Agenda Item: 9.5.1

Source: **Spreadtrum, UNISOC**

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

Document for: Discussion and decision

1   Introduction

It was agreed in WID [1] to specify on-demand SSB for SCell operation.

> 1.   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.

We will share our view on on-demand SSB in this contribution.

2   Scenarios and cases

In RAN1#116 [2], at least the following scenarios (i.e. Scenario #2 and Scenario #3) were agreed to be
discussed.

> **Agreement**
>
> For the following identified scenarios for on-demand SSB SCell operation, focus future RAN1 discussion to down-
> select (both may be selected) between the two scenarios.
>
> - Scenario #2: SCell is configured to a UE but before the UE receives SCell activation command (e.g., as
>   defined in TS 38.321)
> - Scenario #3: After UE receives SCell activation command (e.g., as defined in TS 38.321)
>   - o   This does not preclude SCell for which activation is completed
>   - o   FFS: The case where SCell activation is completed
>
> FFS: Application timing between NW triggering message and on demand SSB transmission

Whether always-on SSB is transmitted in SCell should be clarified. In RAN1#116 [2], two cases for
assumption on always-on SSB was agreed.

> **Agreement**
>
> Regarding the UE assumption on SSB transmission on a cell supporting on-demand SSB SCell operation, the
> following cases are identified for further study:
>
> - Case #1: No always-on SSB on the cell
> - Case #2: Always-on SSB is periodically transmitted on the cell
> - FFS: Whether always-on SSB and on-demand SSB are not cell-defining SSB if transmitted.

- FFS: Which scenario the above applies for

In RAN1#116bis [3], Scenario #2 and Scenario #3 were further elaborated, and then Scenario #2A, Scenario #3A and Scenario #3B were introduced for discussion purpose. As first outcome, at least Scenario #2 and Scenario #2A can be supported.

> **Agreement**
>
> For the identified scenarios and cases (as per RAN1#116 agreement), on-demand SSB can be triggered by gNB at least for the following scenarios/cases:
>
> - Scenario #2 and Case #1
> - Scenario #2 and Case #2
> - Scenario #2A and Case #1
> - Scenario #2A and Case #2
> - FFS: Scenario #3A and Case #1
> - FFS: Scenario #3A and Case #2
> - FFS: Scenario #3B and Case #1
> - FFS: Scenario #3B and Case #2
> - For Case #1, once on-demand SSB is triggered, its transmission is in a periodic manner.
>   - Note: This does not imply periodic on-demand SSB is transmitted indefinitely after triggered.
> - Notes:
>   - Scenario #2A refers to
>   - "When UE receives SCell activation command (e.g., as defined in TS 38.321)"
>   - Scenario #3A refers to
>   - "After UE receives SCell activation command (e.g., as defined in TS 38.321) until SCell activation is completed"
>   - Scenario #3B refers to
>   - "When SCell activation is completed and SCell is activated" or
>   - "After SCell activation is completed and SCell is activated"
>   - For discussion purpose under AI 9.5.1, always-on SSB is SSB supported in Rel-18 specifications.
>   - Timing for on-demand SSB transmission (e.g. when the triggered SSB starts and ends) will be separately discussed.

The remaining issue whether Scenario #3A and 3B can be support. UE need SSB for AGC (automatic gain control), time/frequency synchronization before SCell activation. For Scenario #3A/#3B and Case #1, there is no always-on SSB in Scell, UE can't activate SCell due to lack of SSB. For Scenario #3A/#3B and Case #2, depend on always-on SSB, SCell activation can be achieved. The larger the SSB period, the longer for the SCell activation. It is more beneficial to indicate on-demand SSB before SCell activation if network want to decrease the duration of SCell activation. In our view, Scenario #3A and #3B is low priority in Rel-19.

Proposal 1   Not support Scenario #3A and #3B in Rel-19.

3   Mechanism of on-demand SSB transmission

In RAN1#116b [3], there are some options for mechanisms of on-demand SSB transmission.

Agreement

The following agreement from RAN1#116 is modified (in red)

- For SSB burst(s) ~~triggered~~indicated by on-demand SSB SCell operation, study at least the following options.
    - Option 1: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A.
    - Option 1A: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A until gNB turns OFF the on demand SSB
    - Option 2: UE expects that on-demand SSB burst(s) is transmitted from time instance A to time instance B and not transmitted after time instance B.
    - Option 3: UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted.
    - Option 4: UE expects that on-demand SSB burst(s) is transmitted with a periodicity from time instance A to time instance B and with the other periodicity after time instance B.
    - FFS: The combination of above options
    - FFS: How to define time instance A/B and the value of N per option
    - FFS: Each option is applicable to which Cases or Scenarios (as per the previous agreement)

In RAN1#118bis [4], options for deactivation indication of on-demand SSB were listed as follows.

Agreement

For a cell supporting on-demand SSB SCell operation, deactivation of on-demand SSB transmission is supported. In order to deactivate on-demand SSB transmission from a UE perspective, support at least one of the following options.

- Option 1: Explicit indication of deactivation for on-demand SSB via MAC-CE for on-demand SSB transmission indication
- Option 1A: Explicit indication of deactivation for on-demand SSB via RRC for on-demand SSB transmission indication
- Option 2: Configuration/indication of the number N of on-demand SSB bursts to be transmitted after on-demand SSB is indicated
- Option 3: Configuration/indication of the duration of on-demand SSB transmission window
- Option 4: On-demand SSB transmission, if any, is deactivated when UE receives SCell deactivation MAC-CE for the activated SCell
- Option 4A: On-demand SSB transmission, if any, is deactivated when the timer for SCell deactivation is expired
- Option 5: On-demand SSB transmission, if any, is deactivated when SCell activation is completed
- Option 6: Explicit indication of deactivation for on-demand SSB via [group-common] DCI
- FFS: Each option is applicable to which Cases or Scenarios
- FFS: Details related to each of the above options

It was agreed Option 1 and option 2 for on-demand SSB deactivation were support in RAN1 #119 [5].

