

Agenda item: 7.10.1

Source: Huawei, HiSilicon

Title: Further analysis on uplink transmission skipping

Document for: Discussion and Decision

1 Introduction

In the context of the Rel-13 Study Item “Study on Latency reduction techniques for LTE”, RAN2#91 discussed the uplink transmission skipping when no available data to transmit [1, 2], and the following agreements were made:

Agreements

- 1 It is beneficial to allow UEs to skip (most) dynamic and configured uplink transmissions if no data is available for transmission (the UE still sends the regular MAC CE, if any).
- 2 The eNB may enable this by RRC dedicated signalling.

In this contribution, we will provide further analysis on uplink transmission skipping if the UE has no available data to transmit, for both dynamic scheduling and SPS.

2 Discussion

According to the RAN2 agreement, even if the UE has already been provided with UL Grant (i.e. by either dynamic scheduling or SPS), the UE will still skip the UL PUSCH transmission in case there is no available data to transmit, as shown in Figure 1. Such an optimization can avoid the unnecessary UE battery consumption as well as uplink interference for the pre-scheduling scheme which is allowed by the standard today, for which the UE will anyway send something (e.g. Padding and/or Padding BSR) with the UL Grant.

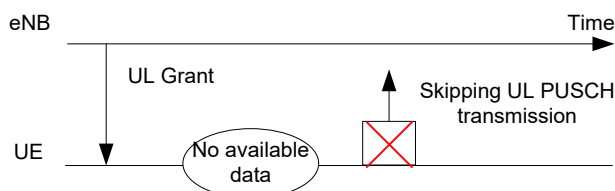


Figure 1: UL PUSCH transmission skipping

If UL grant is provided on PDCCH (i.e. by dynamic scheduling or during SPS activation), the eNB may miss the UL grant due to PDCCH loss. This means, for dynamic scheduling, in case of no UL PUSCH transmission, the eNB cannot distinguish if it is because of PDCCH loss or because of UL PUSCH transmission skipping due to no available data; for SPS, in case of no UL PUSCH transmissions in SPS opportunities, the eNB cannot distinguish if it is because of PDCCH (i.e. the PDCCH for SPS activation) loss or because of UL PUSCH transmission skipping due to no available data.

In RAN2#91, some solutions were proposed to address the above mentioned problem. For dynamic scheduling, it was proposed that the UE could send the BSR from time to time so that the eNB can detect PDCCH loss. Ideally, if the UE has available data to transmit according to the BSR report but doesn't perform UL PUSCH transmission after the provision of UL grant, the eNB could know that PDCCH loss happened. However, ambiguity still exists during the BSR report intervals. For SPS, it was proposed that the UE could send an empty MAC PDU or PUCCH ACK in response to the SPS activation command if there is no available data to transmit. By this way, the eNB can detect the PDCCH loss without any ambiguity. However, the efficiency is doubtful as the empty MAC PDU or PUCCH ACK will still cause UE battery consumption and uplink interference. Furthermore, the eNB may assign the same UL grant to multiple UEs, and in this case collision will happen after the reception of the SPS activation command if acknowledgement is required.

Actually, for both dynamic scheduling and SPS activation, it is not necessary for the UE to provide any feedback if there is no available data to transmit, since the PDCCH loss is a rare case (i.e. the PDCCH loss rate is only 1%). Even if PDCCH loss happens, we don't see any significant problem. For SPS, the UE can still ask for UL grant for data transmission by the SR procedure or RACH procedure, and the eNB will then re-initialise SPS for the UE to compensate the PDCCH loss. For dynamic scheduling, the next PDCCH scheduling will come in a short time to compensate the missing of the previous PDCCH. From the eNB perspective, for both dynamic scheduling and SPS, if the UE is a new UE and UL PUSCH transmission skipping is enabled by RRC signalling, in case no UL PUSCH transmission is detected after the provision of UL grant, the eNB doesn't need to response ACK/NACK on PHICH.

For both dynamic scheduling and SPS activation, "no feedback" will not cause more serious PUSCH resource waste compared to "feedback with empty MAC PDU or PUCCH ACK". Without introducing contention based PUSCH transmission (i.e. assign the same UL grant to multiple UEs), the PUSCH resource waste problem of the pre-scheduling scheme is there anyway.

Proposal: For both dynamic scheduling and SPS activation, the UE doesn't provide any feedback (e.g. empty MAC PDU or PUCCH ACK) if there is no available data to transmit.

3 Conclusion

In this contribution, we provided some further analysis on uplink transmission skipping if the UE has no available data to transmit, and we have the following proposal:

Proposal: For both dynamic scheduling and SPS activation, the UE doesn't provide any feedback (e.g. empty MAC PDU or PUCCH ACK) if there is no available data to transmit.

4 References

- [1] R2-153332, Skipping uplink transmission with no data to transmit; Samsung
- [2] R2-153490, L2 enhancements to reduce latency; Ericsson