3GPP TSG RAN WG1 #120 **R1-2501020**
Athens, Greece, February 17th – 21st, 2025
Agenda Item: 9.5.1
Source: MediaTek Inc.
Title: On-demand SSB SCell operation
Document for: Discussion and decision

1. Introduction

In the WID of Rel-19 network energy savings (NES) [1], the objective of on-demand SSB SCell operation are listed as below:

- 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.

In RAN1 #119 [2], the following is agreed:

Agreement
Response to Q1 (What is the relation in terms of periodicity between always-on SSB and OD-SSB?) of Obj.1:
- The periodicity of on-demand SSB is one of 5 ms, 10 ms, 20 ms, 40 ms, 80 ms, or 160 ms.
- The periodicity of on-demand SSB can be configured separately from the periodicity of always-on SSB.
- RAN1 is discussing what is the relation between periodicity of always-on SSB and periodicity of on-demand SSB and it has been identified that the main use case is that the periodicity of on-demand SSB is equal to or smaller than that of always-on SSB.

Further update to be made based on RAN1#119 progress.

Agreement
Response to Q3 (What is the relation in terms of frequency location between the always-on SSB and OD-SSB?) of Obj.1:
- The frequency location of on-demand SSB is the same as the frequency location of always-on SSB at least for the case where always-on SSB is not CD-SSB. RAN1 is discussing the frequency location of OD-SSB for the case where always-on SSB is CD-SSB.

Agreement
Response to Q4 (What is the spatial relation between the always-on SSB and OD-SSB?) of Obj.1:
- SS/PBCH blocks with the same SSB indexes for always-on SSB and on-demand SSB are quasi co-located with respect to Doppler spread, Doppler shift, average gain, average delay, delay spread, and when applicable, spatial RX parameters.
  - Applies at least for the case when the centre frequency locations of always-on SSB and OD-SSB is same
- When a signal/channel is configured to be QCLed with a SSB index, the signal/channel is QCLed with the same SSB index of always-on SSB and on-demand SSB (if transmitted) with the same QCL parameters according to existing specifications
  - Applies at least for the case when the centre frequency locations of always-on SSB and OD-SSB is same

- At least the case where SSB indices within on-demand SSB burst are identical to SSB indices within always-on SSB burst is supported. RAN1 is discussing whether to support the case where SSB indices within on-demand SSB burst can be subset of SSB indices within always-on SSB burst.

Agreement

- For a cell supporting on-demand SSB SCell operation, support to configure time domain location of on-demand SSB per on-demand SSB periodicity by RRC for both Case #1 and Case #2.
    - For Case #1 (i.e., No always-on SSB on the cell),
        - Based on two parameters, where one is to indicate SFN offset from a reference point and the other is to indicate half frame index
            - The reference point is SFN which satisfies (SFN index *10) modulo (OD-SSB periodicity) = 0
            - If SFN offset parameter is NOT configured, UE assumes SFN offset set to 0.
            - If half frame index parameter is NOT configured, UE assumes half frame index set to 0.
            - The value range of SFN offset is 0 to 15 unless longer periodicity for on-demand SSB than 160 ms is introduced.
            - The value range of half frame index is 0 or 1.
    - For Case #2 (i.e., Always-on SSB is periodically transmitted on the cell), down-select one of the following alternatives.
        - Alt A: Same as for Case #1
        - Alt B: Based on a single parameter which is to indicate the time offset between always-on SSB and on-demand SSB (e.g., similar to *ssb-TimeOffset*)

Agreement

- New periodicity value for on-demand SSB other than the legacy values (i.e., 5 ms, 10 ms, 20 ms, 40 ms, 80 ms, or 160 ms) is NOT introduced in Rel-19.

Agreement

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.

Agreement

Response to Q2 (What is the relation in terms of time location between always-on SSB and OD-SSB?):

- RAN1 understands the time location of OD-SSB in Q2 refers to the time location of possible OD-SSB burst
- RAN1 is still discussing the relation in terms of time location between always-on SSB and OD-SSB

Agreement

For a cell supporting on-demand SSB SCell operation, support at least the following options to deactivate on-demand SSB transmission from a UE perspective.

- Option 1: Explicit indication of deactivation for on-demand SSB via MAC-CE for on-demand SSB transmission indication
    - Deactivation by RRC is up to RAN2
    - FFS: Which scenario Option 1 is used

- Option 2: Configuration/indication of the number N of on-demand SSB bursts to be transmitted after on-demand SSB is indicated
    - FFS: Whether Option 4, 4a is needed in addition to Option 2
    - FFS: Whether the value of N can be implicitly determined using a timer

This contribution provides our views on this topic.

2. Discussions of on-demand SSB SCell operation

2.1 Impact to legacy initial attachment

For a UE performing initial cell search, it would search SSB on the synchronization raster as defined in 38.101-1 [3] Clause 5.4.3. As the on-demand SSB is only transmitted temporarily, it is needed to ensure the on-demand SSB would not be used for initial cell search.

Observation 1: For a UE performing initial cell search, it would search SSB on the synchronization raster as defined in 38.101-1 [3] Clause 5.4.3. As the on-demand SSB is only transmitted temporarily, it is needed to ensure the on-demand SSB would not be used for initial cell search.

In RAN1 #118 [4], the following is agreed:

Agreement
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.

For on-demand SSB to be cell-defining SSB of an SCell, as one SCell of UE A can be PCell of UE B, it may still cause impact to legacy UEs.

Observation 2: For on-demand SSB to be cell-defining SSB of an SCell, as one SCell of UE A can be PCell of UE B, it may still cause impact to legacy UEs.

We hence have the following proposal:

Proposal 1: RAN1 does not support OD-SSB for CD-SSB located on sync-raster.

2.2 Frequency location of on-demand SSB

In RAN1 #119 [2], the following is agreed:

Agreement
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.

We have the following proposal.

Proposal 2: The frequency location of the on-demand SSB should be shifted if the always-on SSB is CD-SSB on the sync raster. I.e., we prefer Alt 1 agreed in RAN1 #119 below:

- **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.**

3. Conclusion

In this contribution, we focus on the discussions of on-demand SSB SCell operation and have the following observations and proposals:

Observation 1: For a UE performing initial cell search, it would search SSB on the synchronization raster as defined in 38.101-1 [3] Clause 5.4.3. As the on-demand SSB is only transmitted temporarily, it is needed to ensure the on-demand SSB would not be used for initial cell search.

Observation 2: For on-demand SSB to be cell-defining SSB of an SCell, as one SCell of UE A can be PCell of UE B, it may still cause impact to legacy UEs.

Proposal 1: RAN1 does not support OD-SSB for CD-SSB located on sync-raster.

Proposal 2: The frequency location of the on-demand SSB should be shifted if the always-on SSB is CD-SSB on the sync raster. I.e., we prefer Alt 1 agreed in RAN1 #119 below:

- **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.**

4. Reference

[1] RP-242354, “Revised WID: Enhancements of network energy savings for NR”, Ericsson, RAN #105

[2] Chairman’s Notes (Younsun’s Session), RAN1 #119 (Rel-19 9.5.1 On-demand SSB SCell operation)

[3] 3GPP TS 38.101-1, V18.4.0, “NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone”

[4] Chairman’s Notes (Younsun’s Session), RAN1 #118 (Rel-19 9.5.1 On-demand SSB SCell operation)