3GPP TSG RAN WG1 #120 **R1-2500263**

Athens, Greece, Feb 17th – 21st, 2025

Agenda Item: 9.5.1

Source: China Telecom

Title: Discussion on on-demand SSB operation for SCell

Document for: Discussion

1. Introduction

The new Rel-19 WI of network energy saving NR was approved in RAN#102 and revised in RAN #105[1], and the following objectives are included.

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.

In last meeting, the general principles and mechanisms were discussed on the on-demand SSB SCell operation, details can be found in [2]. Still, there are still multiple scenarios to be confirmed whether to study or not, and the details about the mechanism are not decided yet. In this contribution, we further discuss the issues about scenarios, the configuration mechanism and time window, providing some observations and considerations on such mechanism.

1. Consideration on scenarios for on-demand SSB Scell operation

In RAN1 #116 meeting, the following agreements was reached on the scenarios for on-demand SSB Scell operation [2], whether to support Scenario #3A and #3B are to be further discussed.

Agreement (RAN1#116bis)

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.

Considering the indication agreed to be specified, the activation mechanism of on-demand SSB with MAC CE based indication can be illustrated in Fig 1.

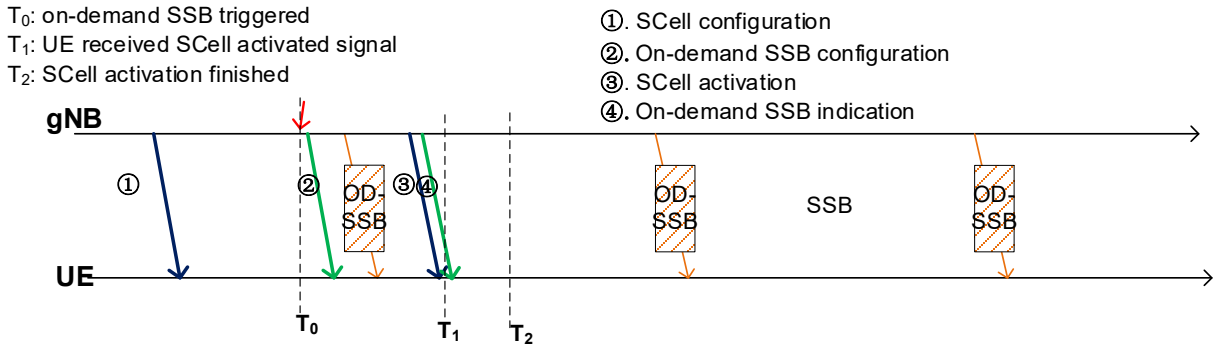

Fig 1-1 MAC CE based indication for Scenario #2

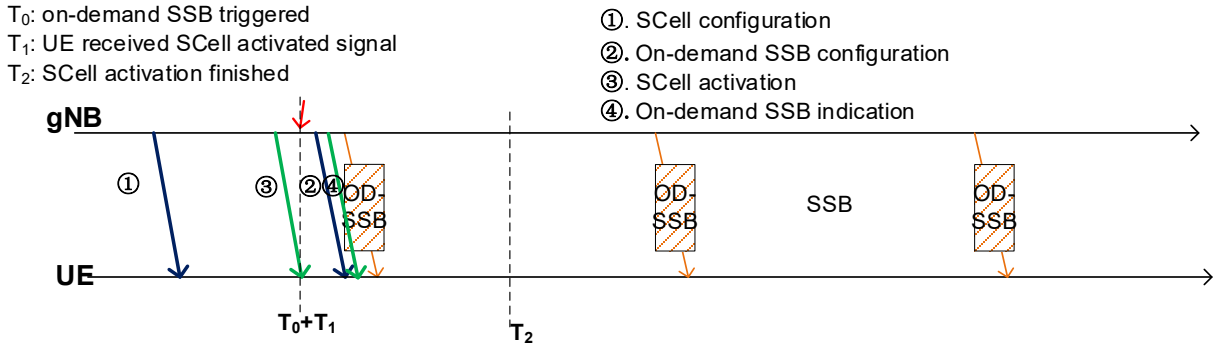

Fig 1-2 MAC CE based indication for Scenario #2A

For further discuss whether to support other scenarios, we think at least two aspects can be taken into consideration:

- Motivation to support such scenario.

