource.*
			* *FFS: detailed state, and whether this state is different across different UEs*
		- *For NBIoT, one state of “HARQ-ACK resource” field in DCI format N1 is used for indication of HARQ feedback disabled, other states are used for indication of HARQ feedback enabled and corresponding HARQ-ACK resource.*
			* *FFS: detailed state, and whether this state is different across different UEs*
* *If reusing/reinterpreting HARQ-ACK related field in DCI is also used for DCI overriding scheme, the interpretation of the state can be different than for DCI-based direct indication.*

*For single TB scheduled by DCI,*

* *Working assumption 1 DCI based overridden indication is applied to both semi-statically HARQ disabled and enabled processes*
	+ *For DCI based overridden indication, adopt indication by reusing/reinterpreting HARQ-ACK related field in DCI*
		- *For eMTC CE mode B, “HARQ-ACK resource offset” field in DCI format 6-1B is used for indication of maintaining/reversing the HARQ feedback enable/disable for the corresponding transmission from per-HARQ process RRC configuration and corresponding HARQ-ACK resource in case of indication of HARQ feedback enabled.*
			* *HARQ feedback disabled is reversed to enabled in case of any states other than state A in “HARQ-ACK resource offset”, otherwise is maintained as disabled.*
			* *HARQ feedback enabled is maintained in case of any states other than state A in “HARQ-ACK resource offset”, otherwise is reversed to disabled.*
				+ *FFS: detailed state A, and whether this state A is different across different UEs*
		- *For NBIoT, “HARQ-ACK resource” field in DCI format N1 is used for indication of maintaining/reversing the HARQ feedback enable/disable for the corresponding transmission from per-HARQ process RRC configuration and corresponding HARQ-ACK resource in case of indication of HARQ feedback enabled.*
			* *The same DCI indication functionality as eMTC is adopted.*

*Agreement*

*For DCI-based direct indication in multiple TBs scheduled by single DCI, reuse/reinterpret the HARQ-ACK related field in corresponding DCI for indication of HARQ feedback enabled/disabled.*

* *The same DCI direct indication functionality as single TB scheduled by DCI scenarios. (i.e., same state of HARQ related field is used)*

*Agreement*

*For the DCI based overridden indication for multiple TBs scheduled by single DCI,*

* *reuse/reinterpret the HARQ-ACK related field in corresponding DCI for overridden indication of HARQ feedback enabled/disabled.*
	+ *The same DCI overridden indication functionality as single TB scheduled by DCI scenarios.*
		- *This implies that all scheduled TBs by single DCI are HARQ feedback enabled or HARQ feedback disabled by the DCI overridden indication.*

*Agreement*

*For both RRC bitmap-based solution and DCI-based solutions (i.e., DCI-based direct indication and DCI-based overridden indication),*

* *For LTE-MTC/NB-IoT multiple TBs scheduled by single DCI without HARQ-ACK bundling,*
	+ *HARQ feedback is reported for each TB at least in case that all TBs scheduled by single DCI are configured/indicated as HARQ feedback enabled.*
	+ *HARQ feedback is not reported at least in case all TBs scheduled by single DCI are configured/indicated as HARQ feedback disabled.*
* *For LTE-MTC/NB-IoT multiple TBs scheduled by single DCI with HARQ-ACK bundling,*
	+ *bundled HARQ feedback is reported at least in case that all TBs scheduled by single DCI are configured/indicated as HARQ feedback enabled.*
	+ *HARQ feedback is not reported at least in case all TBs scheduled by single DCI are configured/indicated as HARQ feedback disabled.*

*Agreement*

*For LTE-MTC/NB-IoT, for the multiple TBs scheduled by single DCI with only RRC bitmap-based solution configuration, down select one of the options at RAN1#114.*

