

Agenda Item: 9.5.1
 Source: Apple
 Title: On-demand SSB SCell Operation
 Document for: Discussion/Decision

1 Introduction

This contribution discusses OD-SSB SCell Operation. The agreements until RAN1 #119 are shown in Annex for convenience.

2 OD-SSB Scenarios

To recap Scenarios in relation to SCell activation command (MAC-CE) as shown in Figure 1.

- Scenario #2: OD-SSB indication before receiving SCell activation command and after SCell configuration
- Scenario #2A: OD-SSB indication when receiving SCell activation command
- Scenario #3A: OD-SSB indication after receiving SCell activation command until SCell activation is completed
- Scenario #3B: OD-SSB indication when or after SCell activation is completed

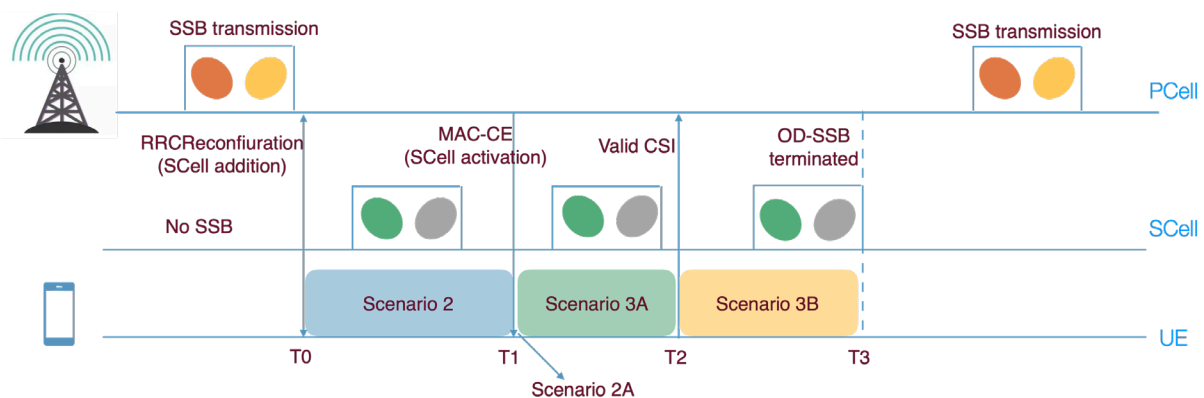


Figure 1 Scenarios for MAC-CE based OD-SSB indication in relation to SCell activation command

It was agreed that Scenario #2 and #2A are supported for both Case #1 (No always-on SSB on the cell) and Case #2 (Always-on SSB is periodically transmitted on the cell).

In our opinion, there is no clear use case to send OD-SSB indication after SCell activation command (Scenario #3A and #3B) for Case #1. To enable SCell activation, OD-SSB needs to be indicated before SCell activation command for AGC, time/frequency synchronization. It does not make sense for network

to activate SCell first and then to send SSB (Scenario #3A). Scenario #3B with Case #1 is not even feasible since UE cannot activate SCell due to lack of SSB.

Observation 1: There is no use case for Scenario #3A/3B with Case #1.

For Case #2 with Scenario #3A and #3B, SCell activation process can rely on the always-on SSB. The longer SSB periodicity, the longer SCell activation completion. It makes sense more to send OD-SSB indication before SCell activation if gNB wants to accelerate SCell activation process.

Observation 2: There is no clear use case for Scenario #3A/3B with Case #2 in the context of SCell activation.

For Case #2, there is no use case for Scenario #3A. In Scenario #3B, L1 measurement can be accelerated by sending additional OD-SSB. In our view, OD-SSB should be continuously transmitted during SCell activation but can be deactivated after SCell deactivation. However, the same goal can be achieved by using AO-SSB periodicity adaptation even without OD-SSB to accelerate L1 measurement.

Observation 3: There is no use case for Scenario #3A with Case #2 in the context of L1 measurement.

Observation 4: There could be use case for Scenario #3B with Case #2 to accelerate L1 measurement. However, the same goal can be achieved by using AO-SSB periodicity adaptation even without OD-SSB.

Proposal 1: Scenario #3A and #3B for both Case #1 and Case #2 are deprioritized.

3 Frequency Location between AO-SSB and OD-SSB for Case #2

RAN1 #118

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

RAN1 #119

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

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.