Motivation is the most import issue when make the determination. If the demand to support such scenario does exist, the scenario should be supported regardless of how much the spec impact will be caused.

- Spec impact

  For some scenarios, the motivation may not be strong enough, but compared with the supported scenario, i.e. Scenario #2/#2A with Case #1/2, there is few or no more spec impact, such scenarios can be supported at the same time.

According to the above principle, the rest of scenarios are analysed and discussed below.

Scenario #3A/3B and Case #1

The illustration Scenario #3A and Case #1 is shown in Fig 2. The motivation of supporting this situation is not clear. The Scell has been activated without configured periodical SSB, then the SCell should have been configured as an SSB-less. It is unreasonable that a SCell not configured with periodical SSB transmission will require the transmission of on-demand just after the SCell activation is transmitted without any feedback from UE or evaluation from network.

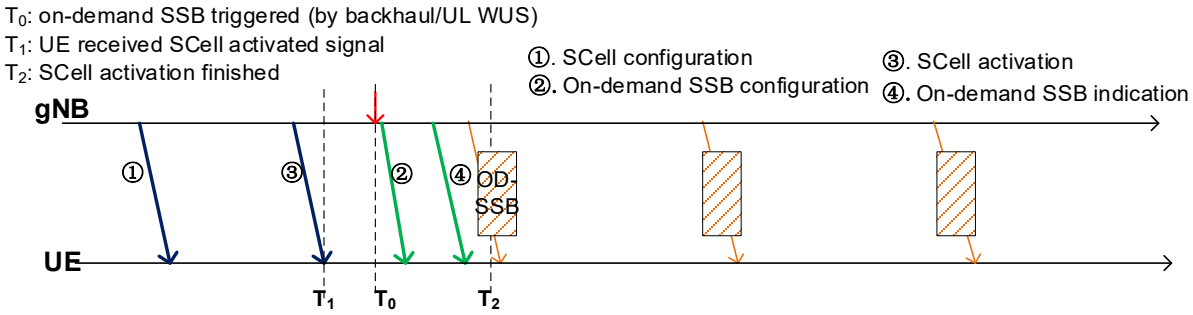

Fig 2 illustration of Scenario #3A and Case #1

Observation 1: The motivation for supporting on-demand SSB for Sceanrio#3A with Case #1 is not clear.

The illustration of Scenario #3B and Case #1 is shown in Fig 3. From our point of view, such situation can be needed. For instance, the SCell can be configured as SSB-less, but the RA/measurement/synchronization performance can't satisfy the demand of UE. On-demand SSB may be needed to ensure the performance in this situation.

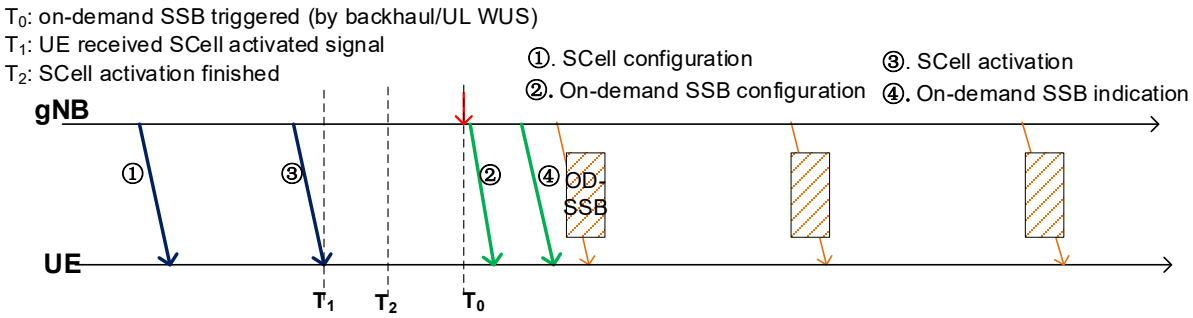

Fig 3 illustration of Scenario #3B and Case #1

In such case, an independent signalling to indicate the OD-SSB is needed, which can be also needed for Scenario #2/#2A. In Scenario #2/#2A, the OD-SSB can be terminated after transmission for a period of time, then a separate indication signalling may also be needed if on-demand SSB is retransmitted and be re-indication, as shown in Fig 4. In such situation, an independent signalling indication of on-demand SSB is still needed.

Proposal 1: Support to introduce a separate signaling to re-indicate UE the on-demand SSB for SCell after the transmission of on-demand SSB restarts after a period of de-activation.