* *Option 2: Support mixed HARQ feedback enabled/disabled configuration, and in case of mixed HARQ feedback enabled/disabled configuration,*
	+ *Option 2a: HARQ feedback is always reported based on the decoding results of corresponding transmission for all scheduled TBs for both HARQ-ACK bundling and non-HARQ-ACK bundling cases.*
	+ *Option 2c: HARQ feedback is reported or not for all scheduled TBs depending on the HARQ feedback enabled/disabled configuration of the TB with the lowest HARQ process number among scheduled TBs for both HARQ-ACK bundling and non-HARQ-ACK bundling cases.*
	+ *Option 2d: HARQ feedback is reported for TB with HARQ feedback enabled configuration and ACK is reported for TB with HARQ feedback disabled configuration for both HARQ-ACK bundling and non-HARQ-ACK bundling cases.*
	+ *Option 2e: HARQ feedback is reported for TB with HARQ feedback enabled configuration.*
		- *Without HARQ-ACK bundling*
			* *HARQ feedback is not reported for TB with HARQ feedback disabled configuration.*
			* *HARQ timing for TBs with HARQ feedback enabled configuration does not count the legacy HARQ-ACK resource/HARQ timing adopted for TBs with HARQ feedback disabled configuration.*
		- *With HARQ-ACK bundling*
			* *HARQ feedback is not reported for TB with HARQ feedback disabled configuration.*
				+ *Mapping of TBs to bundles is done as per legacy (i.e., TS36.213 Table 7.3-1 for LTE-MTC) based on all scheduled TBs.*
				+ *The TB with HARQ feedback disabled configuration does not count in the HARQ bundling (i.e., it is not part of the logical AND operation). If all TBs in a bundle have HARQ feedback disabled, the UE does not send HARQ-ACK corresponding to this TB bundle.*
				+ *HARQ timing for bundles for which HARQ-ACK feedback is sent do not count the legacy HARQ-ACK resource/HARQ timing adopted for bundles for which HARQ-ACK feedback is not sent.*
* *Note: mixed HARQ feedback enabled/disabled configuration means among TBs scheduled by single DCI, some TBs are RRC configured as HARQ feedback enabled, and the other TBs are RRC configured as HARQ feedback disabled.*

*Agreement*

*For LTE-MTC/NB-IoT, for the multiple TBs scheduled by single DCI with only RRC bitmap-based solution configuration and with mixed HARQ feedback enabled/disabled scheduling*

* *Without HARQ-ACK bundling*
	+ *HARQ feedback is not reported for TB with HARQ feedback disabled configuration.*
	+ *HARQ timing for TBs with HARQ feedback enabled configuration does not count the legacy HARQ-ACK resource/HARQ timing adopted for TBs with HARQ feedback disabled configuration. (Option 2e)*
* *With HARQ-ACK bundling*
	+ *Option 2f-b: ACK is reported for TB with HARQ feedback disabled configuration for HARQ-ACK bundling. No change to HARQ feedback timeline. (Option 2d)*

*Agreement*

*For DCI-based direct/overridden indication, for the state of HARQ-related field (i.e., “HARQ-ACK resource offset” field for eMTC, “HARQ-ACK resource” field for NBIoT) in DCI to indicate the HARQ feedback enabled/disabled.*

* *Option 1: one common state is used for all UEs*
	+ *Option 1-1: the state of indication of HARQ feedback disabled and state A are state of “11” for eMTC and state of “1111” for NB-IoT (i.e., for both 3.75kHz and 15kHz subcarrier spacing) respectively.*

**RAN1-114bis**

*Agreement*

*Confirm the following working assumptions from RAN1#113:*

*For single TB scheduled by DCI,*

* *Working assumption 2 For Option 1 + Option 3 DCI based overridden mechanism, for a HARQ process configured as HARQ feedback disabled by per-HARQ process bitmap signaling and further reversed to HARQ feedback enabled by DCI, the NBIoT UE does not wait for an RTT+3ms (i.e., till subframe n+Kmac+3 in TS36.213 section 16.6) before monitoring NPDCCH for the same HARQ process (or monitoring any NPDCCH for the case of single HARQ process configuration).*

*Agreement*

*The TP1b in section 13 of* [*R1-2310356*](https://ericsson-my.sharepoint.com/personal/gerardo_agni_medina_acosta_ericsson_com/Documents/Documents/3GPP_RAN1_Delegate/RAN1_115_Chicago/Docs/R1-2310356.zip) *is endorsed for TS36.213 clause 7.3.*

*Agreement*

*The TP2b in* [*R1-2310356*](https://ericsson-my.sharepoint.com/personal/gerardo_agni_medina_acosta_ericsson_com/Documents/Documents/3GPP_RAN1_Delegate/RAN1_115_Chicago/Docs/R1-2310356.zip) *is endorsed for TS36.213 clause 16.4.2.*