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

On-demand SSB transmission and deactivation can be considered together. Similar as deactivation, Option 2 and 3 for on-demand transmission can be supported. For on-demand SSB transmission, option 2 mentions about starting point of on-demand SSB, e.g., time instance A. Time instance A for MAC-CE triggered is determined in previous meeting. Time instance A for RRC is FFS. In our view, we can follow legacy timeline/requirement for RRC message, e.g., RRC message reception timing as time reference A. We think SCell activation command or a time point after SCell activation command can be considered as time instance B for Scenario #2 and 2A respectively. Or for an unified design, deactivation for on-demand SSB can be considered as time instance B.

Proposal 2   RRC message (for on-demand SSB activation) reception timing can be considered as time reference A.

Proposal 3   For on-demand SSB transmission, Option 2 and 3 can be supported in Rel-19.

> *Option 2: UE expects that on-demand SSB burst(s) is transmitted from time instance A to time instance B and not transmitted after time instance B.*

> *Option 3: UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted.*

For on-demand SSB deactivation, for Option 1, a remaining issue is which scenario to use. It was agreed for Scenarios #2 and #2A, new MAC-CE is introduced to activate on-demand SSB. We think deactivation via MAC-CE can be used for Scenarios #2 and #2A.

Proposal 4   For on-demand SSB deactivation, Option 1 can be used for Scenarios #2 and #2A.

Option 4 and 4a means on-demand SSB deactivation is associated with Scell deactivation. Since after SCell deactivation UE does not need on-demand SSB anymore, we think option 4/4A can be considered.

Proposal 5   For on-demand SSB deactivation, Option 4 and 4A can be considered.

> *Option 4: On-demand SSB transmission, if any, is deactivated when UE receives SCell deactivation MAC-CE for the activated SCell*

Option 4A: On-demand SSB transmission, if any, is deactivated when the timer for SCell deactivation is expired

4   Always-on SSB vs. on-demand SSB

In RAN1#116bis [3], whether always-on SSB or on-demand SSB is cell-defining SSB was discussed and an agreement was drawn.

> **Agreement**
> - For a cell supporting on-demand SSB SCell operation,
>   - Note: It is up to gNB implementation whether always-on SSB (if transmitted) on the cell is cell-defining SSB or not.
>   - For on-demand SSB on the cell, downselect between the following alternatives
>   - Alt-1: It is up to gNB implementation whether on-demand SSB is cell-defining SSB or not.
>   - Alt-2: On-demand SSB is limited to non-cell-defining SSB.
>   - FFS: Further limitations to on-demand SSB

In RAN1 #118 [6], it was agreed that on-demand SSB is not located on synchronization raster and is NCD SSB.

> **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

In RAN1#119 [5], the frequency location of always-on SSB and on-demand SSB had been discussed when always-on SSB is CD-SSB.

> **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.

For the case when always-on SSB is CD-SSB and not on a synchronization raster, Alt A is more flexible.

We don't see strong motivation to restrict always-on SSB and on-demand SSB's frequency location. We prefer to leave the decision to gNB implementation.

For the case when always-on SSB is CD-SSB and on a synchronization raster, firstly, we should discuss whether to support OD-SSB for CD-SSB located on sync-raster or not.

Proposal 6   ***For the case when always-on SSB is CD-SSB and not on a synchronization raster, the frequency location of on-demand SSB and always-on SSB subject to network configuration.***

Proposal 7   ***RAN1 to discuss whether to support OD-SSB for CD-SSB on sync-raster or not.***

5   Conclusion

We have the following observations and proposals.

Proposal 1   ***Not support Scenario #3A and #3B in Rel-19.***

Proposal 2   ***RRC message (for on-demand SSB activation) reception timing can be considered as time reference A.***

Proposal 3   ***For on-demand SSB transmission, Option 2 and 3 can be supported in Rel-19.***

> ***Option 2: UE expects that on-demand SSB burst(s) is transmitted from time instance A to time instance B and not transmitted after time instance B.***

> ***Option 3: UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted.***

Proposal 4   ***For on-demand SSB deactivation, Option 1 can be used for Scenarios #2 and #2A.***

Proposal 5   ***For on-demand SSB deactivation, Option 4 and 4A can be considered.***

> ***Option 4: On-demand SSB transmission, if any, is deactivated when UE receives SCell deactivation MAC-CE for the activated SCell***

> ***Option 4A: On-demand SSB transmission, if any, is deactivated when the timer for SCell deactivation is expired***

Proposal 6   ***For the case when always-on SSB is CD-SSB and not on a synchronization raster, the frequency location of on-demand SSB and always-on SSB subject to network configuration.***

Proposal 7   ***RAN1 to discuss whether to support OD-SSB for CD-SSB on sync-raster or not.***

6   Reference

[1] RP-242354, "Revised WID: Enhancements of network energy savings for NR", Ericsson, RAN#105, Sep 9-12, 2024.

[2] 3GPP RAN1#116 Chair's Notes.

[3] 3GPP RAN1#116bis Chair's Notes.

[4] 3GPP RAN1#118bis Chair's Notes.

[5] 3GPP RAN1#119 Chair's Notes.

[6] 3GPP RAN1#118 Chair's Notes.