- ***FFS: whether the MAC CE based initial indication for on-demand SSB can be reused.***

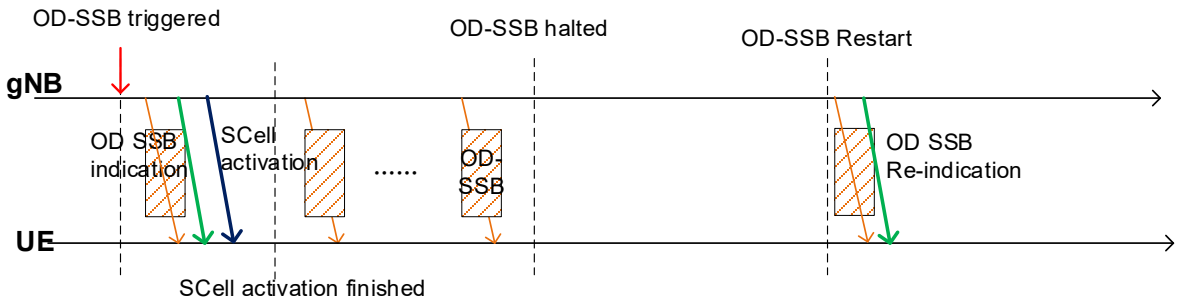

Fig 4 illustration of re-indication of on-demand SSB

The signalling mechanism in above situation can be totally reused in Scenario #3B with Case #1. Thus, it is reasonable to support Scenario #3B and Case #1.

Proposal 2: Support Scenario #3B and Case #1 for on-demand SSB for SCell operation.

However, further comparing Scenario #3A and #3B with Case 1, there is no difference between two situations from the aspects of the signalling design. Thus, Scenario #3A and Case #1 can also be supported if Scenario #3B and Case #1 is supported.

Observation 2: Support Scenario #3A and Case #1 for on-demand SSB if Scenario #3B and Case #1 is supported doesn't cause extra spec impact.

Scenario #3A/3B and Case #2

From our perspective, if on-demand SSB is adopted in scenarios with Case #2, the transmission periodicity of always-on SSB should be larger than that of legacy default value, otherwise on-demand SSB can't bring any NES gain. Thus, the motivation to support Scenario #3A/B with Case #2 should be the same as that with Case #1. As it is agreed in RAN1#116[3] that a common design is strived for on-demand SSB operation considering all applicable CA configurations, as much as possible scenarios should be supported with the same signaling mechanism and framework. Thus, we think supporting Scenario #3B and Case #2 is a situation with strong motivation but little spec impact compared with Scenario #3B with Case #1, and support Scenario #3A and Case #2 can also be supported since there is no more spec impact.

Observation 3: Scenario #3A and Case #2 can also be supported for on-demand SSB for SCell operation if Scenario #3B and Case #2 is supported.

Proposal 3: Support Scenario #3B and Case #2 for on-demand SSB for SCell operation.

2. Considerations on the indication method of on-demand SSB Scell Operation

For the indication method, the DCI based signalling is also not precluded currently. DCI based signalling can indicate the on-demand SSB more efficient. But at least for scenario #2 and #2A, the DCI must be transmitted after the SCell is activated, which means the RRC/MAC CE based signal should have already transmitted. There won't be any benefits to support the DCI based signalling from the aspect of efficiency.

Observation 4: There is no benefit to support DCI based initial indication for on-demand compared with RRC/MAC CE based signalling for scenario #2 and #2A.

And for Scenario #2/#2A mentioned above, when the OD-SSB is retransmitted after the initial transmission of OD-SSB has been terminated, DCI based signalling can be a be much more efficient choice. Since the on-demand SSB

for Scell is configured and SCell is already activated, on-demand SSB can be activated at the same when there are signal/channel to be scheduled with DCI.

Observation 5: For the re-indication of on-demand SSB for SCell operation, DCI based signalling can be more beneficial with high efficiency.

Besides, for Scenario #3A and #3B, DCI based indication method can be quite beneficial. After the on-demand SSB for Scell is configured, on-demand SSB can be activated at the same time when there are signal/channel to be scheduled by DCI, which can enhance the efficiency of indication.

Proposal 4: Support DCI based signalling for on-demand SSB indication if scenario #3A and/or #3B are/is supported.

