

Athens, Greece, February 17th – 21st, 2025

Agenda Item: 9.5.1

Source: Fujitsu

Title: Discussion on on-demand SSB SCell operation

Document for: Discussion/Decision

1. Introduction

In RAN#102, the WID for Rel.19 Network energy saving has been approved [1]. According to the WID, one of the objectives is to specify procedures and signaling methods to support on-demand SSB SCell operation.

- 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 this contribution, we present some further discussions on on-demand SSB SCell operation.

2. Discussion

2.1. Whether to support on-demand SSB being CD-SSB located on sync-raster

Whether on-demand SSB is cell-defining SSB (CD-SSB) or not was discussed in the RAN1#118 meeting, and the following agreement was reached.

Agreement@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

It was agreed to support on-demand SSB that is either not located on synchronization raster or non-cell-defining (NCD) SSB. Whether on-demand SSB can be CD-SSB remains open for further discussion.

The concern regarding on-demand SSB to be a CD-SSB is that it may have a negative impact on idle/inactive UEs, including both legacy and Rel.19 NES-capable UEs. In other words, UEs camping on or performing initial access to the on-demand SSB SCell should be avoided. However, even if the on-demand SSB is a CD-SSB, there are still approaches to avoid UEs camping on the cell or performing initial access to the cell. For example, setting *cellBarred* IE in the MIB of the SCell to “barred” can achieve this, and it is widely used in the current system. Therefore, on-demand SSB being CD-SSB on synchronization raster can also be supported.

Proposal 1. For on-demand SSB transmitted on the SCell, support on-demand SSB for CD-SSB on synchronization raster.

2.2. The relation between on-demand SSB and always-on SSB

2.2.1. Time domain relation

In RAN1#119 meeting, the following agreement was reached.

Agreement @RAN1#119

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.

Regarding the relation in terms of time location between always-on SSB and on-demand SSB, the following two options were provided but were not agreed in the last meeting.

- Option 1: The time locations of on-demand SSB are configured to contain time locations of always-on SSB.
- Option 2: The time locations of on-demand SSB are configured to be different from the time locations of always-on SSB.

The choice of which option to apply depends on the frequency location of both SSBs. If the frequency location of on-demand SSB is the same as that of always-on SSB, both options can be supported and the specific option to apply is subject to gNB configuration.

If the frequency location of on-demand SSB is different from that of always-on SSB, it seems not necessary to make UEs measure both SSBs at the same time location. Therefore, option 2 is preferred to avoid unnecessary energy consumption for both the gNB and UEs.

Proposal 2: At least support time locations of on-demand SSB to be different from the time locations of always-on SSB.

2.2.2. Frequency domain relation

In RAN1#119 meeting, the following agreements were reached.

Agreement@RAN1#119

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@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.

If always-on SSB is CD-SSB on a synchronization raster, the frequency location of on-demand SSB should be different from that of always-on SSB to avoid negative impacts on initial cell selection for idle/inactive UEs. Furthermore, the case where always-on SSB is CD-SSB on the synchronization raster should be supported, since a cell is typically associated with a CD-SSB on the synchronization raster in real deployments.

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 that of always-on SSB, subject to its configuration.

Proposal 3: The case where always-on SSB is CD-SSB on a synchronization raster should be supported.

Proposal 4: Regarding the frequency domain relation between on-demand SSB and always on SSB, support Alt1 and Alt A.

- **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 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.**

2.2.3. Spatial domain relation

Regarding the relation in the spatial domain between on-demand SSB and always-on SSB, the following two alternatives were provided in the FL summary of the last meeting.

- **Alt 1: SSB indices within on-demand SSB burst can be subset of SSB indices within always-on SSB burst, subject to its configuration.**
- **Alt 2: It is NOT supported that SSB indices within on-demand SSB burst are subset of SSB indices within always-on SSB burst, in Rel-19.**

If on-demand SSB is served to a limited number of UEs, the on-demand SSB can be transmitted with a subset of beams to achieve energy saving. For example, when on-demand SSB is triggered in scenario 2A, the gNB can choose to transmit on-demand SSB with a specific beam for fast SCell activation for a particular UE. The precondition is that the gNB has prior information about the suitable SSB beam for this UE.