*Agreement*

*There is ambiguity for definition of NTB in clause 7.1.7.1 and 10.2 as follows:*

* *For clause 10.2: NTB is the number of TBs with HARQ feedback enabled*
* *For clause 7.1.7.1: NTB is the number of scheduled TBs*

*It is recommended to the spec editor of TS36.213 to resolve that ambiguity accounting for HARQ feedback enabling/disabling.*

**RAN1-115**

*Agreement*

*When multiple TBs are scheduled by a single DCI:*

* *For Option 1 + Option 3 DCI based overridden mechanism, when DCI indicates HARQ feedback enabled, then the NB-IoT UE always wait for an RTT+3ms (i.e., till subframe n+Kmac+3 in TS36.213 section 16.6) before monitoring NPDCCH.*

*Agreement*

*It is up to editor to select TP 2-2b or TP 2-3a in section 7 of* [*R1-2312389*](../Docs/R1-2312389.zip) *to be endorsed for TS36.213 clause 7.3.*

*Agreement*

*The TP 4-1c in section 8 of* [*R1-2312460*](../Docs/R1-2312460.zip) *is endorsed for TS36.213 clause 7.3.1.*

This document provides the proposals and summary of discussions with detailed proposals from each company listed in appendix according to the inputs. Companies are encouraged to provide the inputs in the discussion.

# [Active] Capture NPDCCH monitoring behavior for multiple TBs scheduling

To align the UE behavior for multiple TBs scheduled by single DCI, it was agreed that UE always wait for RTT+3ms for multiple TBs are scheduled with the following agreement in RAN1-115.

*Agreement*

*When multiple TBs are scheduled by a single DCI:*

* *For Option 1 + Option 3 DCI based overridden mechanism, when DCI indicates HARQ feedback enabled, then the NB-IoT UE always wait for an RTT+3ms (i.e., till subframe n+Kmac+3 in TS36.213 section 16.6) before monitoring NPDCCH.*

Due to some misunderstanding for above agreement last Email discussion, the corresponding CR (TP) was not endorsed. As commented by [Lenovo, Nokia, Ericsson, Huawei, Qualcomm] in RAN1-116 meeting contributions, the following Table 1 understanding seems to be common among the groups.

Table 1 NPDCCH monitoring behavior for DCI based overridden mechanism

|  |  |  |
| --- | --- | --- |
| UE is **NOT** configured with *npdsch-MultiTB-Config* | **Single** TBs are scheduled by a single DCI | [Agreement in RAN1-114bis] For single TB scheduled by DCI, * Working assumption 2 For Option 1 + Option 3 DCI based overridden mechanism, for a HARQ process configured as HARQ feedback disabled by per-HARQ process bitmap signaling and further reversed to HARQ feedback enabled by DCI, the NBIoT UE does not wait for an RTT+3ms (i.e., till subframe n+Kmac+3 in TS36.213 section 16.6) before monitoring NPDCCH for the same HARQ process (or monitoring any NPDCCH for the case of single HARQ process configuration).

**Understanding*** **Single** TBs are scheduled by a single DCI (No matter that *npdsch-MultiTB-Config* is configured or not)
	+ RRC Disabled + DCI override to Enabled🡪 UE does **NOT** wait for an RTT+3ms (New behavior)
	+ RRC Enabled + DCI maintain to Enabled 🡪 UE does wait for an RTT+3ms (Legacy behavior)
 |
| UE is configured with *npdsch-MultiTB-Config* |
| **Multiple** TBs are scheduled by a single DCI | [Agreement in RAN1-115] When multiple TBs are scheduled by a single DCI:* For Option 1 + Option 3 DCI based overridden mechanism, when DCI indicates HARQ feedback enabled, then the NB-IoT UE always wait for an RTT+3ms (i.e., till subframe n+Kmac+3 in TS36.213 section 16.6) before monitoring NPDCCH.

**Understanding*** **Multiple** TBs are scheduled by a single DCI (*npdsch-MultiTB-Config* is configured)
* RRC Enabled/Disabled + DCI indicate to Enabled 🡪 UE does wait for an RTT+3ms (Legacy behavior)
 |

In order to capture the above UE NPDCCH monitoring behavior, especially for multiple TB scheduled cases to TS36.213, several TPs are proposed this meeting.

