**3GPP T****SG-RAN WG2 Meeting #113-electronic R2-210xxxx**

**Online, January 25th – February 5th, 2021**

**Agenda item: 6.1.3**

**Source: vivo**

**Title: Report of [AT113-e][019][NR16 IIOT] UL Skipping (vivo)**

**Document for: Discussion and Decision**

# 1 Introduction

This contribution is aimed at reporting the discussion and results of the following email discussion:

* [AT113-e][019][NR16 IIOT] UL Skipping (vivo)

Scope: Treat R2-2100028, R2-2100138, R2-2100524, R2-2100218, R2-2101793, R2-2101794, R2-2100340, R2-2101776, R2-2101352, R2-2101377, R2-2101378, R2-2101456, R2-2100341, R2-2100855

Phase 1, determine agreeable parts, Phase 2, for agreeable parts Work on CRs.

Intended outcome: Reports and Agreed CRs if any is agreeable.

Deadline: Schedule A

The rapporteur would like to point out the specific deadline for this discussion with two phases,

* In phase 1, companies are invited to provide their views by Jan. 28th (Thursday), 2021, 12:00 UTC.
* In phase 2, the corresponding summary report, CRs, and draft reply LS will be provided. Any comments on the CRs and draft reply LS are invited to be provided by Feb. 4th (Thursday), 2021, 12:00 UTC.

Hopefully, RAN2 can output agreeable 38.306/321/331 CRs related to the Rel-16 PUSCH skipping feature in this meeting. Otherwise, the corresponding RAN1 correction CR (i.e. R1-2009687) on PUSCH scheduling will not be approved in the RAN plenary again due to a lack of packeted RAN2 CRs. What’s worse, not only the dynamic PUSCH skipping feature but also the whole Rel-16 URLLC Intra-UE prioritization feature can not be implemented based on the PHY spec in the next version.

# 2 Participants

|  |  |
| --- | --- |
| Company name (participant name) | E-mail |
| Yitao Mo (Stephen) | yitao.mo@vivo.com |
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# 3 Discussion

In the previous RAN2#112-e meeting, RAN2 had noted the RAN1 LS (i.e. R1-2007338) regarding DG PUSCH skipping (also namely dynamic UL skipping), After an offline discussion, the corresponding agreements are achieved as follows [1],

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| --- |
| [016] Ph1 General agreements:   * RAN2 confirms that a new UE capability is introduced for Rel-16 dynamic UL skipping. * RAN2 assumes the field name of the new UE capability is *skipUplinkTxDynamic-r16*. * RAN2 assumes that the following is introduced for the field description of the new UE capability (this version is preliminary and the wording may be further updated):   Indicates whether the UE supports skipping UL transmission for a dynamic uplink grant indicated on PDCCH only if no data is available for transmission and no UCI to be multiplexed on the corresponding PUSCH of the uplink grant as specified in TS 38.321 [8].   * RAN2 assumes the Rel-16 dynamic UL skipping isper UE level. FFS whether it is mandatory. * RAN2 assumes the Rel-16 dynamic UL skipping is FDD/TDD differentiation. * RAN2 assumes the Rel-16 dynamic UL skipping is notFR1/FR2 differentiation. * The legacy capability bit (i.e. *skipUplinkTxDynamic*) is not dummified. * A new RRC parameter is introduced to enable Rel-16 dynamic UL skipping. FFS the field name. * The corresponding 38.321/331/306 CR and reply LS for Rel-16 dynamic UL skipping should be done along with the CG case. |

## 3.1 Capability aspects of Rel-16 DG PUSCH skipping

In the previous RAN2#112-e meeting, there was an FFS left that whether the Rel-16 dynamic UL skipping feature is mandatory.

According to the following text quoted from the TR 38.822 [3], we can know that legacy DG PUSCH skipping feature has become mandatory since Rel-16.

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| --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Mandatory/Optional |
| 3. MAC | 3-6 | Skipping UL transmission | 1) Skipping UL transmission for dynamic UL grant  2) Skipping UL transmission for configured UL grant | 1) Yes  2) No | No | 1) Optional with capability signalling. Mandatory with capability signalling from Rel-16  2) Conditional mandatory if the UE supports configured grant |

Considering that the new-defined DG PUSCH skipping feature is directly inherited from the Rel-15 feature, thus, rapporteur thinks it might be natural to set the Rel-16 DG PUSCH skipping as mandatory.

