**3GPP TSG RAN WG1 #104-e R1-210xxxx**

**e-Meeting, Jan. 25th – Feb. 5th, 2021**

**Agenda Item:** 7.2.5

**Source:** Moderator (LG Electronics)

**Title:** Summary on maintenance of other aspects for URLLC/IIOT

**Document for:** Discussion and decision

# Introduction

This document summarizes the topics under AI 7.2.5 based on the contributions submitted to this AI [1-5], especially for related to other aspects for URLLC//IIOT, and provides FL recommendation to organize the subsequent email discussions.

# Issues in RAN1#104-e

* 1. Issue #1 Processing timeline for overlapping update due to SPS release

In [4], an issue has been identified for SPS release processing time. According to [1], gNB and UE may have different understanding for a slot where two SPS PDSCH is configured and one SPS PDSCH is released in the previous slot.

Figure 1 Misunderstanding on SPS configurations between gNB and UE [1]

**Proposed changes from [1]:**

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| --- |
| ------------------------------------ Start of TP 38.214 V16.3.0 section 5.1---------------------------------<unchanged text omitted>If more than one PDSCH on a serving cell each without a corresponding PDCCH transmission are in a slot, and any PDSCH of more than one PDSCH starts before 14symbols after a last symbol of the corresponding SPS release reception, if any, after resolving overlapping with symbols in the slot indicated as uplink by *tdd-UL-DL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated*, a UE receives one or more PDSCHs without corresponding PDCCH transmissions in the slot as specified below.‒ Step 0: set *j=0*, where *j* is thenumber of selected PDSCH(s) for decoding. *Q* is the set of activated PDSCHs without corresponding PDCCH transmissions within the slot‒ Step 1: A UE receives one PDSCH with the lowest configured *sps-ConfigIndex* within *Q*, set *j=j+1*. Designate the received PDSCH as survivor PDSCH.‒ Step 2: The survivor PDSCH in step 1 and any other PDSCH(s) overlapping (even partially) with the survivor PDSCH in step 1 are excluded from *Q*. Step 3: Repeat step 1 and 2 until Q is empty or j is equal to the number of unicast PDSCHs in a slot supported by the UE<unchanged text omitted>------------------------------------ End of TP 38.214 V16.3.0 section 5.1--------------------------------- |

**From FL:**

The similar issue was discussed in the previous meeting for the timeline between SPS PDSCH and SPS release. If we recall the discussion, the issue had been deprioritized by following two reason, 1) it is hard to specify PDCCH reception and 2) there is no specific reason to indicate SPS release at that time.

For the first reason, according to 38.321, UE releases SPS PDSCH right after reception of SPS release. Thus, proposed changes could be conflict with 38.321 description. If some changes is needed, the changes should related only to HARQ-ACK codebook generation only rather than SPS PDSCH reception. Though PDCCH decoding time is not specified in spec, it should be less than PDSCH processing time.

On the other hand, even If we assume that SPS PDSCH occasion to be cancelled is placed right after SPS release reception, the HARQ-ACK transmission for the SPS PDSCH occasion should met PUCCH processing timeline between end of SPS PDSCH and start of PUCCH for SPS HARQ-ACK. It means that, UE always have processing time for SPS release and its effect.

For the second reason, if gNB expects a possibility of blind decoding, gNB would not indicate SPS PDSCH release at the point. For example, if gNB indicate SPS release for SPS configuration #1 in the slot where SPS PDSCH occasion is located, UE and gNB would have no different understanding. In other words, this issue seems not essential and could be solved by gNB scheduling.

Based on above observation, the issues is not realistic. Moreover, if SPS PDSCH is release by RRC re-configuration, the ambiguity exists anyway.

**FL recommendation: No specification changes are needed**

**From FL:**

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**FL recommendation: No specification changes are needed**

* 1. Issue #2 Type-1 HARQ-ACK codebook for SPS PDSCH with PDSCH aggregation

In [2], an issue has been identified for determination of $N\_{PDSCH}^{repeat,max}$. From the previous meeting, it hasn’t been discussed how to handle *repetitionNumber* (previous RepNumR16). In addition to this, [1] point out using maximum of *repetitionNumber* could make redundant HARQ-ACK bit in the codebook especially when UE is not configured with SPS-config. [1] provide two alternative as following:

* Alternative 1: the value of $N\_{PDSCH}^{repeat,max}$ for a serving cell is determined based on *repetitionNumber* when *repetitionNumber* is provided and SPS PDSCH is configured for the serving cell.
* Alternative 2: a UE does not follow the *repetitionNumber* indicated in the activation DCI for the SPS PDSCH configuration when *repetitionNumber* is provided.

