3GPP TSG-RAN WG1 Meeting #102-e R1-20xxxxx

e-Meeting, August 17th – 28th 2020

Agenda Item: 8.9.2

Source: Moderator (Ericsson)

Title: Feature Lead Summary: [102-e-LTE-Rel17\_NB\_IoT\_eMTC-02]

Document for: Discussion and Decision

# 1 Introduction

In the Work Item (WI) on “Additional enhancements for NB-IoT and LTE-MTC” [1], one of the objectives is to specify the following enhancement for LTE-MTC:

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| --- |
| * Support additional PDSCH scheduling delay for introduction of 14-HARQ processes in DL, for HD-FDD Cat M1 UEs. [LTE-MTC] [RAN1] |

This feature lead summary (FLS) collects companies’ views as described in [2-8], classifies technical areas according with the contents in the contributions, and provides potential agreements.

# 2 FLS on 14 HARQ processes in DL in LTE-MTC

## 2.1 Indication of the support of 14 HARQ processes

Background: There is a common view in [4], and [8] that a new UE capability should be introduced to indicate to the network if the UE can support 14-HARQ processes.

The related proposals are shown below:

|  |  |
| --- | --- |
| Company | View |
| Nokia, Nokia Shanghai Bell [4] | Proposal 1: A new UE-EUTRA-capability, ce-PDSCH-FourteenProcesses, is used by UEs to indicate to the network if they can support 14-HARQ processes. |
| Qualcomm Incorporated [8] | Proposal 1: Introduce support of 14 DL HARQ processes for HD-FDD eMTC UEs in CE mode A as follows:  • Introduce a new optional UE capability to indicate support of 14 HARQ processes. |

**Potential Working Assumption 1:**

**Introduce a new optional UE capability to indicate support of 14 HARQ processes**

**Note: The Working Assumption is to be confirmed once RAN1 has selected a 14 HARQ scheme and RAN2 has confirmed that there are no concerns on the working assumption.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree?** | **Comments** |
| Qualcomm | Yes (but see comments) | We dont see a need for RAN2 confirmation. I think we should also be able to make this an agreement, but if peopel feel more comfortable with WA we are OK. |
| ZTE | Yes | Fine with agreement |
| Lenovo&MotoM | Yes | We agree RAN2 confirmation. It seems RAN1 has no chioce and [RAN1 has selected a 14 HARQ scheme] is not needed. |
| Ericsson | Ok | UE capability discussions can usually be handled towards the end of the release (as part of the UE feature list to RAN2), but if appears to be a possible consensus early on, then we can be ok with the Working Assumption. |
| Nokia | Ok | Fine with the WA. |
| Huawei, HiSilicon | OK (see comments) | We have similar view as QC that we didn’t see the necessicity for RAN2 confirmation, and it can be an agreement. In addition, it seems not to be an urgent issue for discussion at the first meeting, there’s no problem for us either if it’s discussed in feature list discussion at the end of the release. |
| Sierra Wireless | Yes | Same view as Qualcomm and Huawei |

## 2.2 Enabling of 14 HARQ processes

Background: There is a common view in [4], and [8] that RRC signalling should be used to enable the 14-HARQ processes.

The related proposals are shown below:

|  |  |
| --- | --- |
| Company | View |
| Nokia, Nokia Shanghai Bell [4] | Proposal 2: The RRC based dedicated PDSCH-configuration procedure is used to configure the UE to use 14-HARQ processes. |
| Qualcomm Incorporated [8] | Proposal 1: Introduce support of 14 DL HARQ processes for HD-FDD eMTC UEs in CE mode A as follows:  • Introduce a new RRC configuration parameter to enable 14 HARQ processes. |