Proposal 5: Regarding the spatial domain relation between on-demand SSB and always-on SSB, support Alt 1.

- **Alt 1: SSB indices within on-demand SSB burst can be subset of SSB indices within always-on SSB burst, subject to its configuration.**

2.3. Signaling for on-demand SSB TX indication

2.3.1. Deactivation of on-demand SSB

In RAN1#119, the following was agreed related to deactivation of on-demand SSB.

Agreement@RAN1#119

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

Explicit indication of deactivation for on-demand SSB via MAC-CE has been agreed in RAN1#119 meeting. Regarding the applicable scenarios which are FFS, it depends on whether it is Case#1 or Case#2. In Case#2, as illustrated in Figure 1, on-demand SSB can be deactivated in any scenario since there is always-on SSB can be relied on. In Case#1, on-demand SSB is only allowed to be deactivated when or after the SCell is deactivated. This is because on-demand SSB is needed for maintaining synchronization and L1/L3 measurement when SCell is in activated state in Case#1. Figure 2 and Figure 3 show the examples that on-demand SSB is deactivated when and after SCell is deactivated, respectively.

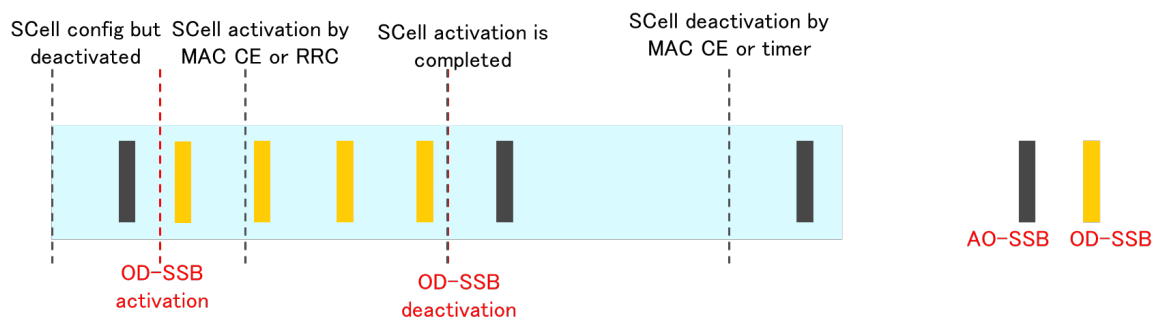


Figure 1 On-demand SSB deactivation in any scenario for Case#2

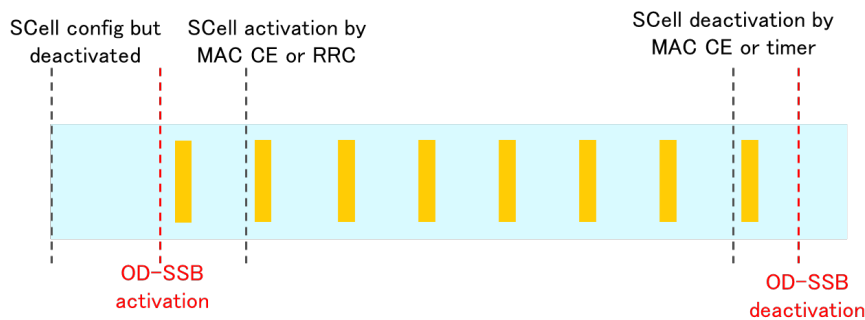


Figure 2 On-demand SSB deactivation in the scenario after SCell is deactivated for Case#1

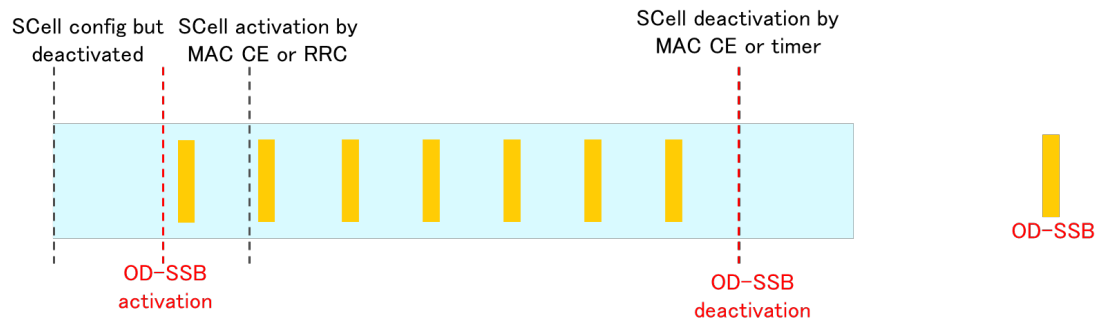


Figure 3 On-demand SSB deactivation in the scenario when SCell is deactivated for Case#1