**Proposed changes from [1]:**

***Proposal 6: The value of*** $N\_{PDSCH}^{repeat,max}$ ***is determined as below:***

* ***If UE is configured with SPS PDSCH and numberOfRepetitions-r16 on a serving cell,*** $N\_{PDSCH}^{repeat,max}$ ***is a maximum value repetitionNumber for the serving cell;***
* ***If UE is not configured with SPS PDSCH or repetitionNumber on a serving cell,*** $N\_{PDSCH}^{repeat,max}$ ***is a maximum value of pdsch-AggregationFactor in PDSCH-Config or SPS-Config for the serving cell, if provided, otherwise*** $N\_{PDSCH}^{repeat,max}=1$***.***

A text proposal is provided below for the Type-1 HARQ-ACK codebook determination.

-------------------------------------------------- Start of text proposal ------------------------------------------------------

<Unchanged text omitted>

If a UE is configured to receive SPS PDSCH on a serving cell and an entry in *pdsch-TimeDomainAllocationList* or *pdsch-TimeDomainAllocationListForDCI-Format1-2* for the serving cell includes *repetitionNumber* in *PDSCH-TimeDomainResourceAllocation-r16*, $N\_{PDSCH}^{repeat,max}$ is a maximum value of *repetitionNumber* for the serving cell*.* If the UE is not configured to receive SPS PDSCH on a serving cell or ~~provided~~ *~~pdsch-AggregationFactor-r16~~* ~~in~~ *~~SPS-Config~~* ~~or~~ *~~pdsch-AggregationFactor~~* ~~in~~ *~~PDSCH-Config~~* ~~and~~ no entry in *pdsch-TimeDomainAllocationList* and *pdsch-TimeDomainAllocationListDCI-1-2* for the serving cell includes *repetitionNumber* in *PDSCH-TimeDomainResourceAllocation-r16*, $N\_{PDSCH}^{repeat,max}$ is a maximum value of *pdsch-AggregationFactor-r16* in *SPS-Config* or *pdsch-AggregationFactor* in *PDSCH-Config* for the serving cell if provided; otherwise $N\_{PDSCH}^{repeat,max}=1$. The UE reports HARQ-ACK information for a PDSCH reception

- from slot $n-N\_{PDSCH}^{repeat}+1$ to slot $n$, if $N\_{PDSCH}^{repeat}$ is provided by *pdsch-AggregationFactor* or *pdsch-AggregationFactor-r16* [6, TS 38.214], or

- from slot $n-repetitionNumber+1$ to slot $n$, if the time domain resource assignment field in the DCI format scheduling or activating the PDSCH reception indicates an entry containing *repetitionNumber,* or

- in slot $n$, otherwise

only in a HARQ-ACK codebook that the UE includes in a PUCCH or PUSCH transmission in slot $n+k$, where $k$ is a number of slots indicated by the PDSCH-to-HARQ\_feedback timing indicator field in a corresponding DCI format or provided by *dl-DataToUL-ACK* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the DCI format. If the UE reports HARQ-ACK information for the PDSCH reception in a slot other than slot $n+k$, the UE sets a value for each corresponding HARQ-ACK information bit to NACK.

<Unchanged text omitted>

----------------------------------------------------- End of text proposal ------------------------------------------------------

**From FL:**

*repetitionNumber* is defined in MIMO AI and it works with *repetitionSchemeConfig-r16* set to one of *'FDMSchemeA'*, *'FDMSchemeB'* and *'TDMSchemeA’*. On the other hand, $N\_{PDSCH}^{repeat,max}$ is determined for the number of slot where PDSCHs for a TB occupy, in order to determine HARQ-ACK codebook. Considering *TDMSchemeA*, which is using *StartingSymbolOffsetK*, *repetitionNumber = 2* may or may not means that PDSCHs over two slots. We we recall that it has been agreed that using $N\_{PDSCH}^{repeat,max}$=1 if *repetitionNumber* configured, we can expect TDMed PDSCH span only one slot in normal operation. In this point of view, it seems not necessary to change $N\_{PDSCH}^{repeat,max}$ according to *repetitionNumber*

**FL recommendation: No specification changes are needed**

* 1. Issue #3 SPS PDSCH release and SPS receptions with slot aggregation

In [3][5], TP and CR is provided for the case of SPS PDSCH release and SPS repetitions. According to [5], When a SPS PDSCH is configured with aggregation factor, some of the SPS PDSCH occasions within the repetition may end before the end of the release PDCCH while some others may end after the end of the release PDCCH, as shown below. In this regard, the figure may be effectively considered as a SPS PDSCH which ends in slot nD=3 and should be supported.



