

Rel-19 Enhancements for Network Energy Savings (NES)

Agenda Item: 5

Source: Intel Corporation

Document for: Discussion



Introduction

- Extensive study on network energy saving was conducted during Release 18, and technical report TR38.864 [1] was published internally in 3GPP. Based on the technical report Release 18 work item for network energy saving was approved and work scope was defined [2].
- The Release 18 work item for network energy saving was targeted to be complete in 9 months and because of this limited number of potential enhancements identified from the study item selected as part of the scope.
- In this presentation, we discuss potential network energy savings enhancements that were not selected during Release 18 work item but have large energy saving benefits that could be good candidates for enhancements in Release 19.

[1] TR38.864 v18.1.0, "Technical Specification Group Radio Access Network; Study on network energy savings for NR," 3GPP, March 2023.

[2] RP-223540 New WID: Network energy savings for NR

Potential Enhancements for Rel-19

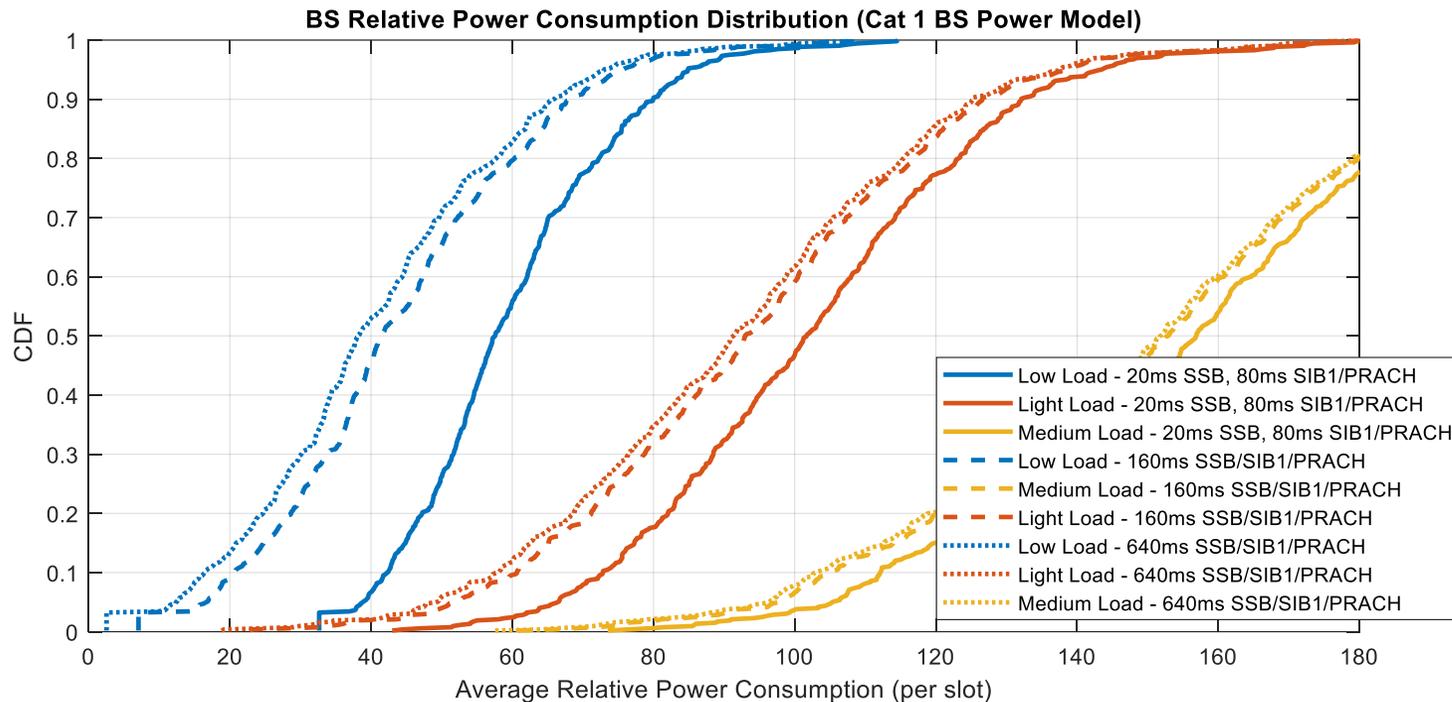
Motivation

- During Release 18 study item on network energy savings, several potential enhancements in time, frequency, spatial, and power domain were identified.
- However, only few potential enhancements were selected for Release 18 work item.
- For Release 19, we believe it will be beneficial to pick up some of the potential enhancements that provided good energy saving gains that were unfortunately not selected as part of the Release 18 work item.