Furthermore, regarding implicit deactivation indication, some companies proposed to use SCell deactivation MAC CE (Option 4) and SCell deactivation timer (Option 4A) as implicit indications for on-demand SSB deactivation. However, the use case for Option 4 and 4A is limited. This is because the essence of on-demand SSB is a broadcast signal. If SCell is deactivated for one UE but remains activated for other UEs, NW still needs to provide on-demand SSB until SCell is deactivated for all UEs. In such cases, the UE whose SCell is deactivated may continue to measure on-demand SSB in preparation for future SCell re-activation.

Regarding the number of N, in our view, both explicit configuration/indication and implicit determination using a timer are workable. For the latter approach, the value(s) of the timer can be provided by the on-demand SSB configuration.

Proposal 6: Regarding the scenario(s) at which Option 1 (explicit deactivation indication for on-demand SSB via MAC-CE) is used, at least support the following scenario.

- **Case#1: the scenario when or after the SCell deactivation is completed and SCell is deactivated.**
- **Case#2: all SCell activation/deactivation scenarios**

Proposal 7: Regarding option 2 (configuration/indication of the number of N for on-demand SSB butsts to be transmitted)

- **Do not support using SCell deactivation MAC CE (option 4) and/or SCell deactivation timer (option 4A) as implicit indication for on-demand SSB deactivation.**
- **Support implicit determination of the value of N based on a timer which is provided by on-demand SSB configuration.**

2.3.2. DCI-based indication of on-demand SSB

Regarding the signaling of on-demand SSB triggering, the following agreements and conclusion were reached in the previous RAN1 meetings.

Agreement@RAN1#117

- For a cell supporting on-demand SSB SCell operation,
 - o Support RRC based signaling to indicate on-demand SSB transmission on the cell.
 - o Support MAC CE based signaling to indicate on-demand SSB transmission on the cell.
 - o FFS: Whether to support DCI based signaling to indicate on-demand SSB transmission on the cell.
 - This DCI signaling does not provide SCell activation/deactivation.
 - If supported, details on DCI including UE-specific or group-common DCI, DCI contents, etc.
 - o FFS: Scenarios where the above signalings are applicable

Conclusion@RAN1#118b

No consensus on the support of on-demand SSB SCell operation triggered by UE.

In addition to RRC and MAC-CE, group-common DCI can also be considered to indicate on-demand SSB transmission. Using group-common DCI, multiple UEs can be informed of on-demand SSB transmission at the same time. Therefore, the signaling overhead can be reduced compared with the RRC/MAC-CE based signaling.

Observation 1. Group-common DCI can achieve less signaling overhead than that of the RRC / MAC-CE based signaling.

In addition, since the SCell activation/deactivation scenarios are UE specific, it is possible that the scenarios differ from the perspective of different UEs. For example, the on-demand SSB that is triggered at scenario #2A from UE 1's perspective might be transmitted in scenario #3B from UE 2's perspective. In such a situation, if the UE 2 is unaware of the on-demand SSB transmission, its UL transmission and DL reception may be impacted. To address this, group-common DCI can be considered to enable notifying UE 1 about the on-demand SSB transmission while also making UE 2 aware of it.

Observation 2. Using group-common DCI can enable notifying the intended receiving UEs about the on-demand SSB transmission while also making other UEs aware of it.

Proposal 8. Group common DCI can be considered for on-demand SSB transmission indication.

2.4. Contents of on-demand SSB configuration/indication

In the RAN1#119 meeting, the following agreement was achieved regarding on-demand SSB configuration.

Agreement @RAN1#119

- 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 $(\text{SFN index} * 10) \bmod (\text{OD-SSB periodicity}) = 0$
 - 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.

