**Ap3GPP TSG-RAN WG1 Meeting #119 R1-2410831**

**Orlando, USA, November 18-22, 2024**

**Agenda Item: 7**

**Source: Moderator (Huawei)**

**Title: Summary of discussion on skipping uplink transmission in case of BWP switching**

**Document for: Discussion and Decision**

# Introduction

This document is created to collect company views on the proposals in [1] and [2].

# Problem description

NR specification supports UE can skip UL transmission for an uplink grant if there is no data available for UE, when *skipUplinkTxDynamic* or *enhancedSkipUplinkTxDynamic-r16* is configured as true. Also, UL DCI-based BWP switching can be implemented by gNB to trigger UE changing a new active BWP quickly. Generally, gNB can rely on whether to receive a PUSCH in new BWP to judge whether the BWP switching is completed or not. However, if UL DCI triggers a BWP switching with scheduling a PUSCH in the new BWP, and skipping UL transmission is enabled simultaneously, UE may skip the PUSCH transmission if it has no data to transmit. In this case, gNB may get two understandings of UE’s active BWP without receiving UL transmission after an uplink grant indicating an active BWP switching is transmitted. The two understandings are shown as follows:

* **Understanding 1:** UE has switched to the new active BWP. The reason of no data received by gNB is that UE has received the uplink grant but there is no data to transmit.
* **Understanding 2:** UE still works on the legacy BWP. The reason of no data received by gNB is that UE misses the detection of the uplink grant.

The two understandings may cause the ambiguity of active BWP between gNB and UE.

**Problem:**

**When UL BWP switching is triggered by UL DCI and dynamic uplink skipping is enabled, the gNB does not know whether the UE has correctly received the DCI and now is operating in the new UL BWP or still in the old BWP.**

# 1st round Discussion

## Companies’ view

**Q1: How to resolve the ambiguity** **of active BWP between gNB and UE, and why?**

**Possible solutions:**

* When skipping UL transmission is enabled, UL grant-based BWP switching is avoided.
* gNB triggers a BWP switching only when it knows UE has data to transmit, i.e., based on SR or BSR
* Skipping UL transmission is temporarily disabled when active BWP is changed by UL grant
* Others are not precluded