**Proposed changes from [5]:**

|  |
| --- |
| 9.1 HARQ-ACK codebook determination\*\*\* Unchanged text is omitted \*\*\*If a UE is configured to receive SPS PDSCHs in a slot for SPS configurations that are indicated to be released by a DCI format, and if the UE receives the PDCCH providing the DCI format in the slot where the end of a last symbol of the PDCCH reception is not after the end of a last symbol of any of the last occasions of SPS PDSCH receptions, if the last occasion is in the slot, and if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH receptions would be multiplexed in a same PUCCH, the UE does not expect to receive the SPS PDSCHs, does not generate HARQ-ACK information for the SPS PDSCH receptions, and generates a HARQ-ACK information bit for the SPS PDSCH release.\*\*\* Unchanged text is omitted \*\*\* |

According to [3], current specification doesn’t care about slot aggregation so that restrict SPS PDSCH reception even when there is no HARQ-ACK bit collision in the type-1 HARQ-ACK codebook. To solve this problem, [3] propose following TP:

**Proposed changes from [3]:**

|  |
| --- |
| 9.1 HARQ-ACK codebook determination\*\*\* Unchanged text is omitted \*\*\*If a UE is configured to receive SPS PDSCHs in a slot for SPS configurations that are indicated to be released by a DCI format, and if the UE receives the PDCCH providing the DCI format in the slot where the end of a last symbol of the PDCCH reception is not after the end of a last symbol of any of the SPS PDSCH receptions, and if HARQ-ACK information for the SPS PDSCH release and the SPS PDSCH receptions would be multiplexed with same value of $b\_{r,k,n\_{D}}$ in a same PUCCH, the UE does not expect to receive the SPS PDSCHs, does not generate HARQ-ACK information for the SPS PDSCH receptions, and generates a HARQ-ACK information bit for the SPS PDSCH release.\*\*\* Unchanged text is omitted \*\*\* |

**From FL:**

As mention in the previous meeting, what makes problem is that the SPS PDSCH and SPS release are mapped to same UCI bit in the same PUCCH. In the figure brought by [5], if they are mapped to same PUCCH, those HARQ-ACK are mapped to different UCI bits due to different K1 value. Though the specification changes may be necessary to clarify previous agreement, but it is not clear whether to consider the last occasion of SPS PDSCH. Regarding this, it would be better to discussion with [3] as start line.

**FL recommendation: Discuss the above case with [3]**

* 1. Issue #4 PUCCH resource for SPS PDSCH HARQ-ACK and SR

According [4], when a SPS PDSCH HARQ-ACK PUCCH overlaps with a SR PUCCH, the SPS PDSCH HARQ-ACK PUCCH is used as the result PUCCH in general. However, in the current spec, PUCCH resource determination of *SPS-PUCCH-AN-List* only includes case of SPS PDSCH HARQ-ACK, the case of SPS PDSCH HARQ-ACK and SR is not included.

**Proposed changes from [4]:**

***Proposal 1: The UCI should include SPS PDSCH HARQ-ACK and SR, if any, when determining a PUCCH resource in SPS-PUCCH-AN-List. The following TP should be adopted.***

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| --- |
| If the UE is provided *SPS-PUCCH-AN-List* and transmits $O\_{UCI}$ UCI information bits that include only HARQ-ACK information bits in response to one or more SPS PDSCH receptions and SR, if any, the UE determines a PUCCH resource to be - a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the first entry in *sps-PUCCH-AN-List* if $O\_{UCI}\leq 2$, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the second entry in *sps-PUCCH-AN-List*, if provided, if $2<O\_{UCI}\leq N\_{1,SPS}$ where $N\_{1,SPS}$ is either provided by *maxPayloadSize* obtained from the second entry in *sps-PUCCH-AN-List* or is otherwise equal to 1706, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the third entry in *sps-PUCCH-AN-List*, if provided, if $N\_{1,SPS}<O\_{UCI}\leq N\_{2,SPS}$ where $N\_{2,SPS}$ is either provided by *maxPayloadSize* obtained from the third entry in *sps-PUCCH-AN-List* or is otherwise equal to 1706, or- a PUCCH resource provided by *sps-PUCCH-AN-ResourceID* obtained from the fourth entry in *sps-PUCCH-AN-List*, if provided, if $N\_{2,SPS}<O\_{UCI}\leq N\_{3,SPS}$ where $N\_{3,SPS}$ is equal to 1706. |