Regarding the configuration of on-demand SSB time domain location in Case#2, two alternatives are identified in RAN1#119 meeting. Alt A is based on two parameters (i.e., SFN offset and half-duplex index) same as for Case#1, and Alt B is utilizing the time offset between always-on SSB and on-demand SSB.

For Alt A, a unified solution is provided for both Case#1 and Case#2.

For Alt B, an additional parameter, i.e., time offset between always-on SSB and on-demand SSB, needs to be specified, which results in a larger specification effort. Note that the periodicity of on-demand SSB is equal to or smaller than that of always-on SSB. This should be explicitly stated in the spec if we go with Alt B.

Alt A is preferred since it provides a unified solution for both Case#1 and Case#2, requiring less specification effort and leading to simpler gNB and UE implementations.

Proposal 9: For time domain location of on-demand SSB per on-demand SSB periodicity in Case#2, support Alt 1 which is same as Case#1.

Furthermore, it has been agreed that multiple candidate values of on-demand SSB periodicities can be configured by RRC and indicated by MAC-CE.

Agreement@RAN1#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

Similarly, SSB positions within an on-demand SSB burst and the number of on-demand SSB bursts can also be configured by RRC and applicable value can be indicated by MAC CE.

Proposal 10: 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.

- SSB positions within an on-demand SSB burst
- The number of on-demand SSB bursts to be transmitted after on-demand SSB is indicated

Note: How to indicate one out of multiple candidate values is up to RAN2.

2.5. L1 measurement based on on-demand SSB

2.5.1. CSI report based on on-demand SSB

Agreement@RAN1#118b

- 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

Before deciding whether only one or both of the above options can be supported, we should first discuss the conditions and scenarios in which the above options can be applied.

If the on-demand SSB has the same properties except for time domain location (such as transmission power, frequency position and beam) as always-on SSB, both SSBs can be considered as a single measurement reference signal. This allows the UE to combine the CSI measurement results from both on-demand SSB and always-on SSB, as both CSI results reflect the same or similar channel characteristics. Under such conditions, the NW can configure a CSI report configuration associated with on-demand SSB and always-on SSB.

If the frequency position or beam for on-demand SSB is different than that of always-on SSB, the CSI result on on-demand SSB cannot be combined with that based on always-on SSB. In this situation, the NW needs to configure separate CSI reports for on-demand SSB and always-on SSB.

Thus, whether only one or both of the above options can be supported depends on whether the properties of on-demand SSB are the same as those of always-on SSB.

Proposal 11: RAN1 to consider either one or both options of CSI report configuration based on the outcome of relation between on-demand SSB and always on SSB.

- **If the configurations of on-demand SSB except for periodicity, such as transmission power, frequency position and beam, are the same as the configurations of always-on SSB, both option 1 and option 2 can be supported.**
- **Otherwise, only option 2 can be supported.**

2.5.1.1. CSI resource configuration for on-demand SSB

Another open issue is how to configure CSI resource for option 1 and option 2.

For option 1, if configurations on on-demand SSB, such as transmission power, frequency position and beam, are the same as that of always-on SSB, the existing SSB-based CSI resource configuration can be reinterpreted to indicate both on-demand SSB and always-on SSB. Otherwise, it is necessary to distinguish between on-demand SSB and always-on SSB in CSI resource configuration. In such cases, CSI resource configuration enhancement is required.

Similarly, for option 2, CSI resource configuration enhancement is required to differentiate on-demand SSB and always-on SSB.

Proposal 12:

- **For option 1 where a CSI report configuration is associated with both on-demand SSB and always-on SSB, the following solutions for CSI resource configuration can be considered**
 - o **The existing CSI resource configuration is re-interpreted to indicate both on-demand SSB and always-on SSB.**
 - o **The CSI resource configuration enhancement is introduced to differentiate on-demand SSB and always-on SSB.**
- **For Option 2 where a CSI report configuration is associated with one on-demand SSB and always-on SSB, the following solution for CSI resource configuration can be considered**
 - o **The CSI resource configuration enhancement is introduced to differentiate on-demand SSB and always-on SSB.**

Regarding the enhancement of CSI resource configuration, there are two options.