TP1-1a Lenovo R1-2400873, Qualcomm R1-2401421 (Correct one typo “in”🡪“is” by FL)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|

|  |  |
| --- | --- |
| **Reason for change:** | Clarify that when multiple TBs are scheduled by a single DCI and DCI indicates HARQ feedback enabled, then the NB-IoT UE always wait for an RTT+3ms (i.e., till subframe n+Kmac+3) before monitoring NPDCCH in clause 16.6. |
|  |  |
| **Summary of change:** | Added condition that NB-IoT UE always wait for an RTT+3ms (i.e., till subframe n+Kmac+3) before monitoring NPDCCH when multiple TBs are scheduled by a single DCI and DCI indicates HARQ feedback enabled. |
|  |  |
| **Consequences if not approved:** | NB-IoT UE will need to monitor NPDCCH during RTT+3ms (i.e., till subframe n+Kmac+3) when multiple TBs are scheduled by a single DCI and DCI indicates HARQ feedback enabled. |

TS36.213<Unchanged parts are omitted>16.6 Narrowband physical downlink control channel related proceduresThroughout this clause, if a NB-IoT UE is configured with higher layer parameter *k-Mac*, *K*mac = *k-Mac* otherwise, *K*mac = 0.<Unchanged parts are omitted>If a NB-IoT UE is configured with higher layer parameter *twoHARQ-ProcessesConfig*- and if the UE has a NPUSCH transmission ending in subframe *n*,- the UE is not required to receive transmissions in the Type B half-duplex guard periods as specified in [3]for FDD ; and- the UE is not expected to receive an NPDCCH with DCI format N0/N1 for the same HARQ process ID as the NPUSCH transmission in any subframe starting from subframe n+1 to subframe n+3, or in a NTN serving cell, in any downlink subframe that overlaps with uplink subframe *n*+1 to subframe *n*+*K*mac+3 except if the UE is configured with higher layer parameter *uplinkHARQ-mode* set to ‘*HARQModeB*’ for the same HARQ process ID, or if the NPUSCH transmission carries ACK/NACK response, as determined in clause 16.4.2, for the same HARQ process ID associated with a transport block scheduled in a NPDCCH indicating a single transport block is scheduled, and the UE is configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-Bitmap-NB* indicating disabled HARQ-ACK information for the same HARQ process ID and configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-DCI-NB;*else if the UE is not using higher layer parameter *edt-Parameters* or if the UE is using higher layer parameter *edt-Parameters* and  - if the NB-IoT UE has a NPUSCH transmission ending in subframe *n*, - the UE is not required to receive transmissions in the Type B half-duplex guard periods as specified in [3] for FDD; and - the UE is not required to monitor NPDCCH in any subframe starting from subframe *n+1* to subframe *n+3* or in a NTN serving cell, in any downlink subframe that overlaps with uplink subframe *n*+*1* to subframe *n*+*K*mac+3 except if the UE is configured with higher layer parameter *uplinkHARQ-mode* set to ‘*HARQModeB*’, or if the NPUSCH transmission carries ACK/NACK response as determined in clause 16.4.2 and the UE is configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-Bitmap-NB* indicating disabled HARQ-ACK information and configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-DCI-NB*. <Unchanged parts are omitted> |

TP1-2a Ericsson R1-2401193 (Add the cover page by FL)

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| **Reason for change:** | Clarify that when multiple TBs are scheduled by a single DCI and DCI indicates HARQ feedback enabled, then the NB-IoT UE always wait for an RTT+3ms (i.e., till subframe n+Kmac+3) before monitoring NPDCCH in clause 16.6. |
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| **Summary of change:** | Added condition that NB-IoT UE always wait for an RTT+3ms (i.e., till subframe n+Kmac+3) before monitoring NPDCCH when multiple TBs are scheduled by a single DCI and DCI indicates HARQ feedback enabled. |
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| **Consequences if not approved:** | NB-IoT UE will need to monitor NPDCCH during RTT+3ms (i.e., till subframe n+Kmac+3) when multiple TBs are scheduled by a single DCI and DCI indicates HARQ feedback enabled. |