3. Considerations on the relation of on-demand SSB with always-on SSB

Based on the discussion on the LS[R1-241-886] about the relation between OD-SSB and always-on SSB in last meeting, multiple agreements were reached. However, for the following agreements, there are still some issues need to be further discussed.

Agreement

Response to Q2 (What is the relation in terms of time location between always-on SSB and OD-SSB?) of Obj.1:

- 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

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 relation of time location between on-demand SSB and always-on SSB, the main issue is whether there can be overlap between OD-SSB and always-on SSB. Where there was also an agreement reached in RAN1 #118bis meeting.

Agreement

For a cell supporting on-demand SSB SCell operation and for Case #2 (i.e., Always-on SSB is periodically transmitted on the cell), study at least the following Mux-Cases.

- Mux-Case #1: No time-domain overlap between always-on SSB and on-demand SSB

- Mux-Case #2: Always-on SSB and on-demand SSB overlap at least in time or frequency domain

From our perspective, the principle to handle this issue is to avoid the OD-SSB and always-on SSB transmitted with overlap in time domain, which can be a waste of energy. Basically, it can be up to gNB's implementation to configure the transmission time of each type of SSB so that there is no such overlap. What's more, it should also be avoided that two neighbor SSBs in different type are transmitted within a short time period, which will also waste energy.

Observation 6: OD-SSB and always-on SSB transmitted close to each other in time domain should also be avoided to save energy.

Thus, a time interval T_0 should be introduced and defined, within which there should be only SSB from one of the SSB bursts transmitted.

Proposal 5: There should be no on-demand SSB and always-on SSB transmitted within a specific time period so that the largest NES gain can be acquired.

For the frequency location relation of on-demand SSB and always-on SSB, it hasn't been decided that whether the frequency location can be the same if always-on SSB is CD-SSB. From our perspective, it is not reasonable to restrict always-on SSB to NCD-SSB. It is legacy to transmit CD-SSB with a larger periodicity, e.g. 160ms, and the motivation to introduce on-demand SSB is to save energy with transmission SSB with smaller periodicity in such case. What's more, even if always-on SSB can be CD-SSB, on-demand SSB can be NCD-SSB for L1/L3 measurement. Thus, there is no need to constrain always-on SSB to be NCD-SSB. Also, since the on-demand SSB and always-on SSB can be different types of SSB, there is no need to align the frequency location of on-demand SSB and always-on SSB.

Proposal 6: Support Alt1, i.e., 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.

Proposal 7: Support 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.

Besides, We think on-demand SSB can be applied to CD-SSB. On the one hand, as specified in TS 38.331 [5], the periodicity of NCD-SSB should be larger than that of CD-SSB. For on-demand, no matter whether always-on SSB exists, the periodicity of OD-SSB should always smaller than that of always-on SSB. So, if the OD-SSB is limited to NCD SSB only, there shouldn't be any CD-SSB transmitted on the SCell, which is not reasonable. On the other hand, in current specs, mechanism for SSB-less can be supported for CD-SSB. The network will schedule the SCell configured as SSB-less only served as SCell for all the UEs, so that no UE will be impacted due to the SSB variation on the PCell. For on-demand SSB, such mechanism can also be reused.

***NonCellDefiningSSB* field descriptions**
absoluteFrequencySSB Frequency of the NCD-SSB. The network configures this field so that the SSB is within the bandwidth of the BWP configured in *BWP-DownlinkCommon*.
ssb-Periodicity The periodicity of this NCD-SSB. The network configures only periodicities that are larger than the periodicity of serving cell's CD-SSB. If the field is absent, the UE applies the SSB periodicity of the CD-SSB (*ssb-periodicityServingCell* configured in *ServingCellConfigCommon* or *ServingCellConfigCommonSIB*).

Proposal 8: On-demand SSB should be supported for CD-SSB located on sync-raster.

- ***Cells adopting on-demand SSB won't be serving as PCell for any UE with network's scheduling.***

4. Considerations on the configuration of on-demand SSB Scell Operation

The following agreement was reached on on-demand SSB configuration of time location in RAN #119

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*)

Firstly, it has been agreed in RAN1#116 that a common design is strived for on-demand SSB operations, which means the configuration method of time domain location of on-demand SSB should be the same in principle. Secondly, since on-demand SSB and always-on SSB should be transmitted in different periodicity, if Alt B is adopted, the time offset should be applied to which always-on SSB should also be configured, which can cause a large latency since the periodicity of always-on SSB is large. Thus, we think for Case #2, the same configuration method for time domain location of on-demand SSB as Case #1 should be adopted. Besides, it should be noticed to keep the smallest possible offset between on-demand SSB and always-on SSB should be larger than a time interval, so that there will be less energy consumption for the same purpose.