**FL recommendation: Take above TP as alignment CR.**

* 1. Issue #5 Dynamic grant PDSCH overriding SPS PDSCH repetition

According to [4], it is necessary to clarify whether DG PDSCH overriding SPS PDSCH repetition is performed per SPS PDSCH configuration or per SPS PDSCH configuration in Rel-15 and Rel-16, in order to align UE behavior between DL and UL.

**From [4]:**

***Proposal 1: RAN1 to conclude whether DG PDSCH overriding SPS PDSCH repetition is performed per SPS PDSCH configuration or per SPS PDSCH repetition.***

**From FL:**

According to current specification, it is clear that DG PDSCH can be overlapped if specified timeline satisfied. Considering that collision among SPS PDSCHs are handled per SPS PDSCH repetitions, it seems natural to handle per PDSCH repetition.

Regarding to UE behavior overriding SPS PDSCH, whether for DG PDSCH to override SPS PDSCH is specified in TS 38.321. According to TS 38.321, only if the PDSCH duration of the configured downlink assignment does not overlap with the PDSCH duration of a downlink assignment received on the PDCCH for this Serving Cell, SPS PDSCH can be received. On the other hands, UE doesn’t expect to receive PDSCH with a HARQ process if the HARQ process is still running with different PDSCH. It means that DG PDSCH may not overlap SPS PDSCH once SPS PDSCH starts to be received. From these specification, it seems already clear how UE works, as following.

* For same HARQ processes between DG PDSCH and SPS PDSCH, UE doesn’t expect to receive PDCCH scheduling DG PDSCH which overlaps the SPS PDSCH other than first repetitions.
* For different HARQ processes between DG PDSCH and SPS PDSCH, DG PDSCH can be scheduled if timeline met. UE MAC would prioritizes DG PDSCH per SPS PDSCH repetition.

**FL recommendation: No specification changes are necessary.**

* 1. Issue #6 PUCCH power control for HARQ-ACK codebook of multiple SPS PDSCH receptions

In [4], an issue is raised for PUCCH power control when all the SPS PDSCHs are cancelled by DCI/dynamic SFI and the UCI only contains the HARQ-ACK codebook for SPS PDSCHs.

According to [3], If all SPS PDSCH corresponding to a PDCCH is cancelled by dynamic SFI, will be 0. If is 0, the HARQ-ACK codebook contains all NACKs and gNB knowns that the HARQ-ACK codebook contains all NACKs. In such case, if =0 and =0,  will be -∞. This should be avoided. In this case, a PUCCH has no SR, no CSI, and all HARQ-ACK bits are known (have NACK values), there is no information in the PUCCH, therefore, UE should not transmit the PUCCH.

**From [3]:**

***Proposal 2: For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits smaller than or equal to 11, if UCI only contains all known NACKs for the cancelled SPS PDSCHs in the HARQ-ACK codebook, UE does not transmit the PUCCH. The following TP should be adopted.***

**From FL:**

This issues has been discussed in the previous meetings [6]. Some proponents thought it can be handled by gNB. In addition, another discussion point was whether transmission with minus infinity TX power can be interpreted no transmission in the UE perspective. If the assumption is acceptable, it wouldn’t be an issue.

**FL recommendation: Based on the previous discussion, no specification changes are necessary.**

# References

1. R1-2100180 Remaining issues on DL SPS enhancement OPPO
2. R1-2100337 Remaining issues on UCI enhancements CATT
3. R1-2100899 Remaining issues of other aspects for URLLC/IIOT LG Electronics
4. R1-2101178 Maintanence on SPS PDSCH Samsung
5. R1-2101179 Draft CR on SPS release for PDSCH with aggregation Samsung
6. R1-2006296, Summary on maintenance of other aspects for URLLC/IIOT, Moderator (LG Electronics)
7. R1-2008846, Summary on maintenance of other aspects for URLLC/IIOT, Moderator (LG Electronics)