TS36.21316.6 Narrowband physical downlink control channel related procedures------------------------------------------------ Text Omitted ----------------------------------------------------------If a NB-IoT UE is configured with higher layer parameter *twoHARQ-ProcessesConfig*- and if the UE has a NPUSCH transmission ending in subframe *n*,- the UE is not required to receive transmissions in the Type B half-duplex guard periods as specified in [3]for FDD ; and- the UE is not expected to receive an NPDCCH with DCI format N0/N1 for the same HARQ process ID as the NPUSCH transmission in any subframe starting from subframe n+1 to subframe n+3, or in a NTN serving cell, in any downlink subframe that overlaps with uplink subframe *n*+1 to subframe *n*+*K*mac+3 except if the UE is configured with higher layer parameter *uplinkHARQ-mode* set to ‘*HARQModeB*’ for the same HARQ process ID, or if the NPUSCH transmission carries ACK/NACK response, as determined in clause 16.4.2, for the same HARQ process ID associated with an NPDCCH scheduling a single transport block, and the UE is configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-Bitmap-NB* indicating disabled HARQ-ACK information for the same HARQ process ID and configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-DCI-NB;*---------------------------------------------- Text End ------------------------------------------------------------------- |

TP1-3a Huawei R1-2401380 (Update with “Change mode” by FL)

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| **Reason for change:** | In RAN1#115, the UE behaviour to NPDCCH monitoring after NPUSCH format 2 carrying HARQ-ACK feedback corresponding to a NPDSCH carrying two TBs scheduled by single DCI was agreed when both *downlinkHARQ-FeedbackDisabled-Bitmap-NB* and *downlinkHARQ-FeedbackDisabled-DCI-NB* are configured. The UE always waits for an RTT+3ms (i.e., till subframe n+Kmac+3 in TS36.213 section 16.6) before monitoring NPDCCH after the ending of NPUSCH format 2 irrespectively of the configuration of *downlinkHARQ-FeedbackDisabled-Bitmap-NB*. |
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| **Summary of change:** | Restrict the NPDCCH monitoring exemption rules after NPUSCH format 2 corresponding NPDSCH carrying single TB.  |
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| **Consequences if not approved:** | The agreement in RAN1#115 on NPDCCH monitoring restriction for UE configured with DCI based overridden mechanism of HARQ disabling is not captured for the case when multiple TBs are scheduled by a single DCI. |

TP for clause 16.6 of TS 36.213<Unchanged parts are omitted>If a NB-IoT UE is configured with higher layer parameter *twoHARQ-ProcessesConfig*- and if the UE has a NPUSCH transmission ending in subframe *n*,- the UE is not required to receive transmissions in the Type B half-duplex guard periods as specified in [3]for FDD ; and- the UE is not expected to receive an NPDCCH with DCI format N0/N1 for the same HARQ process ID as the NPUSCH transmission in any subframe starting from subframe n+1 to subframe n+3, or in a NTN serving cell, in any downlink subframe that overlaps with uplink subframe *n*+1 to subframe *n*+*K*mac+3 except if the UE is configured with higher layer parameter *uplinkHARQ-mode* set to ‘*HARQModeB*’ for the same HARQ process ID, or if the NPUSCH transmission carries ACK/NACK response, as determined in clause 16.4.2, for the same HARQ process ID, and the UE is configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-Bitmap-NB* indicating disabled HARQ-ACK information for the same HARQ process ID and configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-DCI-NB,* and the field of *Number of scheduled TB for Unicast* in the scheduling DCI is set to 0*;*else if the UE is not using higher layer parameter *edt-Parameters* or if the UE is using higher layer parameter *edt-Parameters* and  - if the NB-IoT UE has a NPUSCH transmission ending in subframe *n*, - the UE is not required to receive transmissions in the Type B half-duplex guard periods as specified in [3] for FDD; and - the UE is not required to monitor NPDCCH in any subframe starting from subframe *n+1* to subframe *n+3* or in a NTN serving cell, in any downlink subframe that overlaps with uplink subframe *n*+*1* to subframe *n*+*K*mac+3 except if the UE is configured with higher layer parameter *uplinkHARQ-mode* set to ‘*HARQModeB*’, or if the NPUSCH transmission carries ACK/NACK response as determined in clause 16.4.2 and the UE is configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-Bitmap-NB* indicating disabled HARQ-ACK information and configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-DCI-NB,* and the field of *Number of scheduled TB for Unicast* in the scheduling DCI is set to 0. <Unchanged parts are omitted> |

Question 1: do you think the understanding by FL in Table 1 is correct, if yes, do you agree with any TPs (e.g., TP 1-1a, TP1-2a, TP1-3a) above?