Proposal 9: For Case #2, support reuse the same configuration method of time domain location for on-demand SSB as Case #1.

The following (possible) agreements on on-demand SSB for SCell operation were reached in RAN1#118[4] and #118bis[2] meeting.

Possible Agreement @118

- For a cell supporting on-demand SSB Scell operation,
  - More than one on-demand SSB configurations can be configured for the cell to UE, e.g., on-demand SSB config #0, on-demand SSB config #1, and so on.
  - If multiple on-demand SSB configurations for the cell are provided to UE,
    - RRC signaling for on-demand SSB transmission indication configures an index for one of multiple on-demand SSB configs.

        - MAC CE signaling for on-demand SSB transmission indication indicates an index for one of multiple on-demand SSB configs.
    - **If on-demand SSB transmission is indicated by MAC CE,** two sets for information on on-demand SSB are defined as follows.
        - Info-Set 1: Information for on-demand SSB that can be included in on-demand SSB config, e.g.,
            - Frequency of the on-demand SSB
            - SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*
            - Periodicity of the on-demand SSB
            - Sub-carrier spacing of the on-demand SSB
            - Physical Cell ID of the on-demand SSB
            - Location of on-demand SSB burst
            - Downlink transmit power of on-demand SSB
            - The number of SSB bursts
            - The value of T (for determining time instance A)
            - FFS: If above parameters are not included in on-demand SSB config.
        - Info-Set 2: Information for on-demand SSB that can be carried by MAC CE signaling for on-demand SSB transmission indication, e.g.,
            - Index of on-demand SSB config
            - Scell index
            - SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*
            - Periodicity of the on-demand SSB
            - The number of SSB bursts
            - The value of T (for determining time instance A)
            - Deactivation of on-demand SSB

Agreement @118

For a cell supporting on-demand SSB SCell operation, at least for the following parameter(s), multiple candidate values can be configured by RRC and the applicable value can be indicated by MAC CE for on-demand SSB transmission indication for the cell.

- Periodicity of the on-demand SSB
- FFS: Any other relevant parameters

Agreement @118bis

- For a cell supporting on-demand SSB SCell operation, support to provide at least the following parameters for on-demand SSB configuration by RRC at least for Case #1.
    - Sub-carrier spacing of the on-demand SSB
        - FFS if this can be absent
    - Physical Cell ID of the on-demand SSB
    - FFS: Time domain location of on-demand SSB burst such as SFN offset and half frame index

- Downlink transmit power of on-demand SSB
- FFS: The number N of on-demand SSB bursts to be transmitted after on-demand SSB is indicated
- FFS whether the above parameters are configured by reusing legacy RRC parameters or new RRC parameters

For the configurations of on-demand SSB, it is supported to configure multiple sets for parameters with RRC signalling, then chose one of them to be activated and indicated. Such mechanism can make the on-demand SSB more efficient considering that the on-demand SSB can be reindicated and retriggered after a period.

However, based on our understanding, on-demand SSB 'triggered' means that on-demand SSB will be transmitted at once, which can be even earlier than the on-demand SSB configuration. And currently only Scenario #2 and #2A are supported, which means the configuration of on-demand SSB should have already been decided when it is triggered before the on-demand SSB activated finished. Thus, at least for on-demand SSB indicated with RRC, where the on-demand SSB configuration and indication are transmitted with SCell configuration and activation at the same time, there should be only one on-demand SSB configuration, and triggered by the SCell activation, i.e., *sCellstate* is set to configured in the RRC configuration, as specified in TS 38.321 [4].

The configured SCell(s) is activated and deactivated by:

- receiving the SCell Activation/Deactivation MAC CE described in clause 6.1.3.10;
- receiving the Enhanced SCell Activation/Deactivation MAC CE described in clause 6.1.3.55;
- configuring *sCellDeactivationTimer* timer per configured SCell (except the SCell configured with PUCCH, if any): the associated SCell is deactivated upon its expiry;
- configuring *sCellState* per configured SCell: if configured, the associated SCell is activated upon SCell configuration;
- receiving *scg-State*: the SCells of SCG are deactivated.