### **Q1: Do companies agree to make Rel-16 DG PUSCH skipping feature mandatory?**

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| **Company** | **Yes/No** | **Detailed comments** |
| vivo | Yes | We can take the legacy feature as a reference and make it mandatory, which matches the conclusion made in RAN#80. |
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**Conclusion:**

**TBD**

## 3.2 Rel-16 CG PUSCH skipping

In the RAN1 LS [2] regarding CG PUSCH skipping with UCI, RAN2 is kindly requested to introduce a new capability to differentiate the new UE behavior of CG PUSCH skipping with UCI. Therefore, we need to consider whether to introduce a new UE capability for CG PUSCH skipping.

Amongst all the contributions [4]-[16] talking about the PUSCH skipping with UCI, views (e.g. proposals) on the capability of Rel-16 CG PUSCH skipping are summarized as follows,

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| --- | --- |
| **Contribution Number** | **Views** |
| R2-2100138 | RAN2 confirms that a new UE capability is introduced for Rel-16 CG PUSCH skipping. |
| R2-2101794 | Add new UE capabilities to indicate whether the UE supports skipping of UL transmission for a dynamic grant and a configured grant if no data is available for transmission. |
| R2-2100340 | Introduce only one UE capability along with only one RRC parameter to enable Rel-16 UL skipping feature applied for both configured grant and dynamic grant. |
| R2-2101776 | RAN2 assumes that a new UE capability is introduced for Rel-16 dynamic UL skipping for configured grant with the field name of *skipUplinkTxDynamic-CG-r16*. |
| R2-2101352 | Introduce two new capabilities to indicate the support of the uplink skipping enhancement for CG and DG. |

Based on the input contributions, the majority view is that a new capability should be introduced for Rel-16 CG PUSCH skipping. So rapporteur proposes that a new UE capability is introduced for Rel-16 CG PUSCH skipping. Please companies to provide feedback on this.

### **Q2: Do companies agree to introduce a new UE capability for Rel-16 CG PUSCH skipping?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Detailed comments** |
| vivo | Yes | Take Rel-15 NR as the baseline, we think it is natural to separately introduce capabilities for DG PUSCH skipping and CG PUSCH skipping, considering the detailed attributes/execution timeline of these two features can be different. |
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**Conclusion:**

**TBD**

If the company’s answer to Q2 is Yes, the next coming questions are to discuss attributes of the new UE capability for Rel-16 CG PUSCH skipping.

### **Q3: What are companies’ preferences on the attribute of the new UE capability for Rel-16 CG PUSCH skipping (e.g. Per UE, M, not FDD-TFF DIFF, not FR1-FR2 DIFF)?**

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| --- | --- | --- | --- | --- | --- |
| **Company** | **Response** | | | | **Detailed comments** |
| **Per** | **M** | **FDD-TDD DIFF** | **FR1-FR2**  **DIFF** |
| vivo | UE | Yes | No | No | We prefer to take the legacy CG PUSCH skipping feature as a reference, which is shown in the following, according to TR 38.822. |
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**Conclusion:**

**TBD**

For the Rel-16 DG PUSCH skipping feature, it was agreed in the previous RAN2#112-e meeting that a new RRC was introduced to enable Rel-16 DG UL skipping, which helps to distinguish between Rel-15 and Rel-16 UE behavior, and provide more flexibility for network control.

If a new capability for Rel-16 CG PUSCH skipping is introduced, generally, the same logic might be also applied. Amongst all the contributions [4]-[16], views (e.g. proposals) on the RRC parameter for Rel-16 CG PUSCH skipping are summarized as follows,

|  |  |
| --- | --- |
| **Contribution Number** | **Views** |
| R2-2100138 | A new RRC parameter is introduced to enable Rel-16 CG PUSCH skipping. |
| R2-2101793 | Add enable flags and new UE capabilities to indicate whether the UE supports skipping of UL transmission for a dynamic grant and a configured grant if no data is available for transmission. |
| R2-2100340 | Introduce only one UE capability along with only one RRC parameter to enable Rel-16 UL skipping feature applied for both configured grant and dynamic grant. |
| R2-2101776 | RAN2 assumes that a new RRC parameter is introduced to enable Rel-16 dynamic UL skipping for configured grant with the field name of *skipUplinkTxDynamic-CG-16*. |
| R2-2101352 | Introduce two parameters to enable/disable the enhanced uplink skipping feature for CG and DG separately. |

Based on the input contributions, the majority view is that a new RRC parameter should be introduced for Rel-16 CG PUSCH skipping. So rapporteur proposes that a new RRCparameter is introduced for Rel-16 CG PUSCH skipping. Please companies to provide feedback on this if their answer to Q2 is Yes.