Potential Enhancements

- All the techniques described in the TR38.864 not selected during Release 18 WI should be on the table for discussion.
- Among the enhancements,
 - Technique A-1: Common signal periodicity relaxation, including PRACH and paging
 - Technique A-5 adaptation of SSB/SIB1 including on-demand SSB/SIB1
 - Higher layer aspects for network energy savings:
 - Cell selection/reselection enhancements
 - Cell on/off in CU-DU split deployment
- Note:
 - Frequency domain techniques should not be considered, as no energy saving benefits were observed.

Improvements from common signal periodicity relaxation



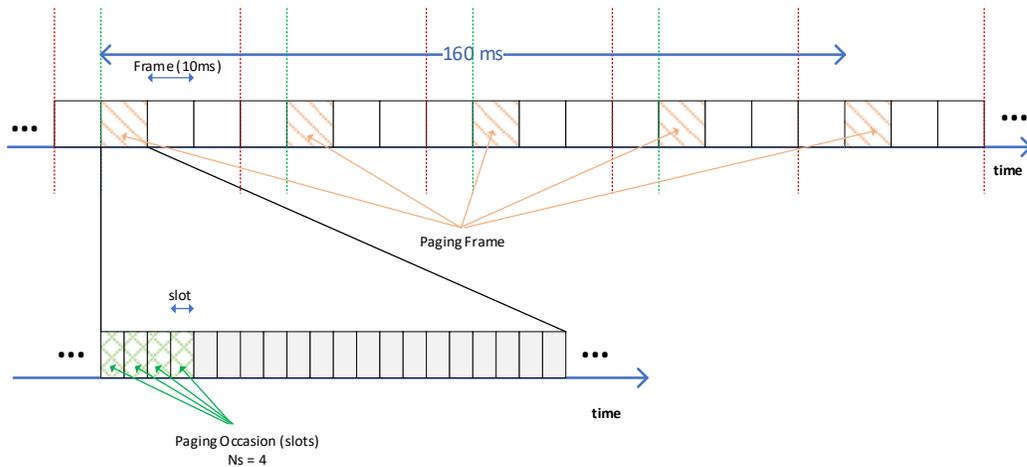
Observation :

- More than 30% power saving gains are observed when network is under low loads (below 15% resource utilization) and network increases the common signal transmission periodicity from 20 msec to 160 msec or longer.

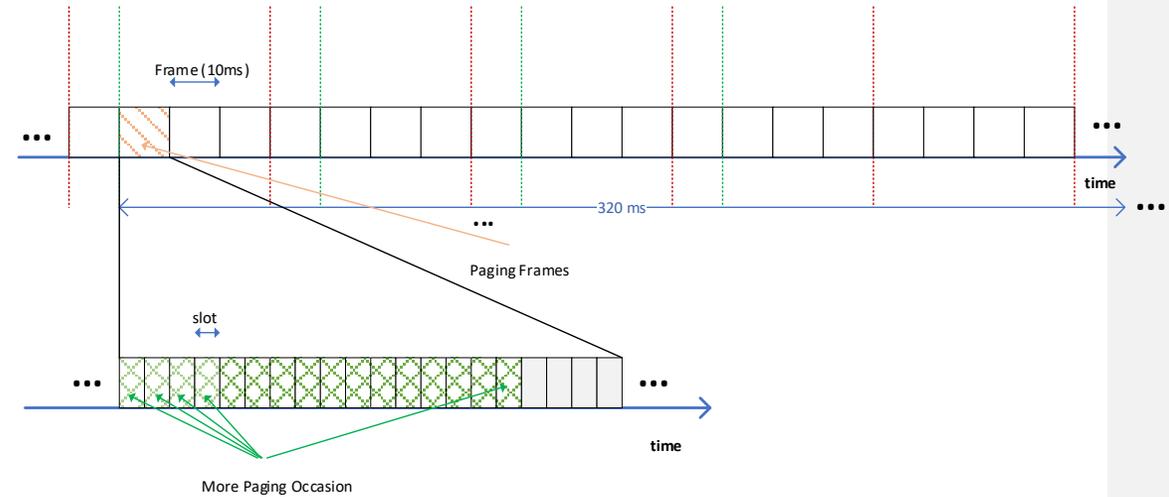
Relative power consumption comparison in low/light/medium load scenarios with 20, 160, and 640 msec SSB periodicity (Cat 1 BS Power Model).