Proposal 10: At least for the RRC-indicated on-demand SSB, there should be only one set of RRC configuration for on-demand SSB.

For the detail of parameters, for RRC-based OD-SSB, for Case #1, where no always-on SSB exists, sub-carrier spacing of the on-demand SSB shouldn't be absent. While for Case #2, if sub-carrier spacing is absent, this parameter should follow the configuration of always-on SSB.

Proposal 11: Sub-carrier spacing shouldn't be absent for Case #1; And for Case#2, this parameter should reuse that of always-on SSB if it is absent.

Also, at least for the on-demand SSB indicated for the first time, when multiple RRC configurations of on-demand SSB exist, from our point of view, the only work MAC CE indication needs to do is to indicate which configuration is being transmitted. For parameters in Info-set 1, we think they should all be configured in RRC parameters, to configured so many parameters with large range of candidate values in MAC CE is not the typical mechanism in specs. Thus, Info-Set 1 should not be carried by MAC CE signalling for on-demand SSB transmission indication.

Proposal 12: Not support the parameters in Info-Set 1 to be carried in the MAC CE signalling for on-demand SSB transmission indication.

For Info-Set 2, if multiple on-demand SSB configurations already be configured, when re-indicating the transmission of on-demand SSB, it is not reasonable to update the configurations via MAC CE, otherwise, there is no need to configure multiple set of RRC parameters for on-demand SSB. As for parameters deactivation of on-demand SSB, it

should depend on the mechanism of how to terminate the activation period of on-demand SSB. If a window is configured when configured, the deactivation information is not needed.

Observation 7: There is no need to configure/update the parameters already configured with RRC configuration for on-demand SSB in Info-Set 2 in the MAC CE indication.

Proposal 13: Only Index of on-demand SSB config and parameters related to the deactivation of on-demand SSB should be carried by MAC CE signalling for on-demand SSB indication.

5. Considerations on mechanism of on-demand SSB transmission on SCell

And in RAN1#119, the following agreements were reached on how define the period that on-demand can be detected by UE.

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

Agreement @118bis (for reference)

- 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

For Option 1, we think it can be applied to all the supported scenarios, i.e. Scenario #2/#2A. For both Scenarios, regardless of the indication is based on RRC or MAC CE, which means the on-demand SSB can be deactivated at any time, the function of deactivation signaling via MAC-CE is decoupled with that of activation. Thus, Option 1 can be applied to all the scenarios for on-demand SSB.

Proposal 14: For the deactivation of on-demand SSB, Option 1, i.e., Explicit indication of deactivation for on-demand SSB via MAC-CE, can be applied to all the scenarios.

Support Option 4 and 4A means that on-demand SSB can be deactivated when SCell is deactivated, which are the legacy mechanism. Since on-demand SSB is only applied to SCell, we think it is nature to also deactivate the on-demand SSB when SCell is deactivated. Thus, Option 4 and 4A can be needed in addition to Option 2, which will reduce the signaling overhead.

Proposal 15: For the deactivation of on-demand SSB, Option 4 and 4A, i.e., the deactivation of SCell, can be sued as the deactivation signal in addition to Option 2.

And for Option 2, to indicate the time window of OD-SSB with value of N or using the timer are actually the same, as long as the periodicity of SSB burst is configured, which was agreed to be supported in former meetings. Thus, we think there is no need to further support to indicate value of N can be implicitly using a timer.

Proposal 16: For the deactivation of on-demand SSB, there is no need to further support to indicate value of N can be implicitly using a timer for Option 2.

6. Consideration on L1 measurement with on-demand SSB

In RAN #118bis, following agreement was reached on L1 measurement with on-demand SSB.

Agreement

- For a cell supporting on-demand SSB SCell operation and for Case #2 (i.e., Always-on SSB is periodically transmitted on the cell), consider only one or both of the following options for UE to perform L1 measurement based on on-demand SSB.
  - Option 1: A CSI report configuration is associated with both of on-demand SSB and always-on SSB
  - Option 2: A CSI report configuration is associated with one of always-on SSB and on-demand SSB
  - FFS: Whether OD-SSB and always on SSB have same beam or not

From out prospective, for CSI report configuration can be associated with any SSBs, regardless of on-demand SSB or always-on SSB. For Case #2, if the always-on SSB is NCD SSB, which are only used for measurement, since they are not terminated when on-demand SSB is indicated, we think the measurement should be done on both OD-SSB and always-on SSB to maximum measurement performance can be acquired. Or the CSI report configuration can only be associated with the on-demand, otherwise there is no need to trigger the on-demand SSB.