Please provide your views and comments.

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| **Company** | **Comments and Views** | **Preferred TP**  |
| Ericsson | We think that “TP 1-1a” is too lengthy and a bit redundant. Thus, we prefer a simplified version of the sentence intended to be added as per “TP1-2a,” or “TP1-3a” which perhaps is a more formal way of capturing it (TS 36.212 can cited in this case). | Either “TP1-2a” or “TP1-3a” |
| Lenovo | For TP1-2a proposed by E///, “the same HARQ process ID associated with an NPDCCH” seems not accurate since when the UE is scheduled with 2 TB by single DCI, the DCI is associated with 2 TB and 2 HARQ process (?), so we can’t say a HARQ process is associated with a DCI, a HARQ process is only associated with a transport block.For TP1-3a proposed by Huawei, the field of *Number of scheduled TB for Unicast* is only present when multiple TB feature is configured. However, the text of clause 16.6 is also adopted to single TB scheduled cases (e.g., multiple TB feature is NOT configured).TS36.212Number of scheduled TB for Unicast – 1 bit, where value 0 indicates a single TB is scheduled and value 1 indicates multiple TB are scheduled. This field is only present if higher layer parameter *npdsch-MultiTB-Config* is enabled and the corresponding DCI is mapped onto the UE specific search space given by the C-RNTI as defined in [3] | TP1-1a |
| QC | Same view as Lenovo | TP1-1a |

# [Active] Clarify DCI field adopted to all scheduled TBs

In RAN1 #113 and #114 meeting, the following agreements were reached regarding the disabling HARQ feedback indication in the DCI for multiple TBs scheduling.

Agreements(#113)

*For NB-IoT and LTE-MTC in CE Mode B, if multiple TBs is configured, for DCI-based HARQ enabling/disabling direct indication in multiple TBs scheduled by single DCI, the same indication is applied to all scheduled TBs, i.e. HARQ is enabled or disabled for all TBs.*

*Agreement*(#114)

*For the DCI based overridden indication for multiple TBs scheduled by single DCI,*

* *Reuse/reinterpret the HARQ-ACK related field in corresponding DCI for overridden indication of HARQ feedback enabled/disabled.*
	+ *The same DCI overridden indication functionality as single TB scheduled by DCI scenarios.*
		- *This implies that all scheduled TBs by single DCI are HARQ feedback enabled or HARQ feedback disabled by the DCI overridden indication.*

However, as commented by [NEC], these agreements were not covered in the existing specification. According to the agreement, the 1 bit disabled HARQ-ACK feedback indication in the DCI is the same and applied to all the scheduled TBs. That is, the HARQ-ACK feedback indication (whether disabled or enabled) remains consistent across all scheduled multiple TBs. Based on the above, [NEC] further proposes the corresponding TP.

TP2-1a NEC R1-2400470 (Cover page TBD)

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| **Reason for change:** |  |
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| **Summary of change:** |  |
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| **Consequences if not approved:** |  |

TP for TS36.2125.3.3.1.13 Format 6-1B**<Unchanged parts are omitted>**- HARQ-ACK resource offset – 0 or 2 bits as defined in clause 10.1 of [3] (this field is 0 bits if Information for SC-MCCH change notification is present). If *downlinkHARQ-FeedbackDisabled-DCI* is configured, or if *downlinkHARQ-FeedbackDisabled-Bitmap* and *downlinkHARQ-FeedbackDisabled-DCI* are configured, and the value is ‘3’, it functions as a HARQ feedback disabled indicator as defined in clause 7.3 of [3]. If multiple TBs are scheduled, this field is applied to all the scheduled TBs.6.4.3.2 DCI Format N1**<Unchanged parts are omitted>**- HARQ-ACK resource – 4 bits as defined in clause 16.4.2 of [3]. If *downlinkHARQ-FeedbackDisabled-DCI-NB* is configured, or if *downlinkHARQ-FeedbackDisabled-Bitmap-NB* and *downlinkHARQ-FeedbackDisabled-DCI-NB* are configured, and the value is ‘15’, it functions as a HARQ feedback disabled indicator. If multiple TBs are scheduled, this field is applied to all the scheduled TBs. |

