**3GPP TSG RAN WG1 #118bis R1-240XXXX**

**Hefei, China, October 14th – 18th, 2024**

**Agenda Item:** 9.5.1

**Source:** Moderator (LG Electronics)

**Title:** Summary #1 of on-demand SSB for NES

**Document for:** Discussion and decision

# Introduction

This is the summary document for agenda item 9.5.1 on-demand SSB for NES, based on the contributions listed in reference section.

# General aspects (including use cases or scenarios)

## Scenarios and Cases

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| Company | Views |
| [1] Futurewei | **Observation 2:** The support of On-demand SSB for an activated SCell in cell DTX mode or in BWP level dormancy may be beneficial for NES.  **Proposal 2:** For the potential enhancements of on-demand SSB SCell operation for a UE in connected mode, consider the following scenario   * Scenario #3B: On-demand SSB for an activated SCell in cell DTX or cell dormancy. |
| [2] Huawei | **Proposal 1:** Support that on-demand SSB SCell operation can be triggered by gNB in   * Scenario #3B and Case #1 * Scenario #3B and Case #2 |
| [3] Spreadtrum | **Proposal 5:** Whether to define on-demand SSB procedure dedicated for Scenario #3A/#3B and Case #1 depends on termination of on-demand SSB.  **Proposal 6:** Whether to define on-demand SSB procedure dedicated for Scenario #3A/#3B and Case #2 depends on termination of on-demand SSB. |
| [4] China Telecom | **Observation 4:** The motivation for supporting on-demand SSB for Sceanrio#3A with Case #1 is not clear.  **Proposal 5:** Support Scenario #3B and Case #1 for on-demand SSB for SCell operation.  **Observation 5:** Scenario #3A and Case #1 can also be supported for on-demand SSB for SCell operation if Scenario #3B and Case #1 is supported.  **Proposal 6:** Support Scenario #3B and Case #2 s for on-demand SSB for SCell operation.  **Observation 6:** Scenario #3A and Case #2 can also be supported for on-demand SSB for SCell operation if Scenario #3B and Case #2 is supported. |
| [6] Nokia | **Proposal-1:** RAN1 to confirm that Scenario#3B is supported for L1 measurements based on network triggered on-demand SSB. |
| [7] vivo | **Proposal 1:** For on-demand SSB SCell operation, support Scenario #3A and it is up to gNB implementation to indicate on-demand SSB in Scenario #2A or Scenario #3A.  **Proposal 2:** For on-demand SSB SCell operation, do not support Scenario #3B, i.e., on-demand SSB should not be indicated by gNB after SCell activation is complete.  **Observation 1:** RAN4 input on the problem of SSB-less Scell is needed to verify the motivation to support on-demand SSB in SSB-less Scell.  **Proposal 3:** Do not discuss support of on-demand SSB in SSB-less SCell where reference cell is configured until more RAN4 input is available. |
| [8] CMCC | **Observation 1:** For Scenario #2 and Case #1, on-demand SSB SCell operation has benefits in avoiding blind activation of SCell and fast SCell activation.  **Proposal 4:** On-demand SSB SCell operation in Scenario #3A is not supported.  **Proposal 5:** On-demand SSB SCell operation in Scenario #3B and Case #1/Case #2 can be supported. |
| [9] Xiaomi | **Proposal 2:** On-demand SSB can be triggered by gNB for the following scenarios/cases with the assumption that gNB indicates UE whether SSB is on or off:   * Scenario #3A and Case #1 * Scenario #3A and Case #2 * Scenario #3B and Case #1 * Scenario #3B and Case #2   **Proposal 7:** Cell on/off indication based SSB triggering method should be deprioritized as there are many negative impacts on legacy procedures if UE follows legacy behaviours without knowing that SSB is shut down.  **Proposal 8:** For scell activation/deactivation signaling based SSB triggering, we need to first achieve common understanding on the relationship between on-demand SSB and Scell activation/deactivation signaling   * Case1: Scell activation signalling based SSB triggering is only needed during SCell activation procedure. After SCell is activated, gNB has full power to control the SSB transmission * Case2: SCell activation/deactivation signalling is reused as a mechanism to indicate UE SSB is on or off despite of scenario. * Case3: On-demand SSB can be used to expedite SCell activation procedure. After SCell is activated, UE wake-up-signal can be used to trigger SSB.   **Proposal 9:** For on-demand SSB triggering mechanism in different scenarios   * gNB based SSB triggering can be used in scenario #2, #2A, and #3A to expedite SCell activation procedure * After SCell is activated, i.e., scenario #3B, both gNB based SSB triggering signal and UE wake-up-signal can be used to trigger SSB. |
| [11] CATT | **Proposal 1:** For the identified scenarios and cases (as per RAN1#116 and RAN1#116-bis agreements), on-demand SSB can be triggered by gNB for the following scenarios/cases:   * Scenario #3A and Case #1 * Scenario #3A and Case #2 * Scenario #3B and Case #1 |
| [12] ZTE | **Proposal 1:** Whether or not support scenario 3A, 3B should be discussed and concluded firstly.  **Proposal 2:** There is no need to support Scenario #3A.  **Observation 1:** On demand SSB transmission in conjunction with case #1 can achieve a good tradeoff between network energy saving and system performance.  **Proposal 3:** Scenario #3B in conjunction with case #1 should be supported. |
| [13] Transsion | **Proposal 1** Scenarios 3A and Case #1 and Scenario #3B and Case #1 should be supported. |
| [14] OPPO | **Proposal 2:** Transmit on-demand SSB indication in Scenario #3A is beneficial to fast SCell activation and can be supported. |
| [16] InterDigital | **Observation 1:** Since the SCell can be transitioned to NES mode (e.g. SSB-less or SSBs are transmitted with long periodicity) after SCell activation is completed, triggering OD-SSB transmission can be beneficial to improve synchronization, timing reference and AGC at the UE  **Proposal 1:** Support on-demand SSB transmission in Scenario #3B for both Case #1 and Case #2 |
| [18] Panasonic | **Proposal 1:** On-demand SSB triggering timing is up to network implementation irrespective of UE situation. Therefore, scenario #3A/3B and Case 1/2should be also supported for on-demand SSB. |
| [19] NEC | **Observation 1:** For Scenario #3B and Case#2, on-demand SSB transmission can improve the beam management performance for an activated SCell when the always-on SSB is transmitted with longer periodicity.  **Proposal 1:** Support on-demand SSB operation for Scenario #3B Case #1 and Scenario #3B Case#2. Further discuss the applicability of Scenario#3A.  **Proposal 3:** For Case#1, gNB does not need to newly trigger on-demand SSB for a UE if the SCell is already active for another UE (FFS: indication).  **Proposal 4:** For Case#1, on-demand SSB is not expected to be deactivated as long as at least one UE is active on the Cell even when the SCell is deactivated for a UE for which the network triggered the on-demand SSB.  **Observation 3:** On-demand SSB would be transmitted periodically for a while as long as at least one UE is active on the cell, as SCell is a capacity cell and traffic on the capacity cell would not be low.  **Proposal 21:** Discuss other cases (e.g. RACH initiation upon TAT expiry) for which on-demand SSB transmission may be required. |
| [21] Apple | **Observation 1:** There is no clear use case for Scenario #3A/3B with both Case #1 and Case #2.  **Proposal 1:** Scenario #3A and #3B for both Case #1 and Case #2 are deprioritized.  **Proposal 2:** The following use cases are considered for OD-SSB SCell operation.   * UC#1 SCell activation/deactivation for intra/inter-band CA with collocated/non-collocated CA * UC#2 Handover to the cell which was SCell * UC#3 SSB-less operation for collocated CA * UC#4 SSB-less operation for non-collocated CA * UC#5 OD-SSB transmissions from multiple neighboring cells on the same frequency as SCells |
| [22] Fujitsu | **Proposal 2.** Regarding the remaining scenarios/cases that can be considered for triggering on-demand SSB, support the following scenario/case.   * Scenario #3B and Case #1: After SCell activation procedure is completed when there is no always-on SSB   + On-demand SSB can be used for maintaining synchronization, RRM measurement and beam tracking. |
| [23] ETRI | **Proposal 1:** In addition to previous agreed scenarios, it is proposed to consider #3A for further discussion for on-demand SSB SCell operation and preclude Scenario #3B. |
| [24] Samsung | **Observation 1:** The division of scenarios is from UE’s perspective, and on-demand SSB transmitted in one scenario for a first UE can be any scenario for a second UE.  **Observation 2:** The transmission of on-demand SSB is cell-specific, and may impact other UEs supporting the feature of on-demand SSB in the cell for particular scenarios. |
| [26] MediaTek | **Observation 1:** For facilitation of SCell activation, on-demand SSB can be triggered to fill in more SSB bursts in one SSB burst period temporarily to reduce the large SCell activation delay, say in FR2, as shown in Figure 1. |
| [27] NTT DOCOMO | **Proposal 4:**  Support at least one of the following options during activated SCell operation (in scenario#3B) for on-demand SSB operation in terms of practical NES operation.   * Opt-I. all SSBs can be turned off during SCell operation with some restriction on UE behavior on SCell operation, i.e., on-demand SSB operation is supported in scenario #3B and Case #1.   + FFS: some restrictions, e.g., during UE DRX. * Opt-II. Longer SSB periodicity than the legacy (e.g., 320ms) is supported during SCell operation.   + The SSB with longer periodicity can be on-demand SSB triggered in the former scenario(s).   **Proposal 8:**  In scenario #3A, indication of on-demand SSB which may change SSB properties that a UE uses for SCell activation procedure is NOT necessary  **Proposal 9:**  In scenario #3B and case1 and case2 where periodic always-on or on-demand SSB that are not turned off during scenario #3B, same indication mechanism as scenario #2 and case1 and 2 respectively can be sup-ported at least for L1/L3 measurement based on on-demand SSB. |
| [28] Ericsson | **Proposal 6** Additionally support MAC-CE signaling to indicate on-demand SSB transmission, at least, for Scenario #3B. |
| [31] Sharp | **Proposal 1** Support Scenario 3B and at least Case #1 for on-demand SSB for SCell operation. |