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| **Company** | **Which understanding?** | **Comment** |
| DCM |  | The third one seems to be reasonable, but spec update should be applied not to RAN1 spec but to RAN2 spec, since the UE behavior will be that MAC layer shall generate UL-SCH for this situation, in our understanding.  [Comment moderator]: I think this can be part of the discussion if the group agrees on having a solution with spec impact. From moderators’ perspective, this should be possible. But for the RAN1 spec impact, we already have a concrete proposal that seems workable also and that I would like to take as starting point. |
| Apple | comments | We are ok with any solution with NO spec change for this issue, as it can be managed by gNB. For FDD, there is no problem to begin with given that UL and DL BWPs switch independently. The issue is mainly for TDD, where in addition to the first two sub-bullets, if gNB is not sure about UL data availability at the UE side, it can indicate BWP switch on DL (and consequently UE switches UL BWP as well). Once the HARQ-ACK on new UL BWP is received, gNB knows BWP switch is completed at the UE side. There could be other spec transparent solutions as well.  [Comment moderator]: For FDD there is a also problem. The UE may miss the DCI ordering the UL BWP switch. The proposed solution to switch UL BWP on DL is a major restriction in our view. The specification supports both UL BWP switching and DL BWP switching. Thus, we need to ensure both of them compatible with other features, such as UL skipping. |
| ZTE |  | Solution 1 or solution 2 can be up to gNB implementation. If gNB really do such scheduling, it will take the risk based on the current spec. It is up to gNB to assume UE in new or legacy BWP.  [Comment moderator]: This is exactly the problem we see today, the operator/NW do not take the risk and therefore UL skipping is not enabled. |
| QC |  | We think the issue can be resolved by either UE or gNB implementation, as the solutions listed above.  [Comment moderator]: We think the solutions mentioned above are more like work-arounds with significant drawbacks, leading to that the UL skipping will not be enabled by the NW and power therefore cannot be saved.  We don’t think spec change is needed. Two comments about spec change/potential CR.   1. The current TP need to clarify “disabling TP skipping” is one shot which only applies to this UL scheduling DCI which switching the BWP. In other words, it is non-sticky and does not applies to later UL scheduling DCI which does not switch UL BWP. 2. How to deal with legacy UE? If spec change is introduced, we assume there will be a new UE capability for this feature of “temporarily disabling UL skipping”. Then, how does gNB handle legacy UE which implemented solution 3 but cannot indicate the new UE capability?   [Comment moderator]: The gNB does not need to change its implementation for legacy UEs. |
| New H3C |  | Alt.1 and Alt.2 belong to gNB implementation or UE implementation.  Alt.3 potentiality has spec impact. If we go with alt.3, we need address UE cap issue raised by QC |
| Samsung |  | It seems that alts 1 and 2 do not have spec impact, while alt 3 may need spec update. We are open to discuss potential solution to address issue. |
| vivo |  | We believe gNB have sufficient methods to handle this issue.  Solution 1 or solution 2 can be used. |
| HW/HiSi |  | The issue exists and should be solved, since in current deployments we see that due to the ambiguity UL skipping is not enabled. This prevents the UE from large power saving opportunities.  The best solution would be a small spec change to send padding bits in case the UE has no real data to transmit. Then the NW can rely on an unambiguous situation and would “dare” to enable both UL BWP switching and dynamic UL skipping.  Other companies have mentioned solutions by implementation. We would like to discuss with them which solutions they have in mind. In our view, the work-arounds we can think about (e.g. waiting for UL data, disabling BWP switching, etc) all have significant drawbacks that result into the same situation as we already have today, i.e. that UL skipping is not enabled.  Therefore, we support “Skipping UL transmission is temporarily disabled when active BWP is changed by UL grant” |

## Summary of 1st round discussion

Thanks to all companies for their feedback during Round 1.

8 companies have responded (HW/HiSi, Samsung, New H3C, QC, ZTE, Apple, DCM, vivo).

* All companies acknowledge that there is an issue
  + 2 companies (HW/HiSi, DCM) prefer a spec change.
  + 2 company (Samsung, New H3C) are open to discuss all possible options
  + 4 companies (Apple, ZTE, QC, vivo) prefer a solution by implementation
* Apple listed one new Implementation approach (using DL BWP switching)

# 2nd round Discussion

Based on the feedback from the previous round it is clear that the ambiguity issue exists and a solution should be found. As a first step, it would be good to conclude this situation.

**Proposal 1:**

**Conclude that when UL BWP change is triggered (e.g. by DCI format 0\_1) and *skipUplinkTxDynamic* or *enhancedSkipUplinkTxDynamic-r16* is set as *true,* following ambiguity exists and that RAN1 should study candidate solutions:**

* **If the UE has no data to transmits, the gNB cannot know if the UE has successfully received the triggering DCI and understood the BWP change.**

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| **Company** | **Comment** |
| Hw/HiSi | Agree. |
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In the moderator’s view, the implementation-based approaches have significant drawbacks, and lead to that the power saving for the UE cannot be achieved in the end. The impacts for each solution are shown below.

Therefore, below the three mentioned implementation work arounds and the solution with spec impact are listed and companies are encouraged to share their views and please indicate whether and why you find this approach useful or not.

Collection of views regarding alternatives approaches:

**Implementation Approach#1**

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| **Implementation based approach #1** | When skipping UL transmission is enabled, UL grant-based BWP switching is avoided. | |
| **Company view** | Useful [Y/N] | Reason |
| Moderator | N | This prevents the NW from BWP switching also resulting into the same problem, that UE power cannot be saved (since BWP switching also is a feature for power saving). |
| HW/HiSi | N | This is not really a solution, but just not enabling the features that have been specified. RAN1 should ensure that several features can be used together. |
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**Implementation Approach #2**