From RAN1 #118, OD-SSB can be:

- Both CD-SSB and NCD-SSB not on a sync raster
- NCD-SSB on a sync raster
- FFS: CD-SSB on a sync raster

On the FFS point (FFS: CD-SSB on a sync raster), the main concern is to impact on initial cell selection and reselection for both legacy and Rel-19 UE. To prevent UE access during initial cell selection, one solution can be to set ‘*cellbarred=true*’ in MIB. However, this bit has been used for other purposes such as network maintenance, network congestion management, cell outage, deployment (reconfiguration), regulatory compliance, etc. Therefore, UE might try to search the cell again later to see if it is not still accessible or not (e.g. if maintenance is over), which could also affect cell reselection procedure. This results in unnecessary efforts to legacy/Rel-19 UE for cell selection and reselection.

Observation 5: CD-SSB on sync-raster should be precluded as OD-SSB SCell operation to avoid impact on initial cell selection / cell reselection for both legacy and Rel-19 UE.

Proposal 2: CD-SSB on sync-raster is not supported for OD-SSB.

There are two aspects from the agreements made in last meeting:

- 1/ Whether or not to support CD-SSB on a sync raster as AO-SSB
- 2/ Whether or not to support different frequency locations between AO-SSB and OD-SSB

UE is allowed to cause only one interruption during SCell activation procedure (due to RF activation) in TS38.133 (see Figure 2 and Figure 3). This could result in unnecessary complication and additional interruption during SCell activation. Therefore, we propose to preclude the case that frequency locations between AO-SSB and OD-SSB are different.

Observation 6: Different frequency locations between AO-SSB and OD-SSB are not desirable due to additional interruption and complication of UE implementation during SCell activation.

Proposal 3: The case of different frequency locations between AO-SSB and OD-SSB is precluded.

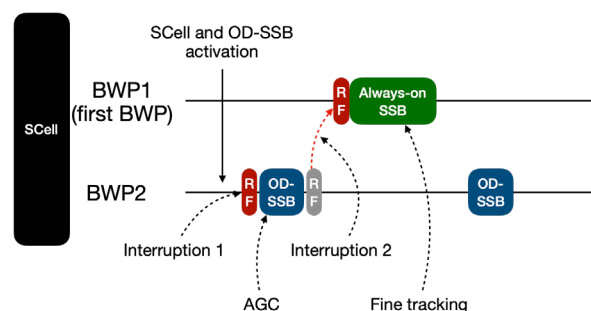


Figure 2 RAN4's Scenario 3 (different frequencies between AO-SSB and OD-SSB) – ex.1

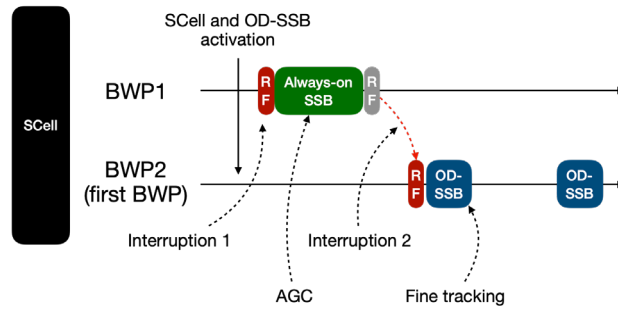


Figure 3 RAN4's Scenario 3 (different frequencies between AO-SSB and OD-SSB) – ex.2

We observe from Observation 6 that different frequency locations between AO-SSB and OD-SSB are not desirable. Then, if AO-SSB is CD-SSB on sync raster, OD-SSB as NCD-SSB should be on the same frequency location. If a UE implemented threshold based PSS detection for initial access, the UE will consider OD-SSB above threshold is detected in initial access and then process SSS/PBCH for final verification. This cause unnecessary UE power consumption and complexity. Therefore, considering support of OD-SSB on sync raster is not desirable, AO-SSB as CD-SSB and OD-SSB on sync raster is preferred to be precluded.

Observation 7: OD-SSB as NCD-SSB on sync raster is not desirable. Therefore, AO-SSB on sync raster is not preferred due to Observation 6 (Different frequencies between AO-SSB and OD-SSB are not desirable).

Proposal 4: AO-SSB as CD-SSB on sync raster is precluded.