**Potential Working Assumption 2:**

**Introduce a new RRC configuration parameter to enable 14 HARQ processes.**

**Note: The Working Assumption is to be confirmed once RAN1 has selected a 14 HARQ scheme and RAN2 has confirmed that there are no concerns on the working assumption.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree?** | **Comments** |
| Qualcomm | Yes (but see comments) | We dont see a need for RAN2 confirmation. I think we should also be able to make this an agreement, but if peopel feel more comfortable with WA we are OK. |
| ZTE | Yes | Fine with agreement |
| Lenovo&MotoM | Yes | We agree RAN2 confirmation. |
| Ericsson | Ok | These signalling aspects are typicall handled a bit later in the release, but if appears to be possible a consensus early on, then we can be ok with the Working Assumption. |
| Nokia | Ok | Fine with the WA. |
| Huawei, HiSilicon | OK ( with comments) | Similar to our comments for section 2.1, we don’t see the necessity for RAN2 confirmation, it can be an agreement. And it seems not very urgent either to discuss the signaling at the first meeting. |
| Sierra Wireless | Yes | Same view as Qualcomm and Huawei |

## 2.3 Design Targets for the support of 14 HARQ processes

Background: In [5], it was mentioned “In realistic network deployments the presence of invalid BL/CE DL subframes (i.e., non-BL/CE DL subframes), invalid BL/CE UL subframes (i.e., non-BL/CE UL subframes), and measurement gaps is no uncommon, therefore in our view the support of “14 HARQ processes in DL using HARQ-ACK bundling for a Cat M1 HD-FDD UE” should account for them”

On the other hand, in [8] it was mentioned “Rel-14 HARQ-ACK bundling, though, is also supported for the case of PUCCH repetition. RAN1 should decide whether the design is optimized for the case of PUCCH repetition or not.”

The related proposals are shown below:

|  |  |
| --- | --- |
| Company | View |
| Ericsson [5] | Proposal 1: The design to support “14 HARQ processes in DL using HARQ-ACK bundling for a Cat M1 HD-FDD UE” includes the possibility of operating in presence of invalid subframes (i.e., non-BL/CE DL subframes and non-BL/CE UL subframes), and measurement gaps. |
| Qualcomm Incorporated [8] | Proposal 5: RAN1 to discuss whether to optimize the design of 14 HARQ processes + scheduling delay for the case of PUCCH repetitions. |

**Potential Agreement 1:**

**The 14 HARQ processes design allows for operating with:**

* **Alt 1: PUCCH repetitions.**
* **Alt 2: PUCCH repetitions and non-BL/CE subframes.**
* **Alt 3: PUCCH repetitions, non-BL/CE subframes, and measurement gaps.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree with Alt?** | **Comments** |
| Qualcomm | - | I think this is the first meeting, and this issue was brought up by a limited number of companies. Probably companies need more time to think and evaluate whether it is possible to cover all the cases. Thus, we would propose to agree on some guidance for the next meeting, something like:  **RAN1 to further discuss how/whether to take into account the following when designing the 14 HARQ feature:**  **- presence of PUCCH repetition**  **- presence of non-BL/CE subframes.**  At the same time, I think we should be able to agree that the case where none of this is present is also optimized for (see 2.4) |
| ZTE | - | We don’t think 14 HARQ processes design needs to consider the proposed alternatives.  From our understanding, the intention to introduce 14 HARQ processes is to improve the peak data rate. This feature is for the UE with high SNR . There is no need to consider the scenario with PUCCH repetitions.  For mesaurement gaps and non-BL/CE subframes, 14 HARQ processes design can follow the rule of existing 10 HARQ processes design. There is no need to consider new design rule. |
| Lenovo&MotoM |  | Single repetition for all channels is assumed for HARQ bundling in Rel.14. So PUCCH repetition is beyond the scope of WID at this stage.  For mesaurement gaps and non-BL/CE subframes issue, we need further study on whether there is problems/issues proposed in E/// contribution. |
| Ericsson | Alt 2 or Alt 3 | We do not think that the 14 HARQ processes scheme in its simplest from will be that useful in realistic network deployments, where e.g., the presence of non-BL/CE subframes is not uncommon.  Companies can argue that e.g., we do not need to consider PUCCH repetitions if this feature is only to be configured in good radio conditions, although I think in some scenarios being able use even a few number of PUCCH repetitions would be useful.  What cannot be argued is the relevance non-BL/CE subframes, since they have become even more important now that they are used for NR coexistence (in the form of Rel-13 invalid subframes or Rel-16 reserved subframes).  For the reasons above, at least the non-BL/CE subframes should from the beginning be part of design of the 14 HARQ scheme. |
| Nokia | - | Share the views of ZTE |
| Huawei, HiSilicon | - | We share similar view with ZTE that:  *For PUCCH repetitions:*  The 14 HARQ is used to improve the peak data rate and is suitable to be used for a UE in good coverage. The required SNR is higher, so the repetitions for all channels(PDCCH/PDSCH/PUCCH) do not need to be considered when 14 HARQ solution is designed. In addition, considering PUCCH repetition would lead to further complexity the 14 HARQ design in terms of scheduling delay and HARQ-ACK delay.  *For invalid subframes and measurement gaps:*  In legacy eMTC, the DL transmmisions cannot be scheduled on the invalid subframes and measurement gaps. There is no reason to block this principle for 14 HARQ. As analysis above, 14 HARQ is used to improve the peak data rate. If the invalid subframes and measurement gaps cause excessive [growth](javascript:;) of the delays, it is not a scenario for peak data rate improment. The eNB has the flexibility whether to configure 14 HARQ. |
| Sierra Wireless | - | Share the views of ZTE |

