3GPP TSG RAN WG1 #107-e R1-210XXXX

e-Meeting, November 11th – 19th, 2021

**Agenda item: 7.2.5**

**Source: Moderator (Nokia)**

**Title:** **[107-e-NR-L1enh-URLLC-06] Discussion on PUCCH multiplexing with SPS HARQ-ACK within a sub-slot**

**Document for: Discussion and Decision**

# Introduction

This document is created to facilitate the email discussion of

* [107-e-NR-L1enh-URLLC-06] Discussion on PUCCH multiplexing with SPS HARQ-ACK within a sub-slot by Nov 17 - Klaus (Nokia)

This email thread is triggered by the following discussion documents.

1. [R1-2111187](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Docs/R1-2111187.zip) (Draft CR) PUCCH Multiplexing with SPS HARQ-ACK within a Sub-slot, Ericsson
2. [R1-2111362](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Docs/R1-2111362.zip) Draft CR on UL multiplexing with SPS HARQ-ACK or SR in one sub-slot, ZTE
3. [R1-2111679](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_107-e/Docs/R1-2111679.zip) [Draft CR] Clarification on Inter-sub-slot multiplexing of low-priority UCIs, Nokia, Nokia Shanghai Bell

The discussion should focus on the needed specification changes resulting from the following agreement from RAN1#106-e (part of [106-e-NR-L1enh-URLLC-10]):

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| **Agreement**  For the multiplexing among overlapping PUCCH channels with a given priority index, if a UE is provided *subslotLengthForPUCCH* for the HARQ-ACK codebook of the given priority, UE does not expect that the HARQ-ACK corresponding only to SPS PDSCH(s) or SR of the given priority index in one sub-slot is moved to a different sub-slot after multiplexing.   * Note: the UE behavior for UL multiplexing with SR and CSI in a slot is maintained if there is no HARQ-ACK in the slot |

# Email discussions

**Option 1: The following changes are proposed by Ericsson [1]:**

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| 9.2.5.2 UE procedure for multiplexing HARQ-ACK/SR/CSI in a PUCCH <Unchanged parts are omitted>  If a UE has one or more CSI reports and zero or more HARQ-ACK/SR information bits to transmit in a PUCCH where the HARQ-ACK, if any, is in response to a PDSCH reception without a corresponding PDCCH  - if any of the CSI reports are overlapping and the UE is provided by *multi-CSI-PUCCH-ResourceList* with  PUCCH resources in a slot, for PUCCH format 2 and/or PUCCH format 3 and/or PUCCH format 4, as described in clause 9.2.1, where the resources are indexed according to an ascending order for the product of a number of corresponding REs, modulation order , and configured code rate ;  - if , the UE uses PUCCH format 2 resource , or the PUCCH format 3 resource , or the PUCCH format 4 resource  - else if  and , , the UE transmits a PUCCH conveying HARQ-ACK information, SR and CSI report(s) in a respective PUCCH where the UE uses the PUCCH format 2 resource , or the PUCCH format 3 resource , or the PUCCH format 4 resource  - else the UE uses the PUCCH format 2 resource , or the PUCCH format 3 resource , or the PUCCH format 4 resource  and the UE selects  CSI report(s) for transmission together with HARQ-ACK information and SR, when any, in ascending priority value as described in [6, TS 38.214]  - else, the UE transmits the  bits in a PUCCH resource provided by *pucch-CSI-ResourceList* and determined as described in clause 9.2.5  If a UE is provided with *subslotLengthForPUCCH* in a given *PUCCH-Config*, in a slot with any HARQ-ACK and consisting of symbols as defined in [4, TS 38.211], for multiplexing overlapping PUCCH(s) with PUCCH resources provided by the given *PUCCH-Config*, the UE does not expect that the HARQ-ACK (if any) or SR (if any) within one set of *subslotLengthForPUCCH* symbols is moved to a different set of *subslotLengthForPUCCH* symbols after multiplexing, where the HARQ-ACK to be multiplexed is in response to PDSCH reception(s) without a corresponding PDCCH.  If a UE has HARQ-ACK, SR and wideband or sub-band CSI reports to transmit and the UE determines a PUCCH resource with PUCCH format 2, or the UE has HARQ-ACK, SR and wideband CSI reports [6, TS 38.214] to transmit and the UE determines a PUCCH resource with PUCCH format 3 or PUCCH format 4, where  <Unchanged parts are omitted> |