### **Q4: Do companies agree to introduce a new RRC parameter to enable Rel-16 CG PUSCH skipping?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Detailed comments** |
| vivo | Yes | A new RRC parameter is needed to indicate whether the Rel-16 CG PUSCH skipping is implemented. Otherwise, it is hard for the UE to distinguish whether to perform the Rel-15 behavior or the Rel-16 behavior, leading to potential misalignment between UE and NW. |
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**Conclusion:**

**TBD**

## 3.2 Rel-16 PUSCH skipping with Intra UE prioritization

In the RAN1 LS [2][17], all the UE behaviors for Rel-16 DG/CG PUSCH skipping are defined under the conditions that Rel-16 URLLC Intra-UE prioritization (including PHY layer prioritization and LCH-based prioritization) is not configured. Thus, it is worthy for RAN2 to discuss whether the defined UE behaviors are still reasonable and acceptable when LCH-based UE prioritization is configured.

In [15], it is proposed that RAN2 should firstly handle the case when LCH-based prioritization is not configured and overlapping PUSCH transmissions have two PHY priorities with UCI, as depicted in the following figure 1. And it held a view that there is no need to consider PHY priority in the MAC grant prioritization procedure considering that the Rel-16 function had been stable and an overhaul of the grant prioritization in terms of the PHY-defined procedure and MAC-defined procedure should be avoided. In other words, from the MAC perspective, DG is always prioritized over CG when *lch-basedPrioritization* is not configured. As a result, the CG PUSCH is ignored (i.e. no MAC PDU will be generated even though it is overlapping with UCI) and does not participate in subsequent physical layer procedure.

On the other hand, in [11], a concern is raised that it is not reasonable to let an empty DG PUSCH override over CG PUSCH with data. Besides, it proposes that UE should select CG when CG has available data but DG has not in CG&DG overlapped case.



Figure 1 overlapping PUSCH transmissions have two PHY priorities with UCI

### **Q5: Do companies agree that DG always overrides CG when LCH-based prioritization is not configured (i.e. no MAC spec change is needed)?**

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| **Company** | **Yes/No** | **Detailed comments** |
| vivo | Yes | No further enhancements for Rel-16. |
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**Conclusion:**

**TBD**

Before going into the details of UE behaviors for Rel-16 DG/CG PUSCH skipping with LCH-based UE prioritization, it might be better to first clarify the understanding of the current MAC spec with LCH-based UE prioritization. Rapporteur understands that the main preparation steps for the generation of the MAC PDU to be transmitted on DG/CG PUSCH are given as follows,

1. The MAC entity receives the UL grants including both dynamic grants and configured grants;
2. The MAC entity delivers the UL grants and the associated HARQ information to the HARQ entity;
3. The MAC entity determines whether a dynamic grant/configured grant is a prioritized uplink grant;
4. The corresponding HARQ entity instructs the multiplexing and assembly entity for the prioritized uplink grant;
5. Then the multiplexing and assembly entity performs the Logical Channel Prioritization (LCP), logical channel (LCH) selection, and resource allocation procedures (including determining whether the PUSCH skipping conditions are met or not);
6. The corresponding HARQ entity obtains the MAC PDU to transmit from the multiplexing and assembly entity;
7. The corresponding HARQ entity triggers a new transmission.

It is the rapporteur’s understanding that the LCH-based prioritization mechanism takes precedence over the PSUCH skipping conditions. In other words, even though the new Rel-16 PUSCH skipping conditions are introduced to MAC spec, the MAC entity will not generate a MAC PDU for a deprioritized uplink grant even though its associated PUSCH is overlapping with PUCCH.

### **Q6: Do companies agree with** **the understanding that LCH-based prioritization mechanism takes precedence over the PSUCH skipping conditions according to the existing MAC spec?**

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| **Company** | **Yes/No** | **Detailed comments** |
| vivo | Yes | We agree with the above view. |
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**Conclusion:**

**TBD**

Next, we come to discuss the UE behavior of PUSCH skipping when *lch-basedPrioritization* is configured.

[4][10] propose the MAC entity does not generate a MAC PDU for a deprioritized uplink grant (i.e. DG and CG) when its associated PUSCH is overlapping with PUCCH (i.e. no spec change on the LCH-based prioritization mechanism). The basic intention is to reduce the spec impact and keep the general principle of the current LCH-based prioritization mechanism that data of higher priority should be prioritized over data of lower priority. Taking Figure 2 as an example, the MAC entity firstly performs the LCH-based UE prioritization procedure at the T1 moment, prioritizing the DG and deprioritizing the CG. As the CG is a deprioritized UL grant, the multiplexing and assembly entity will not be called. Consequently, no MAC PDU will be generated for the CG PUSCH even though there is a PUCCH overlapping with the CG PUSCH. From the PHY layer perspective, the UE transmits the DG PUSCH and the PUCCH (if timeline permits). On the NW side, once successfully decoded the DG PUSCH, it can know that the CG PUSCH is deprioritized and will detect the UCI on the PUCCH.