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| **Agreement (RAN1#116)**  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 (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. |

## [Moderator’s note] Company views for scenarios/cases with FFS in the above agreement made in RAN1#116bis are as follows.

* Scenario #3A and Case #1
  + Supported by vivo, Xiaomi, CATT, Transsion, OPPO, Panasonic, ETRI
  + Objected by CMCC, ZTE, Apple, NTT DOCOMO
* Scenario #3A and Case #2
  + Supported by vivo, Xiaomi, CATT, OPPO, Panasonic, ETRI
  + Objected by CMCC, Apple, NTT DOCOMO
* Scenario #3B and Case #1
  + Supported by Futurewei, Huawei, China Telecom, Nokia, CMCC, Xiaomi, CATT, ZTE, Transsion, InterDigital, Panasonic, NEC, Fujitsu, NTT DOCOMO, Ericsson, Sharp
  + Objected by vivo, Apple, ETRI, Spreadtrum
* Scenario #3B and Case #2
  + Supported by Futurewei, Huawei, China Telecom, Nokia, CMCC, Xiaomi, InterDigital, Panasonic, NEC, NTT DOCOMO, Ericsson
  + Objected by vivo, Apple, ETRI, Spreadtrum
* vivo: Do not discuss support of on-demand SSB in SSB-less SCell where reference cell is configured until more RAN4 input is available

Given the split views on whether to additionally support above combinations of scenarios/cases, this topic is de-prioritized in this meeting. Nevertheless, companies can provide any suggestions that could be acceptable to all companies.

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| Company | Views |
| Spreadtrum | Slightly oppose Scenario #3A/3B |
| ZTE, Sanechips | Given the FFS bullets for identified scenarios and cases, whether or not support scenario 3A, 3B should be discussed and concluded. |
| vivo | We are fine to deprioritize this topic in this meeting, RAN1 can focus on solution supporting scenario 2/2A |
| CMCC | Support Scenario #3B since OD-SSB procedure after SCell activation can be also beneficial for NES gain perspective.  For scenario #3A, since we already have scenario #2A, we do not observe the strong motivation to introduce the additional similar scenario. |
| DCM | We have same view with CMCC. |

## Whether on-demand SSB is CD-SSB or not

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| Company | Views |
| [1] Futurewei | Proposal 3: Regarding the UE assumption on SSB transmission on a cell supporting on-demand SSB SCell operation, consider supporting cell-defining SSB for the following cases:   * Case #1: No always-on SSB on the cell   + The cell is barred for legacy UEs. * Case #2: Always-on SSB is periodically transmitted on the cell   + The always-on SSB is transmitted with very long periodicity.   + The cell is barred for legacy UEs. |
| [3] Spreadtrum | **Proposal 13:** On-demand SSB can be limited to non-cell-defining SSB. |
| [4] China Telecom | **Proposal 17:** 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 |
| [5] Tejas | **Proposal 5:** It should be up to gNB implementation on whether the on-demand SSB is CD-SSB or NCD SSB. |
| [6] Nokia | **Proposal-14:** Whether on-demand SSB is cell-defining or non-cell-defining and ON or OFF the sync raster should be left to network implementation. |
| [7] vivo | **Proposal 4:** For on-demand SSB on the cell, do not support OD-SSB for CD-SSB located on sync raster. |
| [8] CMCC | **Proposal 1:** For a cell supporting on-demand SSB SCell operation, do not support on-demand SSB for CD-SSB located on sync-raster. |
| [9] Xiaomi | **Proposal 1:** On-demand SSB can be CD-SSB located on sync-raster. |
| [12] ZTE | **Observation 3:** The impact of on-demand SSB operation on legacy UEs is manageable.  **Observation 4:** The gNB can prevent the legacy UE from accessing the NES cell with on-demand SSB.  **Proposal 19:** Support of OD-SSB for CD-SSB located on sync-raster. |
| [13] Transsion | **Proposal 2** OD-SSB for CD-SSB located on sync-raster cannot be supported. |
| [16] InterDigital | **Proposal 2:** Support CD-SSB located on sync-raster for a cell supporting OD-SSB SCell operation |
| [18] Panasonic | **Proposal 2:** OD-SSB for CD-SSB located on sync-raster is not supported. |
| [19] NEC | **Proposal 5:** When on-demand SSB is transmitting periodically, NES cell can be used as an SCell for non-NES UEs irrespective of whether on-demand SSB is CD-SSB.  **Proposal 6:** At least for case#1, on-demand SSB can be CD-SSB and transmitted on synch-raster with assumption the network ensures periodic CD-SSB transmission during the NES cell is activated for any UE.  **Proposal 7:** For case#2, on-demand SSB can be transmitted in the same frequency as always-on SSB. In this case, on-demand SSB can be CD-SSB and transmitted on sync raster. |
| [20] Sony | **Proposal 3:** RAN1 should additionally support OD-SSB for CD-SSB located on sync-raster in addition to SSB not on sync raster and NCD-SSB |
| [21] Apple | **Observation 2:** 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 3:** CD-SSB on sync-raster is not supported for OD-SSB. |
| [22] Fujitsu | **Proposal 1.** For on-demand SSB transmitted on the SCell, support on-demand SSB for CD-SSB on synchronization raster. |
| [23] ETRI | **Proposal 2:** Regarding whether on-demand SSB is cell-defining or not, additional support of CD-SSB located on sync-raster as OD-SSB is not necessary. |
| [24] Samsung | **Proposal 2:** On-demand SSB should not be cell-defining SSB located on synchronization raster entries. |
| [25] LG Electronics | **Proposal #2:** Do not support on-demand SSB for CD-SSB located on sync-raster. |
| [26] MediaTek | **Observation 2:** For a UE performing initial cell search, it would search SSB on the synchronization raster as defined in 38.101-1 [4] Clause 5.4.3. As the on-demand SSB is only transmitted temporarily, it is needed to ensure the on-demand SSB would not be used for initial cell search.  **Observation 3:** For on-demand SSB to be cell-defining SSB of an SCell, as one SCell of UE A can be PCell of UE B, it may still cause impact to legacy UEs.  **Proposal 1:** RAN1 does not support OD-SSB for CD-SSB located on sync-raster. |
| [27] NTT DOCOMO | **Proposal 1:** Support OD-SSB for CD-SSB located on sync-raster. |
| [28] Ericsson | **Observation 5** On-demand SSB that is not cell-defining, and not located on synchronization raster is supported as per above agreement.  **Observation 6** Support on-demand SSB that is cell defining or not cell defining, and that is not located on the synchronization raster.  **Observation 7** The following scenarios are possible if on-demand SSB is bundled with always-on SSB and if both are not located on synchronization raster.   * Scenario 1: same frequency, same time offset, different periodicities. * Scenario 2: same frequency, different time offset, different periodicities. * Scenario 3: different frequencies within the same channel bandwidth. |
| [30] Qualcomm | **Observation 1:** Having on-demand SSB configured as cell-defining SSB has negative impact to both legacy idle/inactive UEs and R19 idle/inactive UEs.  **Proposal 1:** On-demand SSB for cell defining SSB located on synchronization raster is not supported |