From Proposal 3 and Proposal 4, we propose the following alternatives:

Proposal 5: From Proposal 3 and Proposal 4,

- **Alt 3: Do not support the case where always-on SSB is CD-SSB 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**

We think the term of 'frequency location' used in agreements need to be clarified. For instance, it can be interpreted:

- Center frequency of SSB, or
- Active BWP on the SCell

Our Proposal 3, 4 and 5 are based on understanding that 'frequency location' means center frequency of SSB. If 'frequency location' means active BWP, Alt 1 (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.) is also acceptable.

Proposal 6: The term of 'frequency location' between AO-SSB and OD-SSB needs to be clarified whether it means center frequency of SSB or active BWP on the SCell.

On the following agreement:

Agreement

For a cell supporting on-demand SSB SCell operation,

- Support RRC based signaling to indicate on-demand SSB transmission on the cell at least for the case where this RRC also configures the SCell, activates the SCell, and provides on-demand SSB configuration.
 - FFS: Whether to support RRC based signaling for other cases.
- Support MAC CE based signaling to indicate on-demand SSB transmission on the cell for Scenarios #2 and #2A.

Note: Deactivation and adaptation of on-demand SSB transmission can be separately discussed.

Similar to RRC based SCell activation, it is beneficial to support RRC based OD-SSB indication. RRC based OD-SSB deactivation before SCell activation command (note that ‘SCell activation command’ implies MAC-CE signaling from the definition in the specification, not RRC) can be also supported if gNB decides not to activate SCell (i.e. no SCell activation command). However, similar to Scenario #3A/3B (OD-SSB indication after SCell activation command) of MAC-CE based OD-SSB indication, there is no use case for RRC based OD-SSB indication and deactivation after SCell activation command. Even assuming Scenario #3A/3B is supported, in our view, there is no benefit of RRC based OD-SSB activation/deactivation compared to MAC-CE based OD-SSB activation/deactivation after SCell activation command.

Observation 6: RRC based OD-SSB activation/deactivation could be beneficial before SCell activation command.

Observation 7: There seems no benefit of RRC based OD-SSB activation/deactivation after SCell activation command, compared to MAC-CE based OD-SSB activation/deactivation.

Proposal 7: RRC based OD-SSB activation/deactivation after SCell activation is not supported.

5 L1 Measurement

From the following agreement:

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

In our view, the implication of defining spatial relation would be to allow UE to be able to average measurements between AO-SSB and OD-SSB. This would make UE implementation more complicated and impact on future RAN4 work (according to RAN4 agreement, RAN4 assumes UE to use OD-SSB to perform SCell activation as a baseline). If UE uses only OD-SSB after OD-SSB is indicated, we think there is no need to specify spatial relation between AO-SSB and OD-SSB. This also could make UE implementation the same as Case 1 (without AO-SSB).

Proposal 8: After OD-SSB transmission is indicated, UE uses OD-SSB only for L1 measurement.

Proposal 9: The spatial relation between AO-SSB and OD-SSB is not specified. That is, Support modified Option 2: A CSI report configuration is associated with ~~one of always-on SSB and on-demand SSB~~ only.

In addition to Proposal 8 and Proposal 9, according to section 5.17 (Beam Failure Detection and Recovery procedure) of TS 38.321, it is specified that the UE is configured with one single set of BFD parameter (e.g. BFD-RS, OD-SSB periodicity, *beamFailureDetectionTimer*) per serving cell and runs only one BFD timer and counter maintenance per serving cell. And only RRC can change the BFD parameters in one serving cell. The RRC configuration for OD-SSB SCell operation would include BFD parameters. In case that OD-SSB is operated with Case #2 (always-on SSB), there is a need to define UE behavior which BFD parameter between always-on SSB and OD-SSB is used once UE receives RRC or MAC-CE based OD-SSB indication. In our view, we should avoid combining the ‘always-on SSB’ with OD-SSB for measurements which would increase UE complexity unnecessarily.

Proposal 10: Together with Proposal 8 and Proposal 9, the RRC configuration for OD-SSB SCell operation to include one set of BFD parameters for OD-SSB per the SCell. Once UE receives RRC or MAC-CE based OD-SSB indication for both Case #1 (No always-on SSB on the cell) and Case #2 (Always-on SSB is periodically transmitted on the cell), UE shall use BFD parameters for OD-SSB.

