Agenda item: **9.5.1**

Source: **ITRI**

Title: **Discussion on On-demand SSB SCell operation**

Document for: **Discussion and Decision**

1   Introduction

Since green future is one of the important goals to pursue, we may study how to save network energy for mobile communication system.   In RAN#98e plenary meeting (December 2022), RP-223540 "New WID: Network Energy Savings for NR" was approved to be a working item for NR Rel-18 [1].   In RAN#102 plenary meeting (December 2023), RP-234065 "New WID: Enhancements of network energy savings for NR" was approved to be a new working item for NR Rel-19 [2].

Specify procedures and signaling method(s) to support on-demand SSB SCell operation for UEs in connected mode configured with CA, for both intra-/inter-band CA. [RAN1/2/3/4]

- Specify triggering method(s) (select from UE uplink wake-up-signal using an existing signal/channel, cell on/off indication via backhaul, SCell activation/deactivation signaling)

- Note1: On-demand SSB transmission can be used by UE for at least SCell time/frequency synchronization, L1/L3 measurements and SCell activation, and is supported for FR1 and FR2 in non-shared spectrum.

This contribution aims to share our opinions on potential enhancements for on-demand SSB (OD-SSB) SCell operation in RAN1 aspect.

2   Discussion

SSB burst is comprised of a set of SSBs wherein different SSBs is potentially transmitted from different beams.   UE derives information required to access the cell by SSB burst, e.g. time-domain synchronization, frequency-domain synchronization, … etc.   For a conventional NR system, SSB burst is transmitted periodically wherein its SSB periodicity is configured via RRC {5ms, 10ms, 20ms, 40ms, 80ms, 160ms}, and the default SSB periodicity is 20ms.   Therefore, conventional SSB is always transmitted periodically, even when data transmission is not on-going.   Since conventional always-on SSB will cause unnecessary energy consumption for the network when there is no data transmission to UE, on-demand SSB SCell operation can be considered for preserving network energy.   And we shared our opinions related to on-demand SSB SCell operation in the following.

<u>Frequency Location of On-demand SSB</u>

For a cell supporting on-demand SSB SCell operation, the frequency location of on-demand SSB are discussed in the following.

Agreements Related to Frequency Location of On-demand SSB

RAN1 meeting for enhancements of network energy savings for NR was launched in RAN1 #116 [3]. RAN1 has discussed about the identified scenarios for on-demand SSB SCell operation. During the discussions, on-demand SSB SCell operation is supported at least for the following two cases: Case 1: On-demand SSB on the cell is not located on synchronization raster. Case 2: On-demand SSB on the cell is non-cell-defining SSB. For the frequency location of on-demand SSB, the following two cases were discussed: Case A: always-on SSB is CD-SSB on a synchronization raster. Case B: Always-on SSB is CD-SSB and not on a synchronization raster. The agreements related to the frequency location of on-demand SSB were made in the following [4][5]:

Agreement made in RAN1 #118

For a cell supporting on-demand SSB SCell operation, at least the following is supported

- On-demand SSB on the cell is not located on synchronization raster.

- On-demand SSB on the cell is non-cell-defining SSB

FFS: Additional support of OD-SSB for CD-SSB located on sync-raster

Agreement made in RAN1 #119

Down-select at least one of the following alternatives.

- Alt 1: If always-on SSB is CD-SSB on a synchronization raster, the frequency location of on-demand SSB is different from the frequency location of always-on SSB.

- Alt 2: If always-on SSB is CD-SSB on a synchronization raster, the frequency location of on-demand SSB is the same as the frequency location of always-on SSB

- Alt 3: Do not support the case where always-on SSB is CD-SSB on a synchronization raster.

Down-select at least one of the following alternatives.

- Alt A: If always-on SSB is CD-SSB and not on a synchronization raster, the frequency location of on-demand SSB can be same or different from the frequency location of always-on SSB, subject to its configuration.

- Alt B: If always-on SSB is CD-SSB and not on a synchronization raster, the frequency location of on-demand SSB is the same as the frequency location of always-on SSB

- Alt C: Do not support the case where always-on SSB is CD-SSB and not on a synchronization raster.

Always-on SSB is CD-SSB on a Synchronization raster

First, the frequency location of on-demand SSB is discussed if always-on SSB is CD-SSB on a synchronization raster. For this case, the following three alternatives are proposed to be down-selected:

- Alt 1: The frequency location of on-demand SSB is different from the frequency location of always-on SSB.

- Alt 2: The frequency location of on-demand SSB is the same as the frequency location of always-on SSB.