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| **Implementation based approach #2** | gNB triggers a BWP switching only when it knows UE has data to transmit, i.e., based on SR or BSR | |
| **Company view** | Useful  [Y/N] | Reason |
| Moderator | N | This precludes pro-active scheduling from the gNB which already is widely used in live-network. UE might have transmitted all of its data in pre-scheduling resource, and **has no chance to report a SR or BSR**. This results that the condition for the gNB to trigger BWP changing cannot be met. |
| HW/HiSi | N | This would prevent pro-active scheduling, resulting in larger latency, and also can impact the gNB scheduling flexibility.  It will result into the same outcome as Approach #1, i..e that UL skipping is not enabled. |
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**Implementation Approach#3**

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| **Implementation based approach #3** | For TDD, if gNB is not sure about UL data availability at the UE side, it can indicate BWP switch on DL (and consequently UE switches UL BWP as well) | |
| **Company view** | Useful  [Y/N] | Reason |
| Moderator: | N | This is not a complete solution, since it only applies for TDD and uses DL part switching also UL BWP. But UL BWP switching should be supported independently from DL BWP switching with other features, such as UL skipping. |
| HW/HiSi | N | This is not a complete solution, since it only applies for TDD and uses DL part also UL BWP switching should be supported independently from DL BWP switching. |
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**Spec impact Approach**

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| **Implementation based approach #3** | Skipping UL transmission is temporarily disabled when active BWP is changed by UL gran | |
| **Company view** | Useful  [Y/N] | Reason |
| Moderator: | Y | This approach guarantees that the UE sends data and the gNB can know whether the UL BWP switch was successful. The spec impact is very small further details of the spec impact can be discussed.  UEs that are already deployed are not affected by this solution. |
| HW/HiSi | Y | This solution can resolve ambiguity and does not give other major drawback (as opposed to the implementation proposals).  We realize that there is spec impact, but it is really small. |
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The following proposal will of course depend on companies’ feedback to the tables above (which was not available yet). But to save time, I would like to outline a potential direction already now. So far, from the moderator’s perspective, significant and critical drawbacks with each implementation approach are expected. And the following tentative proposal for spec impact is made:

Companies are encouraged to give their view on the tentative proposal below:

**Tentative Proposal 2:**

**To resolve ambiguity when UL BWP change is triggered (e.g. by DCI format 0\_1) and *skipUplinkTxDynamic* or *enhancedSkipUplinkTxDynamic-r16* is set as *true,* specification impact is needed.**

* **Use the TP from Appendix A as starting point.**

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| **Company** | **Comment** |
| Hw/HiSi | Agree. |
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# Conclusions

To be updated.

# References

1. R1-2410601, Discussion on skipping uplink transmission in case of BWP switching, Huawei, HiSilicon
2. R1-2410602, Correction on skipping uplink transmission in case of BWP switching, Huawei, HiSilicon

# Appendix A. TS 38.213 v17.11.0, Clause 12, Draft TP

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| 12 Bandwidth part operation < Unchanged parts are omitted >  A UE does not expect to detect a DCI format with a BWP indicator field that indicates an active DL BWP or an active UL BWP change with the corresponding time domain resource assignment field providing a slot offset value for a PDSCH reception or PUSCH transmission that is smaller than a delay required by the UE for an active DL BWP change or UL BWP change, respectively [10, TS 38.133].  If a UE detects a DCI format indicating an active UL BWP change for a cell, and if a UE is configured with *skipUplinkTxDynamic* with value *true*, the UE transmits a PUSCH indicated by that DCI with the assumption of *skipUplinkTxDynamic* value as *false*.  If a UE detects a DCI format with a BWP indicator field that indicates an active DL BWP change for a cell, the UE is not required to receive or transmit in the cell during a time duration from the end of the third symbol of a slot where the UE receives the PDCCH that includes the DCI format in a scheduling cell until the beginning of a slot indicated by the slot offset value of the time domain resource assignment field in the DCI format or determined by the slot offset value corresponding to the first PDSCH of the more than one PDSCH scheduled by the DCI format for the cell.  < Unchanged parts are omitted > |