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| **Agreement (RAN1#116bis)**   * 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 (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 |

## [Moderator’s note] Regarding FFS point for additional support of OD-SSB for CD-SSB located on sync-raster, company views are summarized as follows.

* Supported by
  + Futurewei, China Telecom, Tejas, Nokia, Xiaomi, ZTE, InterDigital, NEC, Sony, Fujitsu, Spreadtrum
* Objected by
  + ~~Spreadtrum,~~ vivo, CMCC, Transsion, Panasonic, Apple, ETRI, Samsung, LG Electronics, MediaTek, Qualcomm

Given the split views on whether to additionally support CD-SSB located on sync-raster as on-demand SSB, this topic is de-prioritized in this meeting. Nevertheless, companies can provide any suggestions that could be acceptable to all companies.

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| Company | Views |
| Spreadtrum | We are fine with CD-SSB. It is up to gNB implementation. SCell for a UE could be PCell for other UEs. |
| CEWiT | Support |
| vivo | We are fine with FL’s suggestion. |
| OPPO | The FFS point should not be supported. In the WID, the reason why we use on-demand SSB SCell operation is to avoid the further consideration for PCell case. But if we agree to support the FFS, the on-demand SSB impact for PCell will have to be considered, which extends the WID scope. |
| CMCC | Support. Also note that SSB adaptation under AI 9.5.3 has the similar issue to be addressed. We can wait the progress in AI 9.5.3 at this moment. |
| DCM | Support OD-SSB for CD-SSB located on sync-raster.  Even in the legacy spec, there is no restriction that a cell which is operated as SCell only (e.g., cellbarred and periodicity=160ms) cannot be a CD-SSB on sync raster. There is no reason to preclude spec support where OD-SSB can be configured in the same way as legacy for SCell.  We believe that the impact on legacy/idle UEs compared b/w the above legacy SSB config. and OD-/adaptive SSB operation is same. |