**Option 2: The following changes are proposed by ZTE [2]:**

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| 9 UE procedure for reporting control information  < Unchanged part is omitted >  If a UE is provided one *PUCCH-Config*  - if the UE is provided *subslotLengthForPUCCH* in the *PUCCH-Config*, the PUCCH resource for any SR configuration with priority index 0 or any CSI report configuration in the *PUCCH-Config* is within the *subslotLengthForPUCCH* symbols in the *PUCCH-Config*  If a UE is provided two *PUCCH-Config*  - if the UE is provided *subslotLengthForPUCCH* in the first *PUCCH-Config*, the PUCCH resource for any SR configuration with priority index 0 or any CSI report configuration in any *PUCCH-Config* is within the *subslotLengthForPUCCH* symbols in the first *PUCCH-Config*  - if the UE is provided *subslotLengthForPUCCH* in the second *PUCCH-Config*, the PUCCH resource for any SR configuration with priority index 1 in any *PUCCH-Config* is within the *subslotLengthForPUCCH* symbols in the second *PUCCH-Config*  For the multiplexing among overlapping PUCCH channels with a given priority index, if a UE is provided one or two *PUCCH-Config* and provided *subslotLengthForPUCCH* for the HARQ-ACK codebook of the given priority, UE does not expect that the HARQ-ACK corresponding only to SPS PDSCH(s) or SR of the given priority index in one sub-slot is moved to a different sub-slot after multiplexing.  < Unchanged part is omitted > |

**Option 3: The following changes are proposed by Nokia/NSB [3]:**

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| 9 UE procedure for reporting control information  < Unchanged parts are omitted >  If a UE is provided one *PUCCH-Config*  - if the UE is provided *subslotLengthForPUCCH* in the *PUCCH-Config*, the PUCCH resource for any SR configuration with priority index 0 or any CSI report configuration in the *PUCCH-Config* is within the *subslotLengthForPUCCH* symbols in the *PUCCH-Config*  If a UE is provided two *PUCCH-Config*  - if the UE is provided *subslotLengthForPUCCH* in the first *PUCCH-Config*, the PUCCH resource for any SR configuration with priority index 0 or any CSI report configuration in any *PUCCH-Config* is within the *subslotLengthForPUCCH* symbols in the first *PUCCH-Config*  - if the UE is provided *subslotLengthForPUCCH* in the second *PUCCH-Config*, the PUCCH resource for any SR configuration with priority index 1 in any *PUCCH-Config* is within the *subslotLengthForPUCCH* symbols in the second *PUCCH-Config*  If a UE is provided *subslotLengthForPUCCH* in a *PUCCH-Config* of a given priority index, the UE does not expect that at least one of a HARQ-ACK corresponding to PDSCH reception without a corresponding PDCCH or an SR of the given priority index in one UL slot for PUCCH transmission is moved to a different slot after the UE multiplexes UCIs, including HARQ-ACK, SR and/or CSI, on PUCCH.  < Unchanged parts are omitted > |

## 2.1 Round 1

Looking at the three draft CRs in [1], [2] and [3], the first question that comes to mind immediately is, that the needed clarification is either included in Sec. 9.2.6 as proposed by Ericsson [1] or in the main section 9 (below the one & two-PUCCH config clauses) as proposed by ZTE [2] & Nokia/NSB [3]. The chosen section would also have an effect on the needed CR within that section, as in Sec. 9.2.5.2 as seems correctly captured in the Ericsson CR we need to define the ‘PUCCH sub-slot’ in terms of symbols in the condition, whereas if we include this in Sec. 9 directly, we can use the term UL slot for PUCCH transmission or similar there directly (as in the ZTE & Nokia/NSB proposal). Let’s see where companies stand, I plan to use majority input from the first round to define on how to proceed in the 2nd round.