Enhancements to Paging

$N = T/4, N_s = 4$
 $(SFN + PF_{offset}) \bmod T = (T/N) * (UEID \bmod N) = \{0, 4, 8, 12, \dots, T-4\}$
 $i_s = \text{floor}(UEID/(T/4)) \bmod N_s = \{0, 1, 2, 3\}$



Current: Rel-15 Paging frame and paging occasion allocation when $N = T/4$ and $N_s = 4$.

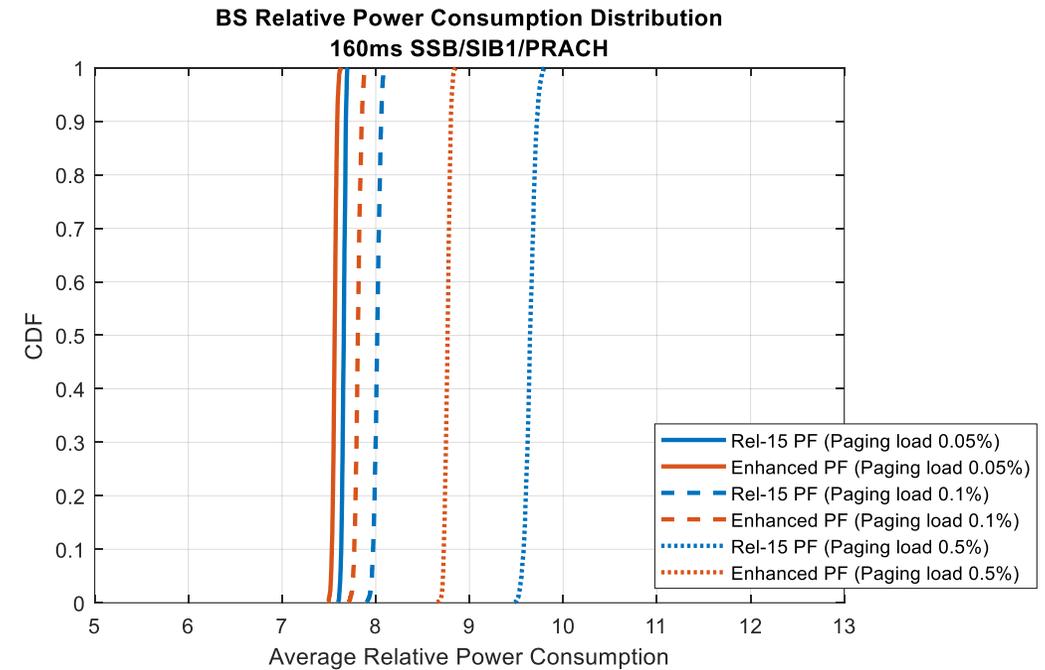
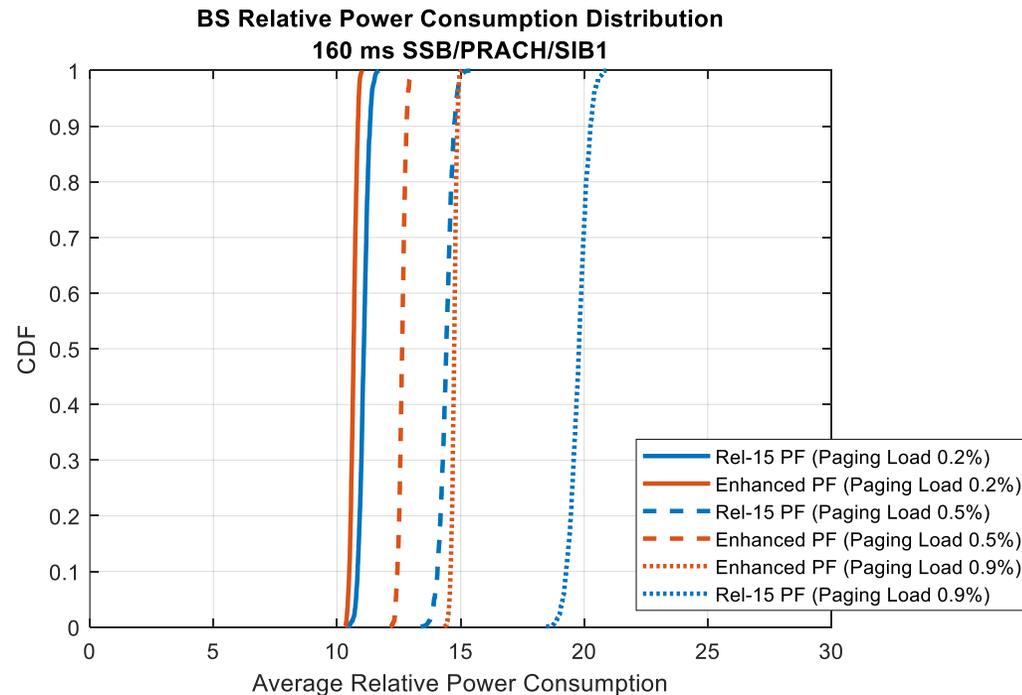


Potential enhancement: concatenate paging frame/occasion into consecutive frames or slots while maintaining the same paging occasion density.