# Signalling methods for on-demand SSB TX indication

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| Company | Views |
| [1] Futurewei | **Proposal 5:** Support DCI indication of OD SSB at least for SCell DTX operation. |
| [2] Huawei | **Proposal 2:** Support on-demand SSB indicating MAC CE to adapt the on-demand SSB transmission.  **Proposal 3:** For on-demand SSB deactivation indication, RAN1 to support MAC CE based signalling and timer-based indication. |
| [3] Spreadtrum | **Proposal 7:** For Scenario #2, on-demand SSB indication can be separate from SCell activation command.  **Proposal 8:** For Scenario #2A, on-demand SSB indication and SCell activation command can be a single signaling. |
| [4] China Telecom | **Proposal 1:** Support to use SCell activation/deactivation signaling to trigger on-demand SSB SCell operation.  **Observation 1:** Methods other than SCell activation should be supported for on-demand SSB for SCell operation, at least for supporting Scenario #2.  **Proposal 2:** Support to specify cell on/off indication via backhaul as a triggering method for on-demand SSB.  **Observation 2:** 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.  **Proposal 4:** 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 halting should be introduced.  FFS: whether the MAC CE based initial indication for on-demand SSB can be reused.  **Observation 3:** For the re-indication of on-demand SSB for SCell operation, DCI based signalling can be more beneficial with high efficiency.  **Proposal 7:** DCI based signalling can be beneficial and should be supported if scenario #3A and/or #3B are/is supported. |
| [6] Nokia | **Proposal-2:** The RRC signaling can be considered as the extension of the existing SCell configuration message which may include new parameters required for the on-demand SSB.   * The RRC signaling may contain the configuration information of one or more on-demand SSB transmissions and may also include the activation information of the on-demand SSB transmission pattern. * The RRC configuration of OD-SSB may be provided during time instance T1 and it may be applied for Scenario#2, Scenario#2A and/or Scenario#3B.   **Proposal-3:** For Scenario#2, considering the on-demand SSB transmission is triggered by gNB at the time instance T1 as shown in Figure-1(a),   * The RRC signaling may carry the configuration as well as the activation information of the on-demand SSB transmission.   **Proposal-4:** For Scenario#2, considering the on-demand SSB transmission is triggered by gNB during the time period between T1 and T2 as shown in Figure-1(a),   * The MAC CE signaling may be a new MAC CE for on-demand SSB operation that is operated independently from the SCell (de-)activation operation. * The MAC CE signaling, may indicate the index of the on-demand SSB configurations to be applied.   **Proposal-5:** RAN1 to confirm that the same new MAC-CE designed for Scenario#2 shall be used for Scenario#2A and Scenario #3B. |
| [7] vivo | **Proposal 11:** Support RRC based signaling to indicate on-demand SSB transmission on the cell for the case where this RRC also configures the SCell, deactivates the SCell, and provides on-demand SSB configuration according to the RAN2 agreement.  **Proposal 12:** Do not support RRC based signaling to indicate on-demand SSB transmission on the cell other than the case where this RRC also configures the SCell and provides on-demand SSB configuration. |
| [8] CMCC | **Proposal 2:** For on-demand SSB SCell operation in Scenario #2, group common DCI can be considered to indicate on-demand SSB on NES SCell.  **Proposal 6:** For on-demand SSB SCell operation in Scenario #3B, group common DCI or UE-specific DCI can be considered to indicate on-demand SSB on NES SCell.  **Proposal 10:** For other cases other than the following case, support RRC based signaling to indicate on-demand SSB transmission.   * This RRC also configures the SCell, activates the SCell, and provides on-demand SSB configuration.   **Proposal 11:** For DCI based SSB triggering method, the following options can be considered:   * Reserved bits in default DCI can be used for OD-SSB triggering * Introduce a new DCI format for OD-SSB triggering purpose. |
| [10] Google | **Proposal 1:** Support group-cast DCI based on-demand SSB indication. |
| [11] CATT | **Proposal 2:** For on-demand SSB TX indication, support RRC based signalling for the case where this RRC also configures the SCell without activating the SCell, and provides on-demand SSB configuration (Scenario# 2).  **Proposal 3:** For on-demand SSB TX indication, a single MAC-CE based signalling (Option 2) should be applied to both Scenario#2 and Scenario#2A. Information on whether to activate/deactivate SCell simultaneously is needed in the signalling, which could be configured per SCell group or per SCell.  **Proposal 4:** A unified group-common DCI could be designed to indicate either on-demand SSB transmission or SSB adaptation. |
| [12] ZTE | **Proposal 13:** Do not support RRC based signaling for other cases.  **Observation 2:** A new MAC CE to provide both SCell activation/deactivation indication and on-demand SSB transmission indication can reduce the signaling overhead and SCell activation latency for scenario #2A.  **Proposal 16:** Discuss whether the DCI based signaling is applicable to scenario #3B. |
| [13] Transsion | **Proposal 3** DCI based signaling to indicate on-demand SSB transmission can be supported.  **Proposal** 4 If DCI based signaling support on-demand SSB transmission, DCI is UE-specific. |
| [14] OPPO | **Proposal 4:** For Scenario #2 and #3A, support GC-PDCCH for on-demand SSB indication. |
| [15] Mavenir | **Proposal 1:** it is not preferred to introduce new RRC signalling for deactivation of the on-demand SSB transmission.  **Proposal 2:** it is preferred supporting group-common DCI, and such DCI content can include periodicity and optionally the repetition number of on-demand SSB transmission. |
| [16] InterDigital | **Proposal 8:** DCI based signalling to indicate OD-SSB transmission is not introduced in Rel-19 |
| [17] Lenovo | **Proposal 4:** In addition to RAN1#117/RAN1#118 agreed RRC and MAC CE based signaling methods, support group common DCI based signalling to indicate on-demand SSB transmission on the cell at least for Scenario #2. |
| [18] Panasonic | **Proposal 12:** In addition to RRC and MAC CE based SSB trigging, DCI-based on-demand SSB triggering indication is supported. By RRC configuration, separate bits for SSB ON/OFF of each SCell and joint indication for each SCell group can be supported. |
| [19] NEC | **Observation 4:** Using MAC CE or RRC based indication for on-demand start indication is expected to increase signalling overhead when indication is sent for scenarios not involving SCell activation.  **Proposal 8:** Support on-demand SSB indication via group-common DCI for Scenario#2 and Scenario#3.  **Proposal 9:** On-demand SSB for SCell may be enabled via DCI format 1\_x on PCell with a carrier indication field to indicate the applicable carrier.  **Observation 6:** gNB can indicate the availability of on-demand SSB within the SCell configuration itself if on-demand SSB is already being transmitted in the cell for another UE.  **Proposal 11:** For Case#1, UE assumes that SSB transmissions are stopped immediately after SCell deactivation. There is no need to define explicit deactivation signalling for on-demand SSB. |
| [20] Sony | **Proposal 2:** DCI based signalling to indicate on-demand SSB transmission on the cell should be de-prioritized in Rel-19. |
| [22] Fujitsu | **Observation 1.** Group-common DCI can achieve less signaling overhead than 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 3.** Group common DCI can be considered for on-demand SSB transmission indication. |
| [23] ETRI | **Proposal 3:** In case of RRC based signaling to indicate on-demand SSB transmission, it is not necessary to consider other cases except for the agreed case where the RRC also configures the SCell, activates the SCell, and provides on-demand SSB configuration.  **Proposal 4:** In addition to RRC based and MAC CE based signaling to indicate on-demand SSB transmission, it is proposed to support DCI based signaling to indicate on-demand SSB transmission.   * DCI based signaling is separate signaling and only applicable to indicate on-demand SSB transmission. * Details can be discussed further. |
| [24] Samsung | **Proposal 4:** The indication of on-demand SSB shall be intended for all Rel-19 NES UEs in the cell.   * Send an LS to RAN2. * RAN1 can revisit the need of DCI format based indication of on-demand SSB if such indication cannot be achieved by RAN2 design. |
| [25] LG Electronics | **Proposal #5:** Consider the following signaling mechanisms to deactivate on-demand SSB transmission.   * Option 1: RRC based signalling * Option 2: MAC CE based signalling * Option 3: (Group-common or UE-specific) DCI   **Proposal #6:** Consider to inform whether on-demand SSB on the SCell is transmitted or not, via DCI.   * At least, DCI should be considered as signaling to indicate deactivation of on-demand SSB transmission. |
| [27] NTT DOCOMO | **Observation 3:**  There could be a case where gNB finds OD-SSB operation applicable after gNB configures SCell addition (without OD-SSB config.) based on some events through its implementation.  **Proposal 6:**  In scenario2, support RRC signaling for indication of on-demand SSB transmission separately from SCell activation/deactivation indication.  **Proposal 7:**  In scenario #2, support group-common DCI signaling for indication of on-demand SSB transmission separately from SCell activation/deactivation indication.  **Proposal 10:**  In scenario #3B and case#1 where there can be no periodic SSB, study and consider indication mechanism of on-demand SSB.  **Proposal 11:**  For time domain behavior of OD-SSB (Option1/1A/4), support MAC CE signaling for adaptation and de-activation of on-demand SSB transmission |
| [28] Ericsson | **Proposal 2** Support on-demand SSB deactivation via MAC CE.  **Proposal 3** MAC CE for on-demand SSB deactivation should be separate from legacy MAC CE for SCell deactivation.  **Proposal 4** Support on-demand SSB transmission indication and configuration indication in the same MAC CE.  **Proposal 5** Support adaptation of on-demand SSB periodicity while SCell is in an activated state. |
| [29] ITRI | **Observation 1:**  MAC CE based signaling can provide more scheduling flexibility and shorter scheduling delay than RRC based signaling  **Proposal 1:**  For a cell supporting on-demand SSB SCell operation, RRC based signaling is not supported for Scenario #2, Scenario # 2A, Scenario #3A and Scenario # 3B. |
| [30] Qualcomm | **Proposal 3:** DCI based signaling to indicate on-demand SSB transmission on the cell is not supported.  **Proposal 7:** For SSB transmission case #1, further discuss the following options for the time instance B:   * Option 1: The time instance B is the time UE receives the Scell deactivation command or the time UE sends HARQ-ACK in response to the reception of Scell deactivation command. * Option 2: The time instance B is the time UE receives the signaling indicating unavailability of on-demand SSB transmission.   **Proposal 8:** For SSB transmission case #2, the time instance B is the time UE successfully completes Scell activation (e.g., transmitting the CSI report after UE receives the Scell activation command). |
| [32] ASUSTeK | **Observation 1:** Fixing on-demand SSB transmission with a single periodicity for an SCell whenever there is at least one UE consider the SCell as activated is harmful to the network energy saving gain of on-demand SSB.  **Observation 2:** there are be two cases where a group common DCI could be utilized to indicate on-demand SSB transmission:   * 1. when the on-demand SSB on a SCell is triggered due to activation of the SCell to other UEs * 2. when the periodicity of on-demand SSB is adjusted   **Proposal 1:** RAN1 further discuss whether using group common DCI to indicate on-demand SSB transmission for the case of :   * 1. when the on-demand SSB on a SCell is triggered due to activation of the SCell to other UEs * 2. when the periodicity of on-demand SSB is adjusted   **Proposal 2:** If group common DCI indicating on-demand SSB transmission is supported, RAN1 further investigate whether there is any misalignment issue between UE and gNB. |

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| **Agreement (RAN1#116bis)**  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   **Agreement (RAN1#117)**   * 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 (RAN1#118)**  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. |

## [Moderator’s note #1] Regarding signaling methods for on-demand SSB transmission indication, company views are summarized as follows.