6 Rate Matching for PDSCH around OD-SSB

SSB Positions in Burst (*ssb-PositionsInBurst*) is provided by SIB-1 and *ServingCellConfigCommon*, and UE expects the same configuration of *ssb-PositionsInBurst* from SIB-1 and *ServingCellConfigCommon*. According to Clause 5.1.4 of TS38.214, rate-matching is performed around SSB according to parameter *ssb-PositionsInBurst*.

SSB Positions in Burst for OD-SSB also needs to be configured when OD-SSB is configured. Once UE receives signaling for OD-SSB activation, UE knows the location of OD-SSB transmission. Once UE receives signaling for OD-SSB deactivation, UE also knows there is no OD-SSB transmission. In order to efficiently utilize DL resource, rate-matching for PDSCH around OD-SSB needs to be specified. Rate matching for PDSCH around OD-SSB is applied from time instance A when UE receives OD-SSB indication. Likewise, rate matching for PDSCH around OD-SSB is not applied from time instance A when UE receives OD-SSB deactivation.

Observation 8: Rate-matching behavior around OD-SSB needs to be specified.

Proposal 11: Support the following rate-matching behavior:

- **Rate-matching for PDSCH around OD-SSB is applied from time instance A when UE receives OD-SSB activation.**
- **Rate-matching for PDSCH around OD-SSB is not applied from time instance A when UE receives OD-SSB deactivation, or not applied after N OD-SSB bursts if configured/indicated.**

7 Summary of Observations/Proposals

<OD-SSB Scenarios>

Observation 1: There is no use case for Scenario #3A/3B with Case #1.

Observation 2: There is no clear use case for Scenario #3A/3B with Case #2 in the context of SCell activation.

Observation 3: There is no use case for Scenario #3A with Case #2 in the context of L1 measurement.

Observation 4: There could be use case for Scenario #3B with Case #2 to accelerate L1 measurement. However, the same goal can be achieved by using AO-SSB periodicity adaptation even without OD-SSB.

Proposal 1: Scenario #3A and #3B for both Case #1 and Case #2 are deprioritized.

< Frequency Location between AO-SSB and OD-SSB for Case #2>

Observation 5: CD-SSB on sync-raster should be precluded as OD-SSB SCell operation to avoid impact on initial cell selection / cell reselection for both legacy and Rel-19 UE.

Proposal 2: CD-SSB on sync-raster is not supported for OD-SSB.

Observation 6: Different frequency locations between AO-SSB and OD-SSB are not desirable due to additional interruption and complication of UE implementation during SCell activation.

Proposal 3: The case of different frequency locations between AO-SSB and OD-SSB is precluded.

Proposal 4: AO-SSB as CD-SSB on sync raster is precluded.

Proposal 5: From Proposal 3 and Proposal 4,

- Alt 3: Do not support the case where always-on SSB is CD-SSB 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

Proposal 6: The term of ‘frequency location’ between AO-SSB and OD-SSB needs to be clarified whether it means center frequency of SSB or active BWP on the SCell.

<Signaling for OD-SSB Indication>

Observation 6: RRC based OD-SSB activation/deactivation could be beneficial before SCell activation command.

Observation 7: There seems no benefit of RRC based OD-SSB activation/deactivation after SCell activation command, compared to MAC-CE based OD-SSB activation/deactivation.

Proposal 7: RRC based OD-SSB activation/deactivation after SCell activation is not supported.

<L1 Measurement>

Proposal 8: After OD-SSB transmission is indicated, UE uses OD-SSB only for L1 measurement.

Proposal 9: The spatial relation between AO-SSB and OD-SSB is not specified. That is,

Support modified Option 2: A CSI report configuration is associated with ~~one of always-on SSB and on-demand SSB~~ **only**.

Proposal 10: Together with Proposal 8 and Proposal 9, the RRC configuration for OD-SSB SCell operation to include one set of BFD parameters for OD-SSB per the SCell. Once UE receives RRC or MAC-CE based OD-SSB indication for both Case #1 (No always-on SSB on the cell) and Case #2 (Always-on SSB is periodically transmitted on the cell), UE shall use BFD parameters for OD-SSB.

< Rate Matching for PDSCH around OD-SSB >

Observation 8: Rate-matching behavior around OD-SSB needs to be specified.