- Alt 3: Do not support the case where always-on SSB is CD-SSB on a synchronization raster.

For Alt 2, since legacy UEs must access CD-SSB on a synchronization raster for initial access, there are some ambiguities for legacy UEs performing initial access if the frequency location of on-demand SSB is the same as the frequency location of always-on SSB. On the other hand, Alt 1 may not cause confusion for the legacy UEs performing initial access, since the frequency location of on-demand SSB is different from the frequency location of always-on SSB. Therefore, we propose that RAN1 should at least support Alt 1 if always-on SSB is CD-SSB on a synchronization raster.

Observation 1:

- *Alt 2 may cause confusion for legacy UEs performing initial access, since the frequency location of on-demand SSB is the same as the frequency location of always-on SSB.*

Proposal 1:

- *RAN1 should at least support Alt 1 if always-on SSB is CD-SSB on a synchronization raster.*
  - *Alt 1: If always-on SSB is CD-SSB on a synchronization raster, the frequency location of on-demand SSB is different from the frequency location of always-on SSB.*

Always-on SSB is CD-SSB and not on a Synchronization Raster

Second, the frequency location of on-demand SSB is discussed if always-on SSB is CD-SSB and not on a synchronization raster. For this case, the following three alternatives are proposed to be down-selected:

- Alt A: If always-on SSB is CD-SSB and not on a synchronization raster, the frequency location of on-demand SSB can be same or different from the frequency location of always-on SSB, subject to its configuration.

- Alt B: If always-on SSB is CD-SSB and not on a synchronization raster, the frequency location of on-demand SSB is the same as the frequency location of always-on SSB

- Alt C: Do not support the case where always-on SSB is CD-SSB and not on a synchronization raster.

It may not cause confusion for the legacy UE access synchronization raster for initial access, since always-on SSB is CD-SSB and not on a synchronization raster. Therefore, Alt A and Alt B can both be supported for the frequency location of on-demand SSB in principle. However, if the frequency location of on-demand SSB is different from the frequency location of always-on SSB, the bandwidth required to transmit SSBs may be wide. Consider to minimizes the bandwidth required to transmit SSBs, RAN 1 should at least support Alt B if always-on SSB is CD-SSB and not on a synchronization raster.

Observation 2:

- *Alt A and Alt B can both be supported for the frequency location of on-demand SSB in principle.*

Proposal 2:

- *RAN 1 should at least support Alt B if always-on SSB is CD-SSB and not on a synchronization raster.*

- *Alt B: If always-on SSB is CD-SSB and not on a synchronization raster, the frequency location of on-demand SSB is the same as the frequency location of always-on SSB*

3   Conclusions

In RAN#102 plenary meeting (December 2023), RP-234065 "New WID: Enhancements of network energy savings for NR" was approved to be a new working item for NR Rel-19 [2].   This contribution aims to share our opinions on potential enhancements for on-demand SSB SCell operation in RAN1 aspect.   RAN1 meeting for enhancements of network energy savings for NR was launched in RAN1 #116 [3], and its related issue is also be discussed in RAN1 #116, and RAN1 #118 [4]-[5].   According to the above discussions, we have the following observations and proposals:

Observation 1:

- *Alt 2 may cause confusion for legacy UEs performing initial access, since the frequency location of on-demand SSB is the same as the frequency location of always-on SSB.*

Proposal 1:

- *RAN1 should at least support Alt 1 if always-on SSB is CD-SSB on a synchronization raster.*

  - *Alt 1: If always-on SSB is CD-SSB on a synchronization raster, the frequency location of on-demand SSB is different from the frequency location of always-on SSB.*

Observation 2:

- *Alt A and Alt B can both be supported for the frequency location of on-demand SSB in principle.*

Proposal 2:

- *RAN 1 should at least support Alt B if always-on SSB is CD-SSB and not on a synchronization raster.*

  - *Alt B: If always-on SSB is CD-SSB and not on a synchronization raster, the frequency location of on-demand SSB is the same as the frequency location of always-on SSB*

References

[1]   RP-223540, "New WID: Network energy savings for NR", Huawei, TSG-RAN Meeting #98e, December, 2022

[2]   RP-234065, "New WID: Enhancements of network energy savings for NR", Ericsson (Moderator), TSG-RAN Meeting #102, December, 2023

[3]   RAN1 Chairman's Notes for 3GPP TSG RAN WG1 #116

[4]   RAN1 Chairman's Notes for 3GPP TSG RAN WG1 #118

[5]   RAN1 Chairman's Notes for 3GPP TSG RAN WG1 #119