## 2.4 Current 14 HARQ designs

Background: Although this is the first meeting for this Rel-17 Work Item objective, many companies submitted their own scheme (in some cases even more than one) for supporting 14 HARQ processes [2-4], [6-8].

The related proposals are shown below:

|  |  |
| --- | --- |
| Company | View |
| Huawei, HiSilicon [2] | Proposal 1: The scheduling delay of the additional HARQ processes (10-13) is fixed as 7 subframes. |
| ZTE [3] | Proposal 1: Introduce an additional bit in DCI when 14 HARQ processes are configured.  ­ The additional bit and HARQ-ACK delay field are jointly coded to indicate the PDSCH scheduling delay and HARQ-ACK delay. |
| Nokia, Nokia Shanghai Bell [4] | Proposal 3: RAN1 support the use of joint encoded DCI fields for the 14-HARQ process support, to expand the range of delay and offset options.  FFS: Details of joint encoding. |
| Sierra Wireless S. A. [6] | Proposal 2: When the 14 HARQ process feature is enabled and the DL grant schedules 1 TB, there is an additional bit in DL grant that indicates a PDSCH scheduling delay of 2 or 7.  • FSS: support for DL multi-TB Grant case |
| Beijing Xiaomi Software Tech [7] | Proposal 2: Consider to determine the scheduling delay based on pre-defined rule instead of indication via DCI |
| Qualcomm Incorporated [8] | Proposal 3: For the indication of PDSCH scheduling delay, downselect among the following options:  • Option 1: Do not introduce a new DCI field, the PDSCH scheduling delay is implicitly determined based on the reinterpretation of some existing field(s) (e.g. HARQ process ID, HARQ-ACK delay).  • Option 2: Introduce a new DCI field explicitly indicating the PDSCH scheduling delay |