* For DCI
  + Supported by Futurewei (at least for SCell DTX operation), China Telecom (for Scenario #3A/3B), CMCC, Xiaomi, Google, CATT, Transsion, OPPO, Mavenir, Lenovo, Panasonic, NEC, Fujitsu, ETRI, LG Electronics, NTT DOCOMO (for Scenario #2), ASUSTeK
    - Group-common DCI: Google, CMCC (for Scenario #2/3B), CATT, OPPO (Scenario #2/3A), Mavenir, Lenovo, NEC (Scenario #2/3), Fujitsu, LG Electronics, NTT DOCOMO (for Scenario #2), ASUSTeK
  + Samsung: RAN1 to revisit the need of DCI format based indication of on-demand SSB if such indication cannot be achieved by RAN2 design.
  + Negative: InterDigital, Sony, Qualcomm
* For RRC
  + vivo, CATT, NTT DOCOMO
    - Based on RAN2 agreement, support RRC based signalling for the case where this RRC also configures the SCell without activating the SCell, and provides on-demand SSB configuration
  + Against supporting additional case: ZTE, ETRI
* For MAC CE
  + Ericsson: Support adaptation of on-demand SSB periodicity while SCell is in an activated state.
* For deactivation of on-demand SSB
  + MAC CE: Huawei, LG Electronics, NTT DOCOMO, Ericsson (separate from legacy MAC CE for SCell deactivation)
  + Timer: Huawei
  + RRC
    - LG Electronics
    - NO: Mavenir
  + NO need: NEC (SCell deactivation is enough)

### Proposal #3-1 (Deactivation):

* For a cell supporting on-demand SSB SCell operation,
  + MAC CE signaling to indicate on-demand SSB transmission is used for deactivating on-demand SSB transmission.

Companies are encouraged to provide views on Proposal #3-1.

|  |  |
| --- | --- |
| Company | Views |
| Google | We think group-cast DCI is better than MAC CE, since SSB is a cell-specific signal. |
| Spreadtrum | We support deactivation of OD-SSB, and signaling is FFS |
| ZTE, Sanechips | I support this proposal. It seems has same design as option1A which is discussed in section 5 (however there’s no corresponding proposal in section 5)   * + 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   Besides, it would be clear if other options (option 2~option 4) were discussed in proposal #3-1. |
| CEWiT | Support |
| vivo | Since there are multiple options for the ending time of OD-SSB transmission, we would prefer to have more discussion on those options, before discussion on this particular proposal. |
| InterDigital | Support. We believe discussion on supporting MAC CE for deactivation of OD-SSB is also ongoing in RAN2. |
| CMCC | Fine with the proposal |
| Xiaomi | Based on the summary of companies’ view, it is clear that DCI-based mechanism is the most popular one. Therefore, DCI based OD-SSB indication should be supported. |
| MTK | We prefer to indicate number of transmitted SSB bursts directly in the activation command. However, we can be open to take the proposal if clear majority of companies prefer to also have deactivation MAC-CE. |
| Fujitsu | Support |
| Sony | Support |
| Nokia, Nokia Shanghai Bell | This is one option that should be considered for deactivation. Other options should also be discussed i.e. deactivation based on RRC configuration (configured number of SSB bursts or RRC configured time duration of OD-SSB) or based on some condition e.g. when gNB receives measurement report from UE. |
| DCM | Support. We’d like to suggest adding the following FFS same as the other proposals.  “FFS: Scenarios where the above signalings are applicable” |
| Apple | Support |

### Proposal #3-2 (DCI):

* For a cell supporting on-demand SSB SCell operation,
  + Support DCI based signaling to inform UE on-demand SSB transmission on the cell.
    - This DCI signaling does not provide SCell activation/deactivation.
    - FFS: Details on DCI including UE-specific or group-common DCI, DCI contents, etc.
    - FFS: Scenarios where the above signalings are applicable

Companies are encouraged to provide views on Proposal #3-2.

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| Company | Views |
| Google | Support |
| vivo | we are negative to support DCI signaling. From latency reduction perspective, MAC CE signaling is sufficient.  Regarding UE-specific or group-common DCI, we think it is not necessary to specify group-common DCI to indicate OD-SSB, since OD-SSB for SCell operation is per UE behavior, |
| OPPO | Support |
| InterDigital | We do not support DCI for indicating OD-SSB transmission, primarily because we do not see there is any motivation/scenario for it in addition to the MAC CE that is already supported. |
| CMCC | At least group common DCI is supported to deal with rate matching and RO resource validation issue for the UEs that the corresponding SCell is activated with low signaling overhead. |
| Xiaomi | Fine with the proposal. |
| MTK | With the MAC-CE on-demand SSB activation agreed before, we see little benefits to define the additional DCI-based signalling. However, we are open to discuss if majority of companies wish to. |
| Fujitsu | Support |
| Nokia, Nokia Shanghai Bell | For currently prioritized scenarios #2 and #2A, DCI based signaling seems not necessary. RAN1 should first discuss if scenario #3B is supported and then DCI based signaling could be considered. |
| DCM | Support.  For UEs in scenario2 (and possibly scenario3B), it is more appropriate that OD-SSB operation is done in a cell-specific manner, thus we support group-common DCI. |
| Apple | We are negative to introduce DCI based signaling. |