Proposal 11: Support the following rate-matching behavior:

- Rate-matching for PDSCH around OD-SSB is applied from time instance A when UE receives OD-SSB activation.
- Rate-matching for PDSCH around OD-SSB is not applied from time instance A when UE receives OD-SSB deactivation, or not applied after N OD-SSB bursts if configured/indicated.

8 Reference

- [1] RP-242354 Revised WID for Enhancements of network energy savings for NR Ericsson

9 Annex: Previous agreements

RAN1 #116

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

Agreement

RAN1 to strive for a common design for on-demand SSB operation considering all applicable CA configurations.

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)

- This does not preclude SCell for which activation is completed
 - FFS: The case where SCell activation is completed
- FFS: Application timing between NW triggering message and on demand SSB transmission

Agreement

Support on-demand SSB SCell operation triggered by gNB.

- FFS Details of associated signaling/indication/configuration provided to UE

Agreement

- For SSB burst(s) triggered 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)

RAN1 #116bis

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.

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

Agreement

- For a cell supporting on-demand SSB SCell operation,
 - L1 and/or L3 measurement based on on-demand SSB is supported for the cell.
 - FFS further details on L1 and/or L3 measurement

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)

Agreement

For a cell supporting on-demand SSB SCell operation, further study the following options.

- Option 1: Separate signaling between legacy/existing signaling (e.g., RRC, MAC CE) providing SCell activation/deactivation and signaling providing On-demand SSB transmission indication.
- Option 2: A single signaling in which both SCell activation/deactivation and On-demand SSB transmission indication are provided.
 - FFS: Details of the signaling
- Other options are not precluded.
- FFS: Details on On-demand SSB transmission indication

RAN1 #117

Agreement

- For a cell supporting on-demand SSB SCell operation,
 - Support RRC based signaling to indicate on-demand SSB transmission on the cell.
 - Support MAC CE based signaling to indicate on-demand SSB transmission on the cell.
 - 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.
- FFS: Scenarios where the above signalings are applicable

Agreement

- For a cell supporting on-demand SSB SCell operation, at least the following for on-demand SSB via higher layer RRC signaling is supported.
 - 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
 - FFS: Whether more than one on-demand SSB configurations can be configured for the cell to UE
 - FFS: Whether the RRC is newly introduced or existing RRC is reused

Agreement

- At least support L1 measurement based on on-demand SSB
 - For L1 measurement based on on-demand SSB, periodic, semi-persistent, [and aperiodic] L1 measurement reports based on existing CSI framework are supported.
 - FFS on potential enhancements of CSI report configuration and/or triggering/activation mechanisms for L1 measurement based on on-demand SSB

Agreement

For SSB burst(s) indicated by on-demand SSB SCell operation via MAC CE, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.

- Alt 3-1: Time instance A is [the slot boundary of] the first SSB time domain position [of actually transmitted on-demand SSB burst] which is T [slots or symbols] after the [slot or symbol] where UE receives a signalling from gNB to indicate on-demand SSB transmission
 - The SSB time domain positions of on-demand SSB burst are configured by gNB.
- FFS: Details of the value of T (≥ 0) including possibility of T comprising of multiple components
- Note: The value of T is not less than existing timeline required for UE's MAC CE processing for SCell activation
- FFS: Whether the value of T is predefined or indicated/configured by gNB
- FFS: Details of “the [slot or symbol] where UE receives a signalling from gNB” or “the [slot or symbol] where UE transmits HARQ-ACK corresponding to a signalling from gNB to trigger on-demand SSB”

Above applies at least for the case where SCell with on demand SSB transmission and cell with signalling transmission have the same numerology.

Agreement

- For a cell supporting on-demand SSB SCell operation, at least the followings for on-demand SSB are known to UE.
 - 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
 - FFS: Other parameters
 - FFS: Whether each of above parameters is configured/indicated explicitly or not

RAN1 #118

Agreement

- Update the previous RAN1 agreement as follows.