- Option A: CSI resource enhancement at the level of resource set list
- Option B: CSI resource enhancement at the level of the resource set

In option A, we can define a new resource set list for on-demand SSB dedicated to on-demand SSB, e.g., *CSI-OD-SSB-ResourceSetList*. The resource set list can consist of multiple *CSI-SSB-ResourceSet*. The existing resource set parameter or a newly defined resource set parameter, e.g., *CSI-OD-SSB-ResourceSet* can be considered for *CSI-SSB-ResourceSet*.

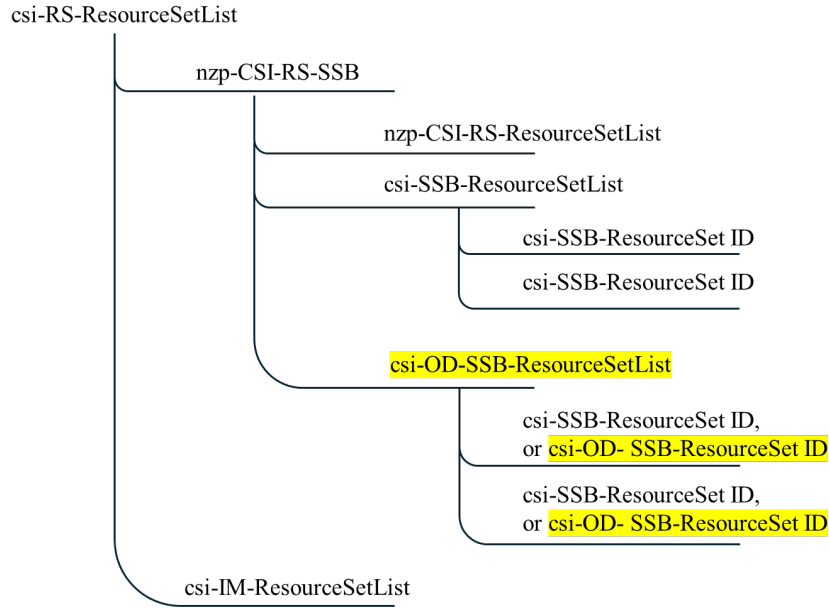


Figure 4 CSI resource enhancement in the level of resource set list

In option B, we can distinguish always-on SSB and on-demand SSB at the level of the resource set. For example, we can specify whether the existing *CSI-SSB-ResourceSet* refers to always-on SSB or on-demand SSB using on-demand SSB indicator in *CSI-SSB-ResourceSet*. As shown in the following figure, if the on-demand SSB indicator is present, the current resource set *CSI-SSB-ResourceSet* refers to on-demand SSB, otherwise the *CSI-SSB-ResourceSet* refers to always-on SSB as the legacy way.

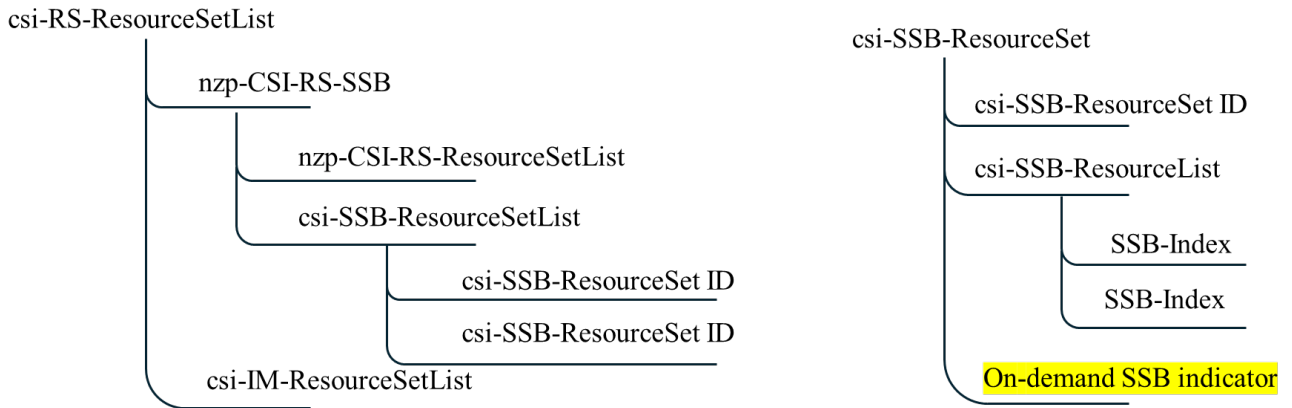


Figure 5 CSI resource enhancement in the level of resource set

Proposal 13. For CSI resource configuration enhancement for on-demand SSB associated with CSI report configuration, the following two options can be considered.