Note: We expect similar enhancements to PRACH is feasible

Improvements from Paging Enhancements

Relative power consumption comparison between Rel-15 paging and enhanced paging with $N_s = 4, N = T/4$ and $N_s = 4, N = T/16$

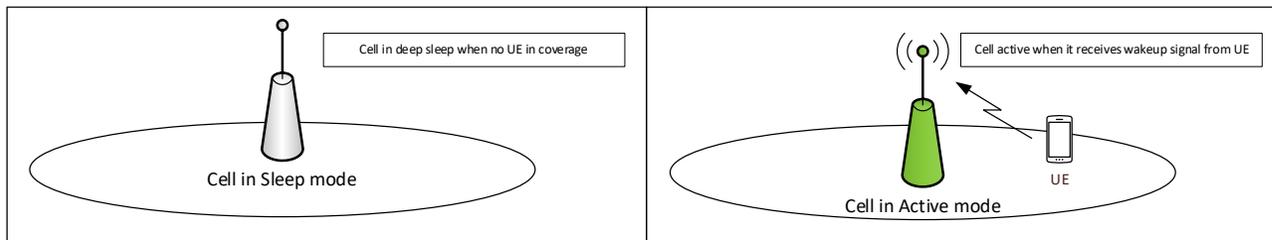


Observation :

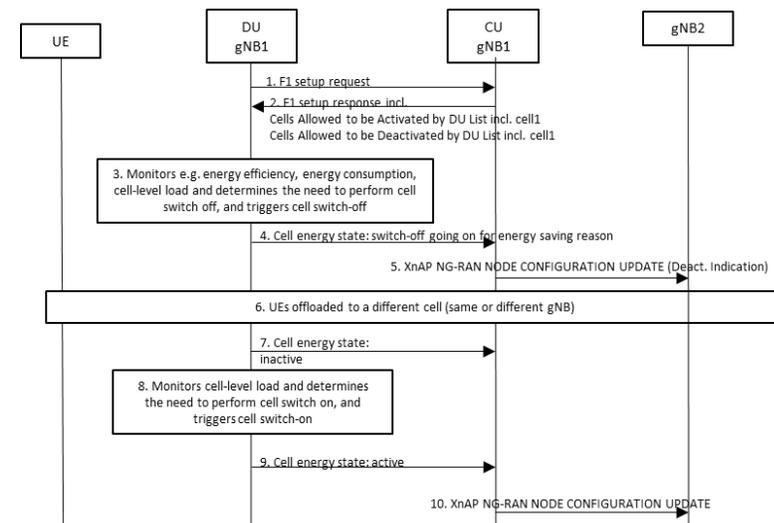
- Up to 25% power saving gains are observed from paging enhancement that compact the POs to be more bursty (e.g. consecutive slots and/or frames) when network is with zero data load (0% resource utilization) but with low paging loads.

Higher layer related enhancements

- Cell reselection enhancement
 - Enable NES-capable UE to prioritize/down-prioritize a specific NES cell or NES cells on a specific frequency
- Wakeup signal to wake up cell in deep sleep
 - Also act as on-demand SIB1 request



- Cell on/off in CU-DU split deployment
 - Option 1: CU-DU sync on detailed energy consumption information over F1 and CU decides cell on/off
 - Option 2: DU autonomy on cell on/off and informs CU



Conclusion

- Proposal 1:
 - Consider support of common signal periodicity relaxation and enhancements that enable gNB to increase the non-activity periods, including enhancements to PRACH and paging for Release 19.
- Proposal 2:
 - Do not consider frequency domain adaptation enhancements for network energy saving for Release 19.
- Proposal 3:
 - Consider support of reselection enhancement, i.e. prioritize/down-prioritize a specific NES cell or NES cells on a specific frequency, and on-demand SIB1 request based wake up signal.
- Proposal 4:
 - Consider support of cell switch-on/off in the gNB-DU.

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