On the contrary, [15][16] propose that a UCI-to-be-multiplexed grant should be prioritized even though no data is available. Otherwise, the gNB needs to blindly decode two hypotheses in each serving cell, i.e., one hypothesis is that UCI is multiplexed on CG PUSCH and another hypothesis is that the UCI is transmitted on PUCCH, which may highly increase the complexity of network detection in CA case. Taking Figure 2 as an example, the MAC entity should first prioritize the CG grant (e.g. with the highest priority) at the T1 moment, then the DG will be deprioritized. Finally, the UE can multiplex the UCI on CG PUSCH and transmit the CG PUSCH. On the network, double-decoding is not needed for the UCI.



Figure 2. PUSCH overlapping with PUCCH with LCH-based prioritization

Rapporteur thinks this is hard to conclude since both options are feasible and have their advantages. Anyway, a decision is needed and other potential options are not precluded for now. So the rapporteur thinks the following options can be considered:

- **Option 1:** The MAC entity does not generate a MAC PDU for a deprioritized uplink grant even when its associated PUSCH is overlapping with PUCCH (i.e. no spec change on the LCH-based prioritization mechanism).

- **Option 2:** Prioritize the uplink grant for which there is UCI to be multiplexed (i.e. spec changes on the LCH-based prioritization mechanism is needed).

* Option 2.1: the highest priority can be used for a UCI-to-be-multiplexed grant;
* Option 2.2: network configurable priority adjustment (e.g. different priorities for PUSCH with data of lower priority and empty PUSCH);
* FFS other options.

- **Option 3:** …

### **Q7: What are companies’ preferences?**

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| **Company** | **Which option(s) do you prefer?** | **Detailed comments** |
| vivo | Option 1 | If option2 is adopted, the MAC may prioritize an empty PUSCH (e.g. no data available) overlapping with a HARQ feedback for data of low priority over a PUSCH with data of higher priority. The general principle of Intra-UE prioritization would be broken, which definitely requires a lot of discussion on the new principle and spec polishment. We think it is too late for Rel-16.  For simplicity, we prefer Option1. Other enhancements can be further discussed in Rel-17 IIoT/URLLC WI. |
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**Conclusion:**

**TBD**

## 3.3 Other potential impacts/enhancements

Last but not least, companies can provide their comments on the remaining issues of Rel-16 PUSCH skipping if they are not covered by this discussion.

### **Q8: Are there any additional comments on the remaining issues of Rel-16 PUSCH skipping?**

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| **Company** | **Yes/No** | **Detailed comments** |
| vivo | Yes | Regarding the PUSCH repetition/aggregation impacts, we can wait for more RAN1 input and maybe discuss the potential RAN2 impacts in round 2 based on the RAN1 LS (if any). |
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**Conclusion:**

**TBD**

# 3 Conclusion

The contribution is summarized as follows,

# 4 References

[1] RAN2 112-e Chairman Notes EOM Corr w ChMark 2020-11-17.

[2] R2-2100028, LS on PUSCH skipping with UCI in Rel-16, vivo.

[3] 3GPP TS 38.822, User Equipment (UE) feature list, V15.0.1.

[4] R2-2100138, Remaining Issues on PUSCH Skipping with UCI in Rel-16, vivo.

[5] R2-2100524, Draft Reply LS on PUSCH skipping with UCI in Rel-16, vivo.

[6] R2-2100218, Correction for DG and CG UL skipping with UCI overlap, CATT.

[7] R2-2101793, Correction on CG-DG skipping capabilities and configuration when PUCCH with UCI overlaps with PUSCH, CATT.

[8] R2-2101794, Correction on CG and DG skipping capabilities when PUCCH with UCI overlaps with PUSCH, CATT.

[9] R2-2100340, UL PUSCH skipping without intra-UE prioritization, Ericsson.

[10] R2-2101776, Updates to RAN2 aspects of PUSCH with UL skipping, Huawei, HiSilicon.

[11] R2-2101352, RAN2 Impact on UL Skipping Enhancement, Apple.

[12] R2-2101377, MAC CR on UL skipping enhancement, Apple.

[13] R2-2101378, RRC CR on UL skipping enhancement, Apple.

[14] R2-2101456, UE capability on UL skipping enhancement, Apple.

[15] R2-2100341, UL PUSCH skipping with Intra-UE prioritization, Ericsson.

[16] R2-2100855, UL skipping and intra-UE prioritization, Apple.

[17] R1-2007338, LS on PUSCH with UL skipping, vivo.