Proposal 17: For a cell supporting on-demand SSB SCell operation and for Case #2, CSI report configuration can be associated with both of n-demand SSB and always-on SSB or only with on-demand SSB.

7. Conclusion

In this paper, we discuss on-demand SSB operation and have the following observations and proposals.

Observation 1: The motivation for supporting on-demand SSB for Sceanrio#3A with Case #1 is not clear.

Observation 2: Support Scenario #3A and Case #1 for on-demand SSB if Scenario #3B and Case #1 is supported doesn't cause extra spec impact.

Observation 3: Scenario #3A and Case #2 can also be supported for on-demand SSB for SCell operation if Scenario #3B and Case #2 is supported.

Observation 4: There is no benefit to support DCI based initial indication for on-demand compared with RRC/MAC CE based signalling for scenario #2 and #2A.

Observation 5: For the re-indication of on-demand SSB for SCell operation, DCI based signalling can be more beneficial with high efficiency.

Observation 6: OD-SSB and always-on SSB transmitted close to each other in time domain should also be avoided to save energy.

Observation 7: There is no need to configure/update the parameters already configured with RRC configuration for on-demand SSB in Info-Set 2 in the MAC CE indication.

Proposal 1: Support to introduce a separate signaling to re-indicate UE the on-demand SSB for SCell after the transmission of on-demand SSB restarts after a period of de-activation.

- ***FFS: whether the MAC CE based initial indication for on-demand SSB can be reused.***

Proposal 2: Support Scenario #3B and Case #1 for on-demand SSB for SCell operation.

Proposal 3: Support Scenario #3B and Case #2 for on-demand SSB for SCell operation.

Proposal 4: Support DCI based signalling for on-demand SSB indication if scenario #3A and/or #3B are/is supported.

Proposal 5: There should be no on-demand SSB and always-on SSB transmitted within a specific time period so that the largest NES gain can be acquired.

Proposal 6: Support Alt1, i.e., 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.

Proposal 7: Support 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.

Proposal 8: On-demand SSB should be supported for CD-SSB located on sync-raster.

Proposal 9: For Case #2, support reuse the same configuration method of time domain location for on-demand SSB as Case #1.

Proposal 10: At least for the RRC-indicated on-demand SSB, there should be only one set of RRC configuration for on-demand SSB.

Proposal 11: Sub-carrier spacing shouldn't be absent for Case #1; And for Case#2, this parameter should reuse that of always-on SSB if it is absent.

Proposal 12: Not support the parameters in Info-Set 1 to be carried in the MAC CE signalling for on-demand SSB transmission indication.

Proposal 13: Only Index of on-demand SSB config and parameters related to the deactivation of on-demand SSB should be carried by MAC CE signalling for on-demand SSB indication.

Proposal 14: For the deactivation of on-demand SSB, Option 1, i.e., Explicit indication of deactivation for on-demand SSB via MAC-CE, can be applied to all the scenarios.

Proposal 15: For the deactivation of on-demand SSB, Option 4 and 4A, i.e., the deactivation of SCell, can be sued as the deactivation signal in addition to Option 2.

Proposal 16: For the deactivation of on-demand SSB, there is no need to further support to indicate value of N can be implicitly using a timer for Option 2.

Proposal 17: For a cell supporting on-demand SSB SCell operation and for Case #2, CSI report configuration can be associated with both of n-demand SSB and always-on SSB or only with on-demand SSB.

8. References

[1] 3GPP RP-242354, "Revised WID for Enhancements of network energy savings for NR", Ericsson, RAN#105, Melbourne, Sep 9-12, 2024.

[2] "Chair notes RAN1 #118-bis", October, 2024.

[3] "Chair notes RAN1 #116", April, 2024.

[4] "Chair notes RAN1 #118", August, 2024.

[5] 3GPP TS 38.321 v 18.2.0, "Medium Access Control (MAC) protocol specification"

[6] 3GPP TS 38.331 v 18.3.0, "Radio Resource Control (RRC) protocol specification"