

Agenda Item: 8.8.2
Source: ETRI
Title: Details of Short SPS procedure for latency reduction
Document for: Discussion and Decision

1. Introduction

RAN2 has actively discussed the Study Item, “FS_LTE_LATRED (Study on latency reduction techniques for LTE)”, and TR 36.881 includes RAN2 outcome and RAN1 performance evaluations. As a way forward, RAN #71 approved a Rel-14 Work Item “L2 latency reduction techniques for LTE” to realize the RAN2 agreement. The paper tries to describe the detailed procedure of Short SPS for uplink latency reduction.

2. Discussions

TR 36.881 includes the agreement of FS_LTE_LATRED and Rel-14 WID describes the scope of RAN2 discussion for latency reduction [1][2].

The objective of this work item is to specify L2 latency enhancements as identified in RAN2:

- Introduction of short SPS period to allow UL prescheduling
- 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

Based on the objective of the WI, detailed procedures need to be clarified and remained open issues would be handled for progressing the Stage 3 discussion.

During the SI discussion, RAN2’s consensus is that the introduction of Short SPS period is beneficial for uplink latency enhancement. Additionally, periodicity of 1 TTI can be easily added to RRC spec, *semiPersistSchedIntervalUL* for minimum value. So, it is the common understanding that the Short SPS mechanism is introduced in Rel-14 by reusing the existing LTE SPS procedure and the procedure includes RRC dedicated signaling for SPS configuration.

Proposal 1. Confirm that Short SPS periodicity (1 TTI) is supported for latency reduction.

Assuming Proposal 1, detailed SPS procedures, such as activation, deactivation, overriding, etc., need to be clarified for the efficient realization of the Short SPS mechanism. Prior to the discussion, it would be the RAN2’s consensus that UE’s Short SPS operation would be effective during the uplink time synchronization (*timeAlignmentTimer*) is established. If *timeAlignmentTimer* is expired, the activated SPS operation is deactivated implicitly.

Proposal 2. Short SPS procedure is stopped if uplink time synchronization is released.

2.1 Activation/deactivation

We think that the existing activation/deactivation procedure can be mostly reused and minor modifications may be required for the efficiency of the mechanism. So, the following procedure can be applied to the Short SPS.

For (re)activation, eNB uses PDCCH (re)activation mechanism and UE transmits PUSCH based on the successfully received UL grant. The UE always follows UL grants, so padding transmissions are essential for empty UL buffer. The eNB can determine the successful SPS (re)activation by the PUSCH data, thus additional new MAC CE for confirming SPS activation may be redundant.

For deactivation, both explicit and implicit deactivation mechanisms are reused for the Short SPS procedure. eNB transmits PDCCH deactivation and then UE stops the configured SPS without any feedbacks, such as padding or additional MAC CE. Explicit deactivation error can be protected by implicit mechanism and *implicitReleaseAfter* would have bigger value to accommodate 1 TTI periodicity.

Proposal 3. SPS (re)activation reuses PDCCH grant and PUSCH transmission.

Proposal 4. SPS deactivation reuses explicit and implicit deactivation procedure.

2.2 Skipping UL grants

Though the Short SPS is solely targeting at UL latency enhancements, continuous padding transmissions for UL grants may be seriously increase redundant transmissions and power consumption. So, skipping semi-persistently allocated UL grants would be the essential feature for SPS operations.

However, eNB's NACK transmissions might be inevitable since the eNB may not recognize UE's buffer status. The approach doesn't provoke additional errors since UE can ignore PHICH receptions when the UE has empty buffer.

Proposal 5. Skipping UL grants is necessary for efficiency.

Proposal 6. eNB follows typical HARQ procedure for PUSCH and UE ignores PHICH monitoring.

2.3 Overriding

Since the Short SPS reserves continuous resources, overriding situation happens frequently for PUSCH, PUCCH transmissions.

Considering PUSCH transmission, dynamic grant can override SPS allocation by using the existing LTE procedure. As an example, eNB would allocate PUSCH resources dynamically when the UE requests resources by BSR for larger UL resource. In this case, the UE follows the dynamic UL grant and ignores configured SPS grant. The procedure would be good for flexibility and system performance.

Additionally, PUCCH can be conveyed by SPS allocation if PUSCH and PUCCH have to be transmitted at the same subframe. However, the Short SPS has different characteristics considering skipping UL grants when UE has empty buffer. So, it would be discussed whether we decide to send PUCCH data through SPS resource at that situation. We support PUCCH data are transmitted via configured SPS resource only if UE

has data in the UL buffer. If not, entire PUCCH data may be transmitted by using PUSCH during the Short SPS operation.

Proposal 7. Dynamic UL grant overrides configured SPS resource.

Proposal 8. PUCCH data are transferred via configured SPS resource only if UE has data for PUSCH transmission.

2.4 Others

For latency enhancements, UE's power consumption may be increased to continuously handle UL data. Assuming DRX optimization, UE's operation can be slightly modified by restricting the DRX procedure. In addition, allowing SPS per cell would be considered to support adaptable configurations.

Proposal 9. DRX operation should be optimized for battery power saving.

3. Conclusion

The paper has described the detailed procedure of Short SPS for uplink latency reduction and suggests the following proposals:

Proposal 1. Confirm that Short SPS periodicity (1 TTI) is supported for latency reduction.

Proposal 2. Short SPS procedure is stopped if uplink time synchronization is released.

Proposal 3. SPS (re)activation reuses PDCCH grant and PUSCH transmission.

Proposal 4. SPS deactivation reuses explicit and implicit deactivation procedure.

Proposal 5. Skipping UL grants is necessary for efficiency.

Proposal 6. eNB follows typical HARQ procedure for PUSCH and UE ignores PHICH monitoring.

Proposal 7. Dynamic UL grant overrides configured SPS resource.

Proposal 8. PUCCH data are transferred via configured SPS resource only if UE has data for PUSCH transmission.

Proposal 9. DRX operation should be optimized for battery power saving.

4. References

[1] TR 36.881 Study on Latency reduction techniques for LTE

[2] RP-160667 New WI proposal: L2 latency reduction techniques for LTE, Ericsson