As the FL’s understanding, in case that the field of HARQ-ACK resource in DCI Format N1 functions as a HARQ feedback disabled indicator (no matter that single TB or multiple TBs are scheduled by the DCI), UE will not generate/report HARQ-ACK for corresponding PDSCH as specified in TS36.213 Clause 16.4.2 as highlighted part. So if multiple TBs are scheduled, the field of HARQ-ACK resource (as a function of a HARQ feedback disabled indicator) is applied to all scheduled TBs, and the field of HARQ-ACK resource (as a function of legacy HARQ-ACK resource) is specified in TS36.213 Clause 16.4.2 as highlighted part, so the field of HARQ-ACK resource is adopted to multiple TBs cases if scheduled, which has already been captured in TS36.213 implicitly.

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| 16.4.2 UE procedure for reporting ACK/NACKThe UE shall upon detection of a NPDSCH transmission ending in NB-IoT subframe *n* intended for the UE and for which an ACK/NACK shall be provided, start, after the end of -  DL subframe for FDD,-  NB-IoT UL subframes following the end of n+12 subframe for TDD,transmission of the NPUSCH carrying ACK/NACK response, and SR (if any) if the serving cell is FDD and the UE is configured with higher layer parameter *sr-with-HARQ-ACK-Config*, using NPUSCH format 2 in *N* consecutive NB-IoT UL slots, where**<Text are omitted>**- allocated subcarrier for ACK/NACK and value of *k0* is determined by the ACK/NACK resource field in the DCI format of the corresponding NPDCCH according to Table 16.4.2-1, and Table 16.4.2-2,- for FDD, .- for TDD, .- For - if the UE is configured with higher layer parameter *harq-AckBundling* in *npdsch-MultiTB-Config*, and the NPDSCH corresponding to a NPDCCH with DCI CRC scrambled by C-RNTI,- if the UE is in a NTN serving cell and if the UE is not configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-DCI-NB* and configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-Bitmap-NB* indicating disabled HARQ-ACK information for a HARQ process associated with a transport block in the NPDSCH, the UE shall generate an ACK for HARQ-ACK corresponding to the transport block- the ACK/NACK response is generated by performing a logical AND operation of HARQ-ACKs corresponding to the TB*r+*1 , - otherwise,- if - the ACK/NACK response is the HARQ-ACK corresponding to the transport block associated with the HARQ process with enabled HARQ-ACK information- otherwise- NB-IoT UL slots  with  of the NPUSCH carry ACK/NACK response for TB*r+*1 ,except if the UE is in a NTN serving cell, and the UE is not configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-DCI-NB* and configured with higher layer parameter *downlinkHARQ-FeedbackDisabled-Bitmap-NB* indicating disabled HARQ-ACK information for all HARQ process(es) associated with transport block(s) in the NPDSCH, or the HARQ-ACK Resource field functions as HARQ feedback disabled indicator in DCI format N1 as specified in [4] in the NPDCCH corresponding to the NPDSCH. |

Question 2: do you think the clarification proposed by NEC (R1-2400470) is reasonable/needed, if yes, do you agree with TP proposed by NEC (e.g., TP 2-1a) above?

Please provide your views and comments.

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| **Company** | **Comments and Views** |
| Ericsson | In our understanding what has been brought up by NEC is an implicit aspect in the procedures described in 16.4.2.If this were intended to be explicitly clarified as per NEC’s intention, we think that in any case the proposed CR needs to be revised as to make the update applicable for the Disabling HARQ feature (i.e., not in general) and we would need to cite the Information Element of Multi-TB grant (e.g., *ce-PDSCH-MultiTB-Config*). |
| QC | We think 213 already captures the behavior described by NEC, as highlighted by FL. Therefore we do not think this CR is needed. |

# Proposals for discussion at Offline 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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