**Question 1: The clarification on the SPS HARQ and SR in 38.213 is to be provided in**

* **Alt. 1: Sec. 9.2.5.2 (as proposed in [1])**
* **Alt. 2: Sec. 9 (as proposed in [2] and [3])**
* **Alt. 3: Other**

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| Alt. 1 – supporting companies |  |
| Alt. 2 – supporting companies |  |
| Alt. 3 – supporting companies for other section |  |

Comments:

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| *Company* | *Comments* |
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In case we go for Sec. 9.2.5.2, what changes to the Ericsson proposal do you see as needed:

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| **Ericsson in [1] for Sec. 9.2.5.2 of TS 38.213:**  If a UE is provided with *subslotLengthForPUCCH* in a given *PUCCH-Config*, in a slot with any HARQ-ACK and consisting of symbols as defined in [4, TS 38.211], for multiplexing overlapping PUCCH(s) with PUCCH resources provided by the given *PUCCH-Config*, the UE does not expect that the HARQ-ACK (if any) or SR (if any) within one set of *subslotLengthForPUCCH* symbols is moved to a different set of *subslotLengthForPUCCH* symbols after multiplexing, where the HARQ-ACK to be multiplexed is in response to PDSCH reception(s) without a corresponding PDCCH. |

**Question 2: In case the clarification is to be provided in Sec. 9.2.5.2, what changes to the Ericsson proposed text above do you think would be needed?**

Comments:

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| *Company* | *Comments* |
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**When looking at the proposed changes for Sec. 9 of 38.213 in ZTE [2] and Nokia/NSB [3],**

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| **ZTE in [2]**  For the multiplexing among overlapping PUCCH channels with a given priority index, if a UE is provided one or two *PUCCH-Config* and provided *subslotLengthForPUCCH* for the HARQ-ACK codebook of the given priority, UE does not expect that the HARQ-ACK corresponding only to SPS PDSCH(s) or SR of the given priority index in one sub-slot is moved to a different sub-slot after multiplexing.  **Nokia/NSB in [3]**  If a UE is provided *subslotLengthForPUCCH* in a *PUCCH-Config* of a given priority index, the UE does not expect that at least one of a HARQ-ACK corresponding to PDSCH reception without a corresponding PDCCH or an SR of the given priority index in one UL slot for PUCCH transmission is moved to a different slot after the UE multiplexes UCIs, including HARQ-ACK, SR and/or CSI, on PUCCH. |

they clearly address the same with partially even the same wording with some minor differences:

* ZTE spelling out the one or two PUCCH config cases again whereas Nokia only referring directly to a PUCCH config (marked in yellow).
* Nokia uses the wording ‘*at least one of*’ (in magenta) SPS HARQ or SR (which include the case of SPS HARQ & SR), whereas ZTE does not use this (which seems to imply either SPS HARQ or SR)
* ZTE using the wording of ‘*HARQ-ACK corresponding only to SPS PDSCH(s)*’ whereas Nokia using the formulation of ‘*HARQ-ACK corresponding to PDSCH reception without a corresponding PDCCH*’ to differentiate activation / release operation (in blue)
* ZTE uses the wording of ‘*sub-slot*’ not defined in 38.213 whereas Nokia/NSB uses the term ‘*UL slot for PUCCH transmission*’ (in green)

**Question 3: If the clarification is provided in Sec. 9 of 38.213, which type of formulation do you prefer:**

* **Alt. 1: ZTE in [2]**
* **Alt. 2: Nokia in [3]**
* **Alt. 3: Other (e.g., combination)**

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| Alt. 1 – supporting companies |  |
| Alt. 2 – supporting companies |  |
| Alt. 3 – none / other |  |

Comments on either ZTE and/or Nokia wording, addressing e.g., also some of the differences marked in yellow, magenta, blue, green above:

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| *Company* | *Comments* |
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