# Contents of on-demand SSB configuration/indication

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| --- | --- |
| Company | Views |
| [1] Futurewei | **Proposal 6:** Support the potential indication/signaling mechanisms:   * Scenario #3B: On-demand SSB for an activated SCell in cell DTX or cell dormancy:   + A new DCI to indicate on-demand SSB for on-demand Active Period (for SCell in cell DTX) or switching to a non-dormant BWP (for SCell in cell dormancy). * The MAC CE or DCI is sent on another cell, which selects options configured in RRC for at least the availability of on-demand SSB (time offset, number of bursts, beam, etc.). |
| [2] Huawei | **Proposal 4:** To enable more efficient on-demand SSB operation for SCell, the time-domain configuration of on-demand SSB includes:   * Candidate SS/PBCH block positions within an on-demand SSB burst, e.g., gap between candidate SS/PBCH blocks; * The gap between SSB bursts, considering on-demand SSB with periodicity less than 5ms. |
| [3] Spreadtrum | **Proposal 13:** At least for Case #1, SCS of the on-demand SSB should be configured to UE via RRC signaling.  **Proposal 14:** at least for Case #1, PCI of the on-demand SSB should be configured to UE via RRC signaling. |
| [4] China Telecom | **Proposal 8:** At least for the RRC-indicated on-demand SSB, there should be only one set of RRC configuration for on-demand SSB.  **Proposal 9:** At least for Scenario #2, if only one set of RRC parameter for on-demand SSB is configured, the MAC CE based indication of SCell activation should indicate the configured on-demand SSB without any modification.  **Proposal 10:** Not support all the parameters in Info-Set 1 to be carried in the MAC CE signalling for on-demand SSB transmission indication.  **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 11:** 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 12:** For the RRC configuration of on-demand SSB, the following parameters should be configured ate least once, and if the parameters are configured separately in multiple sets, there should be one on-demand config index configured for each set.   * Index on-demand SSB config * 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 |
| [5] Tejas | **Proposal 1:** Supporting more than one on-demand SSB configuration to the UE.  **Proposal 2:** Two SSB configurations can be used. One SSB configuration with longer SSB periodicity and always on. Another SSB configuration with shorter periodicity and can be enabled/disabled based on the network requirement.  **Observation 1:** SSB position in the burst should be configured by RRC and should be indicated by the MAC-CE.  **Proposal 3:** 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,   * SSB position in burst * Sub carrier spacing of the SSB * Physical CELL ID * DL SSB transmit power * Location of the on-demand SSB burst within a frame   **Proposal 4:** SSB position in burst can be assigned with all zeros, to indicate that on-demand SSB burst is turned off. |
| [6] Nokia | **Proposal-2:** The RRC signaling can be considered as the extension of the existing SCell configuration message which may include new parameters required for the on-demand SSB.   * The RRC signaling may contain the configuration information of one or more on-demand SSB transmissions and may also include the activation information of the on-demand SSB transmission pattern. * The RRC configuration of OD-SSB may be provided during time instance T1 and it may be applied for Scenario#2, Scenario#2A and/or Scenario#3B.   **Proposal-3:** For Scenario#2, considering the on-demand SSB transmission is triggered by gNB at the time instance T1 as shown in Figure-1(a),   * The RRC signaling may carry the configuration as well as the activation information of the on-demand SSB transmission.   **Proposal-4:** For Scenario#2, considering the on-demand SSB transmission is triggered by gNB during the time period between T1 and T2 as shown in Figure-1(a),   * The MAC CE signaling may be a new MAC CE for on-demand SSB operation that is operated independently from the SCell (de-)activation operation. * The MAC CE signaling, may indicate the index of the on-demand SSB configurations to be applied.   **Proposal-5:** RAN1 to confirm that the same new MAC-CE designed for Scenario#2 shall be used for Scenario#2A and Scenario #3B.  **Proposal-6:** RAN1 to clarify if some of the parameters for on-demand SSB may be reused/referenced from the legacy SSB configuration for assisting RAN2 discussion.  **Proposal-13:** RAN1 to clarify if the UE is expected to measure SSBs on different ARFCN when configured with always-on and on-demand SSB. |
| [7] vivo | **Proposal 13:** The on-demand SSB transmission number N can be configured with multiple candidate values by RRC and the applicable value can be indicated by MAC CE.  **Proposal 14:** The following parameters are configured to UE:   * Sub-carrier spacing of the on-demand SSB * Candidate location of on-demand SSB burst * Downlink transmit power of on-demand SSB * Frequency of the on-demand SSB * SSB positions within an on-demand SSB burst   **Proposal 15:** In addition to periodicity and transmission number N, the following parameters could be explicitly indicated to UE through the on-demand SSB triggering MAC CE :   * Serving cell ID of the on-demand SSB |
| [8] CMCC | **Proposal 7:** The SCS and Physical Cell ID of on-demand SSB is the same as that of always-on SSB.  **Proposal 8:** The parameters to determine the location of on-demand SSB burst, e.g. the number of SSB bursts or time duration between time instance A and time instance B, are configured by RRC.  **Proposal 9:** The downlink transmit power of on-demand SSB can be configured by RRC if it is different type of SSB from always-on SSB, otherwise it is the same as that of always-on SSB. |
| [9] Xiaomi | **Observation 2:** No matter which mechanism is adopted for SSB triggering, UE may not be able to recognize SSB transmission status.  **Proposal 12:** UE needs to recognize the transmission status of SSB in order to avoid wasting power and guarantee accurate measurement result.   * FFS: detail mechanisms for UE to identify the transmission status of SSB |
| [10] Google | **Proposal 3:** Support the MAC CE based on-demand SSB indication for SCell to provide the following information in addition to the periodicity of the on-demand SSB:   * SCell index * Activation/deactivation status for each SSB for the SCell * The value of the action delay T   **Proposal 4:** Support the NW configures one on-demand SSB configuration and introduce new RRC parameters for the agreed configuration for on-demand SSB including   * 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 |
| [11] CATT | **Proposal 5:** More than one on-demand SSB configurations can be configured for the cell to UE.  **Proposal 6:** Besides periodicity, multiple candidate values can also be configured by RRC for the following parameters:   * The number of SSB bursts that will be transmitted, if supported * SSB positions within an on-demand SSB burst   **Proposal 7:** The following information for on-demand SSB should be included in on-demand SSB configuration:   * Periodicity of the on-demand SSB * Location of on-demand SSB burst * The number of SSB bursts, if supported * Frequency of the on-demand SSB * Sub-carrier spacing of the on-demand SSB * SSB positions within an on-demand SSB burst * Downlink transmit power of on-demand SSB * Physical Cell ID of the on-demand SSB   **Proposal 8:** The following information for on-demand SSB could be carried by MAC-CE based signalling:   * Index of OD-SSB config * SSB positions within an on-demand SSB burst * Deactivation of on-demand SSB |
| [12] ZTE | **Proposal 9:** A unified on-demand SSB configuration for multiple scenarios/cases is needed.  **Proposal 10:** Support to configure following parameters in the on-demand SSB configurations:   * Frequency of the on-demand SSB * SSB positions within an on-demand SSB burst * Periodicity of the on-demand SSB * Sub-carrier spacing of the on-demand SSB * Downlink transmit power of on-demand SSB * The value of T (for determining time instance A) * The number of SSB bursts or the duration for on-demand SSB transmission (for determining time instance B)   **Proposal 11:** More than one on-demand SSB patterns can be configured for the SCell to UE, and each on-demand SSB pattern is associated with one or more on-demand SSB related parameters.  **Proposal 12:** A target on-demand SSB transmission pattern index or a default on-demand SSB transmission pattern can be configured by RRC signaling.  **Proposal 14:** The new MAC CE that contains two independent indication fields to indicate the SCell activation/deactivation and on-demand SSB transmission respectively can be used for all scenarios which supports the on-demand SSB.  **Proposal 15:** The target SCell and target on-demand SSB transmission pattern index can be indicated by the MAC CE. |