- **Option A: CSI resource enhancement at the level of the resource set list**
 - o To specify a dedicated resource set list for on-demand SSB.
- **Option B: CSI resource enhancement at the level of CSI-SSB resource set**
 - o To introduce an on-demand SSB indicator within the *CSI-SSB-ResourceSet*.

In current specification, a list of associated reports is included in the aperiodic trigger state list and SSB resources can be configured as resources for channel within each associated report configuration. For triggering/activation mechanisms for CSI report configurations based on on-demand SSB, if a new resource set for on-demand SSB has been introduced according to Option 1 in Proposal 10, e.g., *csi-OD-SSB-ResourceSet*, the corresponding CSI resources enhancement in *CSI-AperiodicTriggerStateList* should be supported as well.

As shown in the following figure, a newly defined resource set for on-demand SSB named *csi-OD-SSB-ResourceSet* should be included in the parameter *resourceForChannel*. Otherwise, there needs no potential enhancement for triggering/activation mechanisms.

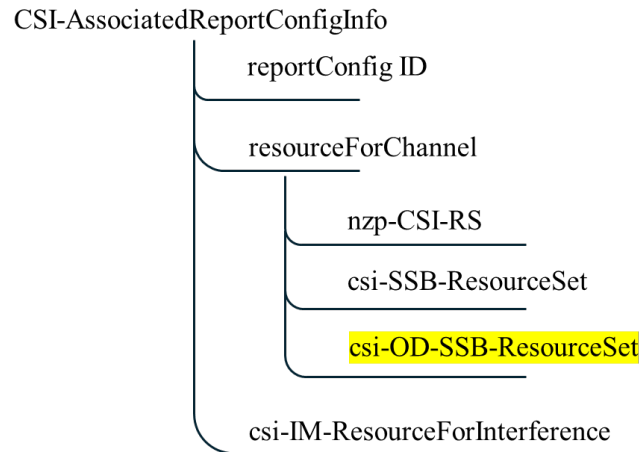


Figure 6 CSI resource enhancement in aperiodic trigger state list

Proposal 14. If a newly defined resource set parameter, e.g., *CSI-OD-SSB-ResourceSet*, is supported, the corresponding enhancement in the aperiodic trigger state list should be considered as well.

- E.g., *CSI-OD-SSB-ResourceSet* should be included in *CSI-AperiodicTriggerStateList*.

2.5.2. Beam failure detection and recovery based on on-demand SSB

The UE can use a specific reference resource, e.g., SSB or CSI-RS, to detect beam failure and/or search candidate beams with good quality. If a configured number of beam failure instances are detected, the UE performs beam failure recovery process to select a candidate beam.

For beam failure detection on SCell, it is specified in TS 38.331 that only periodic 1-port CSI-RS can be configured on SCell for beam failure detection purposes.

<i>RadioLinkMonitoringRS</i> field descriptions
<i>detectionResource</i> A reference signal that the UE shall use for radio link monitoring or beam failure detection (depending on the indicated <i>purpose</i>). Only periodic 1-port CSI-RS can be configured on SCell for beam failure detection purpose.

Following the same principle, beam failure detection based on on-demand SSB does not need to be supported for SCell. UEs could perform beam failure detection using periodic 1-port CSI-RS following the legacy way.

For candidate beam selection on SCell, both CSI-RS and SSB can be utilized according to the existing spec. Therefore, candidate beam selection based on-demand SSB can be supported at least in Case#1. In Case#2, candidate beam selection can rely on always-on SSB.

Observation 3: *In the existing spec on SCell, only periodic CSI-RS can be configured for beam failure detection purposes, while either SSB or periodic CSI-RS can be configured for beam failure recovery.*

Proposal 15: At least support candidate beam selection based on on-demand SSB in Case#1.