- At least support L1 measurement based on on-demand SSB
 - For L1 measurement based on on-demand SSB, periodic, semi-persistent, ~~and aperiodic~~ L1 measurement reports based on existing CSI framework are supported.
 - FFS on potential enhancements of CSI report configuration and/or triggering/activation mechanisms for L1 measurement based on on-demand SSB
 - The support of LTM is a separate discussion point

Agreement

For a cell supporting on-demand SSB SCell operation,

- Support RRC based signaling to indicate on-demand SSB transmission on the cell at least for the case where this RRC also configures the SCell, activates the SCell, and provides on-demand SSB configuration.
 - FFS: Whether to support RRC based signaling for other cases.
- Support MAC CE based signaling to indicate on-demand SSB transmission on the cell for Scenarios #2 and #2A.

Note: Deactivation and adaptation of on-demand SSB transmission can be separately discussed.

Agreement

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

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

Support L3 measurement based on on-demand SSB

- Further work on L3 measurement is up to RAN2/RAN4

Agreement

LS to RAN2 for on-demand SSB SCell operation is agreed. Final LS in R1-2407438.

Agreement

The previous RAN1 agreement made in RAN1#117 is revised as follows.

- For SSB burst(s) indicated by on-demand SSB SCell operation via MAC CE, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.
 - Alt 3-1: Time instance A is the beginning of the first slot containing [candidate SSB index 0 or the first actually transmitted SSB index] of on-demand SSB burst ~~{the slot boundary of the first SSB time domain position [of actually transmitted on-demand SSB burst] which is at least T [slots or symbols] after the [slot or symbol] where UE receives a signalling from gNB to indicate on-demand SSB transmission~~
 - The SSB time domain positions of on-demand SSB burst are configured by gNB.
 - ~~○ FFS: Details of the value of T (≥ 0) including possibility of T comprising of multiple components~~

- Note: The value of T is not less than existing timeline required for UE's MAC CE processing for SCell activation
- (Working assumption): T is not less than $T_{\min} = m + 3N_{\text{slot}}^{\text{subframe}, \mu} + 1$ where slot $n+m$ is a slot indicated for PUCCH transmission with HARQ-QCK information when the UE receives MAC CE signaling to indicate on-demand SSB transmission ending in slot n , and $N_{\text{slot}}^{\text{subframe}, \mu}$ is as defined in current specification.
 - RAN4 to confirm that T_{\min} can be equal to $m + 3N_{\text{slot}}^{\text{subframe}, \mu} + 1$
- ~~○ FFS: Whether the value of T is predefined or indicated/configured by gNB~~
- (Working assumption) $T = T_{\min}$
- ~~○ FFS: Details of "the [slot or symbol] where UE receives a signalling from gNB" or "the [slot or symbol] where UE transmits HARQ-ACK corresponding to a signalling from gNB to trigger on-demand SSB"~~
- Above applies at least for the case where SCell with on demand SSB transmission and cell with signalling transmission have the same numerology.

Agreement

LS on timeline for On-demand SSB operation on SCell is agreed in R1-2407565.

RAN1 #118bis

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

Agreement

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

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

Conclusion

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

Agreement

The previous RAN1 agreement is partly confirmed and further revised as follows.

- For SSB burst(s) indicated by on-demand SSB SCell operation via a MAC CE, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.
 - Alt 3-1: Time instance A is the beginning of the first slot containing ~~{candidate SSB index 0 or the first actually transmitted SSB index}~~ of within the first “possible” on-demand SSB burst which is at least T slots after the slot where UE receives a signalling from gNB to indicate on-demand SSB transmission
 - The SSB time domain positions of on-demand SSB burst are configured by gNB.
 - The location(s) (e.g., SFN offset, half frame index) in the time domain of “possible” on-demand SSB burst and SSB position within the burst should be configured by the gNB
 - Note: The value of T is not less than existing timeline required for UE’s MAC CE processing for SCell activation
 - (Working assumption): T is not less than $T_{\min} = m + 3N_{\text{slot}}^{\text{subframe}, \mu} + 1$ where slot $n+m$ is a slot indicated for PUCCH transmission with HARQ-QCK information when the UE receives MAC CE signaling to indicate on-demand SSB transmission ending in slot n , and $N_{\text{slot}}^{\text{subframe}, \mu}$ is as defined in current specification.
 - RAN4 to confirm that T_{\min} can be equal to $m + 3N_{\text{slot}}^{\text{subframe}, \mu} + 1$
 - (Working assumption) $T = T_{\min}$
- Above applies at least for the case where SCell with on demand SSB transmission and cell with signalling transmission have the same numerology.

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

RAN1 #119

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

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