| [14] OPPO | **Proposal 3:** Separate on-demand SSB and always-on SSB if the always-on SSB is cell-defining SSB. |
| [16] InterDigital | **Proposal 5:** Configuration of more than one OD-SSB configurations per frequency range is not supported  **Proposal 6:** Signalling of additional parameters (i.e. aside from periodicity) is not supported in the MAC CE indicating OD-SSB transmission |
| [17] Lenovo | **Proposal 5:** UE is either indicated with a time duration for on-demand SSB transmission or is indicated with the number of SSB bursts of on-demand SSB. The indication can be in MAC CE. |
| [18] Panasonic | **Proposal 11:** On-demand SSB triggering indication can be before, at the same time with or after the SCell activation without limitation. The validity period can be RRC configurable. If not configured, on-demand SSB is default to be valid until gNB indicates to turn OFF the SSB.  **Proposal 12:** In addition to RRC and MAC CE based SSB trigging, DCI-based on-demand SSB triggering indication is supported. By RRC configuration, separate bits for SSB ON/OFF of each SCell and joint indication for each SCell group can be supported.  **Proposal 13:** 9.5.1 only supports that periodicity of the on-demand SSB can be indicated. |
| [19] NEC | **Proposal 10:** Support indication of availability of on-demand SSB transmission using a parameter within the SCell configuration.  **Proposal 12:** For Case#2, UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted.  **Proposal 24:** For Case#1, on-demand SSB configuration can reuse the SCell SSB IEs (*absoluteFrequencySSB*, *ssb-periodicityServingCell*, *ssb-periodicityServingCell*, *ssbSubcarrierSpacing*, *ss-PBCH-BlockPower*) included within *ServingCellConfigCommon*.   * Additional IEs can be introduced for remaining aspects specific to on demand SSB operation.   **Proposal 25:** For Case#2, if on-demand SSB is transmitted in the same frequency as always-on SSB, the on-demand SSB and always-on SSB can share some of the transmission parameters (*absoluteFrequencySSB*, *ssb-periodicityServingCell*, *ssb-periodicityServingCell*, *ssbSubcarrierSpacing*, *ss-PBCH-BlockPower*).   * Additional IEs can be introduced for other remaining aspects specific to on-demand SSB operation.   **Proposal 26:** For Case#2, if on-demand SSB is not transmitted in the same frequency as always-on SSB, the on-demand SSB configuration can be provided using *NonCellDefiningSSB-r17*   * Additional IEs can be introduced for remaining aspects specific to on-demand SSB operation.   **Proposal 27:** For a cell supporting on-demand SSB SCell operation, gNB indicates the following to the UE:   * Whether a configured SSB is always-on or on-demand transmitted. FFS whether this indication is provided explicitly or implicitly using another parameter. * Parameters for UE request for on-demand SSB. * Parameters for time window for monitoring on-demand SSB by the UE.   **Proposal 28:** For Case#2, on-demand SSB can share some of the parameters with always-on SSB including SCS and SSB transmission power. Following transmission parameters are additionally configured for on-demand SSB (different than parameters for always-on SSB):   * Time offset between the always-on SSB burst occasions and on-demand SSB burst occasions * Periodicity of on-demand SSB |
| [21] Apple | **Proposal 4:** In addition to OD-SSB periodicity, at least the following parameters for OD-SSB configuration by RRC can be included:   * OD-SSB periodicity (*ssb-periodicityServingCell*) => agreed * Physical cell ID (*physCellId*) * SSB position in burst (*ssb-PositionsInBurst*) * SSB subcarrier spacing (*ssbSubcarrierSpacing*) * EPRE for SSS (*ss-PBCH-BlockPower*) * SSB frequency (*absoluteFrequencySSB*) * Activation/Deactivation of OD-SSB transmission (in case of RRC based OD-SSB indication) * At least one set of BFD parameters (see Section 5)   **Proposal 5:** Multiple candidate values for other parameters than OD-SSB periodicity in OD-SSB configuration need a strong justification. |
| [23] ETRI | **Proposal 5:** For on-demand SSB operation, most of parameters except for location of on-demand SSB burst are already in existing RRC IE, *ServingCellConfigCommon* or *ServingCellConfig* and can be reused. In addition to the existing parameters, the following parameters can be added.   * For location of on-demand SSB burst, at least system frame number (SFN) and half frame index can be added. * For on-demand SSB transmission from time instance A, the number of on-demand SSB burst(s) can be added if adopted. * FFS: other parameters   **Proposal 9:** It is proposed to report additional information for proper configuration for on-demand SSB transmission.   * Details of additional information can be discussed further. |
| [24] Samsung | **Proposal 10:** For parameters of on-demand SSB, adopt the following delivery methods correspondingly.   |  |  | | --- | --- | | Parameter of on-demand SSB | Delivery method | | Frequency of the on-demand SSB | New RRC parameter | | Periodicity(ies) of the on-demand SSB | New RRC parameter | | Physical cell ID of the on-demand SSB | Same as the RRC parameter for periodic SSB in the cell, if any; new RRC parameter, otherwise. | | Subcarrier spacing of the on-demand SSB | Same as the RRC parameter for periodic SSB in the cell, if any; new RRC parameter, otherwise. | | Transmission power of the on-demand SSB | Same as the RRC parameter for periodic SSB in the cell, if any; new RRC parameter, otherwise. | | SSB positions in burst | Same as the RRC parameter for periodic SSB in the cell, if any; new RRC parameter, otherwise.  Also in the MAC CE indicating the on-demand SSB transmission, to indicate a subset from the RRC parameter. | | A number of bursts for the on-demand SSB (for Option 3) | DL indicator (RRC or MAC CE indicating the on-demand SSB transmission). | |
| [25] LG Electronics | **Proposal #1:** For Case #1 (i.e., No always-on SSB on a cell), how to inform the UE whether timing reference cell for the cell is provided or not.  **Proposal #3:** Discuss whether on-demand SSB is configured per serving cell or can be configured per BWP.  **Proposal #7:** The half frame index where on-demand SSB for an SCell is transmitted is known implicitly to UE by using the half frame index for always-on SSB in the SCell or in the other serving cell, or can be explicitly configured by RRC parameter.  **Proposal #8:** In addition to periodicity (as agreed in RAN1#118), for the following parameters, multiple candidate values can be configured by RRC and the applicable value can be indicated by MAC CE for on-demand SSB transmission indication.   * The number of on-demand SSB bursts to be transmitted after on-demand SSB is indicated (alternatively, the duration of on-demand SSB transmission window) * Frequency of the on-demand SSB * SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*   **Proposal #9:** Support more than one on-demand SSB configurations that are provided by RRC signalling.   * One index of multiple on-demand SSB configurations is indicated by signaling for on-demand SSB transmission indication. * One on-demand SSB configuration includes a set of parameters for which multiple candidate values can be configured by RRC and the applicable value can be indicated by MAC CE for on-demand SSB transmission indication. |
| [26] MediaTek | **Proposal 2:** As the RAN1 #118 agreement only states the start time instant (time instance A) of the on-demand SSB but not the stop time instant, the DL MAC-CE should include the following time domain properties of the to-be-transmitted on-demand SSB:   * Number of SSB bursts * Number of SSB burst clusters (one cluster includes multiple SSB burst) |
| [28] Ericsson | **Observation 3** MAC CE indication of SSB positions within a burst allows NW to adapt SSB transmissions to served UEs without RRC reconfiguration.  **Proposal 8** Support, at least for the following parameter(s), that 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.   * On-demand SSB periodicity. * On-demand SSB positions in a burst. * On-demand SSB duration.   **Proposal 11** Support, at least, both always-on SSB and on-demand SSB in non-synchronization raster where both have the same frequency and time offset but different periodicities. |
| [29] ITRI | **Proposal 2:**  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.   * Time interval between A and B if Option 2/Option 4 is supported for SSB burst(s) indicated by on-demand SSB SCell operation. * Number of on-demand SSB bursts (N) if Option 3 is supported for SSB burst(s) indicated by on-demand SSB SCell operation. |
| [33] CEWiT | **Observation 4:** Configuring multiple candidate values for the number of SSBs in a burst based on channel conditions, UE density, and traffic requirements, and indicating the applicable value via MAC CE for on-demand SSB transmission, can reduce transmissions and save energy at the gNB.  **Proposal 8:** Support the configuration of the number of on-demand SSBs active within a burst for the UE. |