3. Conclusions

In this contribution, we discussed on-demand SSB for SCell. The following observations and proposals are provided.

Proposal 1: For on-demand SSB transmitted on the SCell, support on-demand SSB for CD-SSB on synchronization raster.

Proposal 2: At least support time locations of on-demand SSB to be different from the time locations of always-on SSB.

Proposal 3: The case where always-on SSB is CD-SSB on a synchronization raster should be supported.

Proposal 4: Regarding the frequency domain relation between on-demand SSB and always on SSB, support Alt1 and Alt A.

- 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 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 5: Regarding the spatial domain relation between on-demand SSB and always-on SSB, support Alt 1.

- Alt 1: SSB indices within on-demand SSB burst can be subset of SSB indices within always-on SSB burst, subject to its configuration.

Proposal 6: Regarding the scenario(s) at which Option 1 (explicit deactivation indication for on-demand SSB via MAC-CE) is used, at least support the following scenario

- Case#1: the scenario when or after the SCell deactivation is completed and SCell is deactivated.
- Case#2: all SCell activation/deactivation scenarios

Proposal 7: Regarding option 2 (configuration/indication of the number of N for on-demand SSB bursts to be transmitted)

- Do not support using SCell deactivation MAC CE (option 4) and/or SCell deactivation timer (option 4A) as implicit indication for on-demand SSB deactivation.
- Support implicit determination of the value of N based on a timer which is provided by on-demand SSB configuration.

Observation 1. Group-common DCI can achieve less signaling overhead than that of the RRC / MAC-CE based signaling.

Observation 2. Using group-common DCI can enable notifying the intended receiving UEs about the on-demand SSB transmission while also making other UEs aware of it.

Proposal 8. Group common DCI can be considered for on-demand SSB transmission indication.

Proposal 9: For time domain location of on-demand SSB per on-demand SSB periodicity in Case#2, support Alt 1 which is same as Case#1.

Proposal 10: 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.

- SSB positions within an on-demand SSB burst
- The number of on-demand SSB bursts to be transmitted after on-demand SSB is indicated

Note: How to indicate one out of multiple candidate values is up to RAN2.

Proposal 11: RAN1 to consider either one or both options of CSI report configuration based on the outcome of relation between on-demand SSB and always on SSB.

- If the configurations of on-demand SSB except for periodicity, such as transmission power, frequency position and beam, are the same as the configurations of always-on SSB, both option 1 and option 2 can be supported.
- Otherwise, only option 2 can be supported.

Proposal 12:

- For option 1 where a CSI report configuration is associated with both on-demand SSB and always-on SSB, the following solutions for CSI resource configuration can be considered
 - o The existing CSI resource configuration is re-interpreted to indicate both on-demand SSB and always-on SSB.
 - o The CSI resource configuration enhancement is introduced to differentiate on-demand SSB and always-on SSB.
- For Option 2 where a CSI report configuration is associated with one on-demand SSB and always-on SSB, the following solution for CSI resource configuration can be considered
 - o The CSI resource configuration enhancement is introduced to differentiate on-demand SSB and always-on SSB.

Proposal 13. CSI resource configuration enhancement for on-demand SSB associated with CSI report configuration is necessary.

- **Option A:** CSI resource enhancement at the level of the resource set list
 - o To specify a dedicated resource set list for on-demand SSB.
- **Option B:** CSI resource enhancement at the level of CSI-SSB resource set
 - o To introduce an on-demand SSB indicator within the *CSI-SSB-ResourceSet*.

Proposal 14. If a newly defined resource set parameter, e.g., *CSI-OD-SSB-ResourceSet*, is supported, the corresponding enhancement in the aperiodic trigger state list should be considered as well.

- E.g., *CSI-OD-SSB-ResourceSet* should be included in *CSI-AperiodicTriggerStateList*.

Observation 3: In the existing spec on SCell, only periodic CSI-RS can be configured for beam failure detection purposes, while either SSB or periodic CSI-RS can be configured for beam failure recovery.

Proposal 15: At least support candidate beam selection based on on-demand SSB in Case#1.

References

[1] RP-234065, “New WID: Enhancements of network energy savings for NR”, RAN#102, Dec. 11-15, 2023