**Possible Conclusion:**

**Revise the 14 HARQ schemes as to fulfil the design targets in the potential agreement 1 and discuss in the next RAN1 meeting.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Ok?** | **Comments** |
| Qualcomm |  | We agree with further looking into 2.3, but I think all companies agree that at least a scheduling delay of 7 is introduced for PDSCH. The details of this (singaling / applicability to a subset of the HARQ process) can be decided in a later meeting. So, maybe we can do something as follows:  **Proposal: At least a scheduling delay of 7 subframes is introduced for PDSCH (i.e., MPDCCH in subframe *N* schedules PDSCH in subframe *N+7*)**   * **FFS: Details, including signaling in DCI.** * **FFS: Other values.** |
| ZTE | No | Detailed 14 HARQ processes design can be decided in a later meeting.  Besides existing scheduling delay of 2, we are fine to introduce additional scheduling delay of 7.  To support flexible bundling pattern, we think at least all HARQ-ACK delay values in current spec should be supported for 14 HARQ processes design. |
| Lenovo&MotoM |  | If consider the non-BL/CE subframes, the scheduling delay may not be 7, right? So we should decide 2.3 first. |
| Ericsson | Ok | For the reasons we provided in the comment‘s field in section 2.3, we also think we should decide on 2.3 first. |
| Nokia | No | Do not agree with the conclusion. It immediately assumes that there is a RAN1 consensus agreeing to the potential issues identified in section 2.3, which from comments thus far, is not clear.  The qualcomm proposal is a step in the right direction, but even without such a proposal, it is clear that companies need to study the solutions presented and agree on a one solution.  We feel our solution, provides the most flexible and widest range of delays for ALL process IDs, without any impact to DCI size. Other solutions with more restricted sets of delays depending on the HARQ ID, invariably impact scheduling flexibility and efficiency (acks per bundle), particularly when „out of order“ retransmissions are needed. |
| Huawei, HiSilicon | No | The WID states that support additional PDSCH scheduling delay for introduction of 14-HARQ processes in DL. Although the detailed designs of many companies are quite different, introduing a new PDSCH scheduling delay is clear and necessary, and most companies propose a new scheduling delay of 7 subframes.  So to make some progress, the possible agreement can be achieved, and the detailed design can be FFS:  *Introduce a scheduling delay of 7 subframes for at least the new HARQ processes*. |
| Ericsson v007 |  | About the comment "*I think all companies agree* *that at least a scheduling delay of 7 is introduced for PDSCH*", we have a technical question, what are the units for such a value of 7?  Are the units the same as the legacy PDSCH scheduling delay equal to 2? |
| Sierra Wireless | No | Too early. |

## 2.5 Others

Background: In [6], it has been proposed to have an FFS on the “support for DL multi-TB Grant case”.

The related proposals are shown below:

|  |  |
| --- | --- |
| Company | View |
| Sierra Wireless S. A. [6] | Proposal 2: When the 14 HARQ process feature is enabled and the DL grant schedules 1 TB, there is an additional bit in DL grant that indicates a PDSCH scheduling delay of 2 or 7.  • FSS: support for DL multi-TB Grant case |

**Potential Agreement 2:**

**FFS:** **Whether the 14 HARQ scheme will support multi-TB Grant.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree?** | **Comments** |
| Qualcomm | Too early | Maybe add as FFS for next meeting. |
| ZTE | Too early | Need further study on the benefit for peak data rate |
| Lenovo&MotoM | Too early | Need further study |
| Ericsson | Ok | The proposal is not to agree now on the support of multi-TB Grant, but rather to let For Further Study whether to support it or not. We are open to study e.g., the potential benefits versus the added complexity, that is why we can be Ok with the FFS. |
| Nokia | Too early | FFS |
| Huawei, HiSilicon | Too early | Prefer to discuss this after companies have a clearer understanding of 14HARQ. |
| Sierra Wireless | Too early | I mentioned it in my tdoc so that everyone can take some time to think about it. I do however want to make sure that we don’t make any agreement now which would prevent us from supporting 14 HARQ with M-TB G. |

# 3 Compendium of possible agreements for 14 HARQ processes in DL in LTE-MTC

The set of bullets below reflect the outcome of the discussions contained in this FLS.

* **Indication of the support of 14 HARQ processes (Section 2.1):** The Working Assumption (WA) looks stable. Three of the received inputs would prefer to do not include a confirmation from RAN2, whereas four of them are ok with it. The potential WA follows the preferences of the slight majority.

**Potential Working Assumption 1:**

**Introduce a new optional UE capability to indicate support of 14 HARQ processes**

**Note: The Working Assumption is to be confirmed once RAN1 has selected a 14 HARQ scheme and RAN2 has confirmed that there are no concerns on the working assumption.**

* **Enabling of 14 HARQ processes (Section 2.2):** Similarly, the Working Assumption (WA) looks stable. Three of the received inputs would prefer to do not include a confirmation from RAN2, whereas four of them are ok with it. The potential WA follows the preferences of the slight majority.

