

Agenda item: 8.8.2
Source: Qualcomm Incorporated
Title: Open issues for skipping UL grants
Document for: Discussion and Decision

1. Introduction

During the Study Item phase of “Latency reduction techniques for LTE” [1], RAN2 has concluded that shortening SPS periodicity and pre-allocation of dynamic grants can reduce uplink latency by allowing the UE to use these grants for faster access to transmissions. However, the current specifications require that UE send a padded PDU even when there is no data available for transmission in the UE buffer. Since this can create significant uplink interference and UE battery consumption with reduced SPS periodicities, it was also concluded that skipping UL grants when there is no data is available is beneficial.

The Work Item “New WI proposal: L2 latency reduction techniques for LTE” has the above conclusions as an objective as follows [2]:

- *Reduction of padding in case of dynamic and SPS based UL pre-scheduling to reduce interference and UE power consumption*
- *Further discussion and, if concluded, introduction of feedback for SPS activation, reactivation and deactivation command*

In this contribution, we discuss the open issues for skipping UL grants and provide resolutions.

2. Discussion

One of the open issues for skipping UL grants when there is no data is the handling of SPS configuration and mainly the activation and deactivation/release of SPS.

In the existing specification, the UE releases SPS configuration after sending *implicitRelease* after number of consecutive transmissions with zero MAC SDU. Since the UE will now be allowed to skip SPS transmissions when there is no data, the implicit release will never happen and thus SPS can only be deactivated by the PDCCH grant.

Observation 1: If skipping of UL grants when there is no data is enabled, the release of SPS will only happen with PDCCH grant for SPS deactivation.

The reliability of deactivation is now more important since if the UE misses the PDCCH grant, it will never release the SPS configuration and the eNB will not be aware of this. This can create a problem when the UE uses these grants to transmit data on the uplink before the eNB can detect and react to this. With the reduced SPS periodicities (e.g. every TTI) being planned in this WI, the interference before eNB reaction could be significant. Therefore, it is beneficial to have a more reliable mechanism for the eNB to confirm the release of SPS. This can be achieved by sending a feedback in response to the PDCCH grant with SPS deactivation as captured in the Study Item TR [3]. Even though this is a new UE behavior, it can be justified due to the removal of implicit release and reduced SPS periodicities. As discussed during the Study Item, this feedback can be in the form of MAC PDU containing zero MAC SDU. We note that HARQ feedback for UL SPS deactivation was discussed but not adopted by RAN1 in the past due to potential specification impact as additional UE handling in one UL subframe will be necessary in order to convey the HARQ responses for both DL traffic and UL SPS release; however using MAC PDU here will not interfere with DL traffic feedback.

Proposal 1: UE feedback for SPS deactivation should be used to prevent the uplink interference which can be triggered by PDCCH loss. The feedback will be in the form of MAC PDU containing zero MAC SDU.

For SPS activation, a similar feedback is also beneficial but, in this case, the fallback mechanism of UE starting an SR procedure can enable the eNB to detect the problem and re-initiate SPS or provide a dynamic grant. However, for uniform UE behaviour, it may be desirable to use feedback for both activation and deactivation.

Proposal 2: UE feedback for SPS activation similar to deactivation should be used for uniform UE behaviour.

Even though the current WI does not have any RAN1 allocation, skipping UL grants may also have impacts on PHY layer specifications. In particular:

1. **UCI Transmission:** In current specification (36.213), if the UE is not configured with simultaneous PUSCH and PUCCH, the UCI is sent on PUSCH if the UE is transmitting PUSCH on a subframe and PUCCH otherwise. It should be clarified which option applies when skipping UL transmissions is allowed when there is no data.
2. **TTI bundling:** TTI bundling is currently allowed for SPS. However, this will not be feasible when the SPS periodicity is very small. Therefore, the conditions when simultaneous configuration is allowed should be captured.

Proposal 3: RAN2 to send an LS to RAN1 for feedback on UCI transmission with UL skipping and TTI bundling with reduced SPS periodicities.

3. Conclusion

In this contribution, we discussed the open issue for skipping UL grants and propose the following:

Proposal 1: UE feedback for SPS deactivation should be used to prevent the uplink interference which can be triggered by PDCCH loss. The feedback will be in the form of MAC PDU containing zero MAC SDU.

Proposal 2: UE feedback for SPS activation similar to deactivation should be used for uniform UE behaviour.

Proposal 3: RAN2 to send an LS to RAN1 for feedback on UCI transmission with UL skipping and TTI bundling with reduced SPS periodicities.

4. References

- [1] RP-150465, “New SI proposal: Study on Latency reduction techniques for LTE”
- [2] RP-150667, “New WI proposal: L2 latency reduction techniques for LTE”
- [3] 36.881, “Study on latency reduction techniques for LTE”