**Potential Working Assumption 2:**

**Introduce a new RRC configuration parameter to enable 14 HARQ processes.**

**Note: The Working Assumption is to be confirmed once RAN1 has selected a 14 HARQ scheme and RAN2 has confirmed that there are no concerns on the working assumption.**

* **Design Targets for the support of 14 HARQ processes (Section 2.3):** Given the feedback received from companies and its tight connection with section 2.4, we can move to the next section and discuss the potential agreement related to section 2.4.
* **Current 14 HARQ designs (Section 2.4):** The majority view is “*that at least a scheduling delay of 7 is introduced for PDSCH*”. In relation to it, a discussion on “*what are the units for such a value of 7?*” resulted in letting it for FFS. Moreover, although the majority view supports the introduction of a simple 14 HARQ scheme, there were three companies open to further study the support of other scenarios (see section 2.3): “*non-BL/CE subframes … have become even more important now that they are used for NR coexistence*”, “*we need further study on whether there is problems/issues proposed in E/// contribution*”, “RAN1 to further discuss how/whether to take into account … - presence of PUCCH repetition - presence of non-BL/CE subframes”.

Thus, the following proposal is intended to capture the above technical aspects:

**Potential Agreement:**

**For a UE configured with 14 HARQ processes, a PDSCH scheduling delay of 2 BL/CE DL subframes and 7 [FFS subframes type(s)] is supported at least in the PUCCH non-repetition case:**

**• FFS details of signaling.**

**• FFS other delay values to account for the presence of non-BL/CE subframes in the PUCCH repetition case and the PUCCH non-repetition case.**

* **Others (Section 2.5):** In this section a potential agreement to have an FFS on “Whether the 14 HARQ scheme will support multi-TB Grant” was subject to feedback, for which the majority of companies responded that it was “Too early” for it. So, there is no potential agreement for section 2.5 of this FLS.

# 4 References

1. [RP-201306](http://www.3gpp.org/ftp/TSG_RAN/TSG_RAN/TSGR_88e/Docs/RP-201306.zip), WID: Additional enhancements for NB-IoT and LTE-MTC, RAN #88e, Electronic Meeting, June 29th-3rd, 2020.
2. [R1-2005305](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005305.zip), “Support of 14-HARQ processes in DL for HD-FDD MTC UEs,” Huawei, HiSilicon, RAN1 #102-e, Electronic Meeting, August 17-28, 2020.
3. [R1-2005480](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005480.zip), “Support additional PDSCH scheduling delay for introduction of 14-HARQ processes in DL for eMTC,” ZTE, RAN1 #102-e, Electronic Meeting, August 17-28, 2020.
4. [R1-2005530](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005530.zip), “Support of 14-HARQ processes in DL for eMTC,” Nokia, Nokia Shanghai Bell, RAN1 #102-e, Electronic Meeting, August 17-28, 2020.
5. [R1-2005558](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005558.zip), “Support of 14 HARQ processes in DL in LTE-MTC,” Ericsson, RAN1 #102-e, Electronic Meeting, August 17-28, 2020.
6. [R1-2005940](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005940.zip), “Design consideration to support 14-HARQ for LTE-M,” Sierra Wireless, S.A. RAN1 #102-e, Electronic Meeting, August 17-28, 2020.
7. [R1-2005973](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2005973.zip), “Initial discussion on support of additional PDSCH scheduling delay for introduction of 14 HARQ processes in DL for eMTC,” Beijing Xiaomi Software Tech, RAN1 #102-e, Electronic Meeting, August 17-28, 2020.
8. [R1-2006193](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_102-e/Docs/R1-2006193.zip), “Support of 14 HARQ processes and scheduling delay,” Qualcomm Incorporated, RAN1 #102-e, Electronic Meeting, August 17-28, 2020.