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| **Agreement (RAN1#117)**   * 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 (RAN1#117)**   * 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   **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 |

## [Moderator’s note #1] Regarding contents of on-demand SSB configuration/indication, company views are summarized as follows.

* Details on higher layer parameter signaling
  + Frequency of the on-demand SSB
    - Explicit RRC signaling: Huawei, Google, CATT, ZTE, Apple, ETRI, Samsung
  + SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*
    - Explicit RRC signaling: Spreadtrum, Google, CATT, ZTE, ETRI, Samsung (also in on-demand SSB indication signaling)
    - Same as always-on SSB: Samsung
    - Tejas: SSB position in burst can be assigned with all zeros, to indicate that on-demand SSB burst is turned off
  + Periodicity of the on-demand SSB
    - Explicit RRC signaling: Google, CATT, ZTE, Apple, ETRI, Samsung
    - Huawei: New value
  + Sub-carrier spacing of the on-demand SSB
    - Explicit RRC signaling: CATT, ZTE, Apple, ETRI, Samsung
    - Same as always-on SSB: CMCC, Samsung
  + Physical Cell ID of the on-demand SSB
    - Explicit RRC signaling: Huawei, Spreadtrum, CATT, Apple, ETRI, Samsung
    - Same as always-on SSB: CMCC, Samsung
  + Location of on-demand SSB burst (or half-frame index of the on-demand SSB)
    - Implicitly known: LG Electronics
    - Explicit signaling: CATT, ETRI (SFN as well), LG Electronics
  + Downlink transmit power of on-demand SSB
    - Explicit RRC signaling: CATT, CMCC, ZTE, Apple, ETRI, Samsung
    - Same as always-on SSB: CMCC, Samsung
  + Others
    - # of SSB bursts: CMCC, CATT, ZTE, Lenovo, NEC, ETRI, Samsung (in on-demand SSB indication signaling), LG Electronics, MediaTek
    - Transmission duration/window: CMCC, ZTE, Lenovo, Panasonic, NEC
    - On/Off status of on-demand SSB: CATT, ZTE, Apple (for RRC based indication)
    - Huawei: gap between candidate SS/PBCH blocks & gap between SSB bursts (e.g., less than 5 ms)
    - Reuse legacy parameters as much as possible: NEC, ETRI
    - At least one set of BFD parameters: Apple
    - Offset between always-on SSB and on-demand SSB: NEC
    - Timing reference cell: LG Electronics
    - Configuration granularity (per cell or per BWP): LG Electronics
* Multiple on-demand SSB configurations
  + Supported by Futurewei, China Telecom, Nokia, CATT, ZTE, LG Electronics
    - Also, indication of configuration index is supported by China Telecom, Nokia, CATT, ZTE, LG Electronics
  + Single configuration is enough: InterDigital
* Multiple candidate configuration + one applicable value indication
  + Only Periodicity
    - InterDigital, Panasonic, Apple
  + SSB position in burst
    - Tejas, CATT, LG Electronics, Ericsson, CEWiT
    - NO: vivo
  + The on-demand SSB transmission number N
    - vivo, CATT, LG Electronics, ITRI
  + Duration
    - Ericsson, ITRI, LG Electronics
  + Serving cell ID
    - vivo, Google
  + Sub carrier spacing of the SSB
    - Tejas
    - NO: vivo
  + Physical CELL ID
    - Tejas
  + DL SSB transmit power
    - Tejas
    - NO: vivo
  + Location of the on-demand SSB burst within a frame
    - Tejas
    - NO: vivo
  + Frequency of OD-SSB
    - LG Electronics
    - NO: vivo
  + Activation/deactivation status of each SSB
    - Google
  + The value of T (by reverting WA)
    - Google

### Proposal #4-1 (OD-SSB config):

* For a cell supporting on-demand SSB SCell operation, support to provide at least the following parameters for on-demand SSB configuration by RRC (e.g., *OD-SSB-Config-r19*), separately from SSB supported in Rel-18 specifications.
  + Periodicity of the on-demand SSB (e.g., *ssb-Periodicity*), as agreed in RAN1#118
  + Frequency of the on-demand SSB (e.g., *absoluteFrequencySSB*)
    - FFS if this can be absent for Case #2
  + SSB positions within an on-demand SSB burst (e.g., *ssb-PositionsInBurst*)
    - FFS if this can be absent for Case #2
  + Sub-carrier spacing of the on-demand SSB (e.g., *ssbSubcarrierSpacing*)
    - FFS if this can be absent
  + [Physical Cell ID of the on-demand SSB (e.g., *physCellId*)]
    - FFS if this can be absent
  + Time domain location of on-demand SSB burst (e.g., *sfn-SSB-Offset*, *halfFrameIndex*)
    - FFS if this can be absent
  + Downlink transmit power of on-demand SSB (e.g., *ss-PBCH-BlockPower*)
    - FFS if this can be absent
  + The number N of on-demand SSB bursts to be transmitted after on-demand SSB is indicated

Companies are encouraged to provide views on Proposal #4-1.

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| Company | Views |
| Google | We think we should discuss whether always-on SSB is configured or not. If always-on SSB is configured, some parameters like frequency of on-demand SSB may not be necessary. |
| Spreadtrum | We should separate two cases, i.e. Case #1 (SSB-less) and Case #2 (always-on SSB). For always-on SSB, some parameters are configured already. |
| ZTE, Sanechips | I support this proposal. Having separate on-demand SSB configuration is clear. Regarding the parameters, “configuration index” can be considered for additional benefit of signaling overhead. |
| Sharp | For Case #2, when always-on SSB and on-demand SSB on the cell have different SSB frequency, frequency of the on-demand SSB shall be present. It can be absent otherwise. |
| OPPO | Generally ok. But we think the number of N may contain multiple values, and if the MAC-CE trigger is used, MAC-CE can select a value among multiple configured values. |
| InterDigital | Generally supportive. Regarding the last sub-bullet (number N of OD-SSB bursts), our preference is to exclude it from the list until further progress is made on the OD-SSB transmission pattern discussion. |
| CMCC | Our understanding on time domain location of on-demand SSB burst is that it may not need since the gNB can transmit the OD-SSB ASAP after the delay..  In addition, for Physical Cell ID, our understanding is that it can be implicitly indicated, e.g., by including the OD-SSB configuration under *ServingCellConfigCommon*. |
| Xiaomi | Google raise a good point. We need to discuss the necessary parameters for on-demand SSB per case.  Besides, we are confused on the necessity of introducing several parameters, such as ‘Time domain location of on-demand SSB burst’ and ‘Physical Cell ID of the on-demand SSB’. |
| MTK | Generally fine with the proposal. |
| Fujitsu | The duration of on-demand SSB transmission window can also be included. Similar to proposal #4-2, both number N of on-demand SSB bursts to be transmitted and duration of on-demand transmission window can be put in square bracket. |
| Sony | Generally ok for the proposal for Case#1. But, we can discuss for Case#1 and Case#2 separately. |
| Nokia, Nokia Shanghai Bell | For case #2 some of the parameters of always-on SSB can be referenced/reused so it may not be necessary to configure them, or the default value of the parameter could be the same as the value of the always-on SSB. |
| DCM | This proposal seems OK, but it seems better for RAN1 first to conclude UE behaviors regarding after OD-SSB is indicated and transmitted in each scenario/case/use-case (i.e., Proposals 3, 5 and 6 are more important).  The necessary RRC parameters will be naturally determined according to the agreed UE behaviors. |
| Apple | 1/ Okay except time domain location  2/ If we do not include BFD parameters, how can we support BFD using OD-SSB? |

### Proposal #4-2 (RRC+MAC-CE indication):

For a cell supporting on-demand SSB SCell operation, in addition to periodicity of the on-demand SSB, 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 N of on-demand SSB bursts to be transmitted after on-demand SSB is indicated or duration of on-demand SSB transmission window]

Companies are encouraged to provide views on Proposal #4-2.

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| Company | Views |
| Google | Support |
| Spreadtrum | Do not understand those within square bracket. We are defining deactivation now. |
| ZTE, Sanechips | Supportive. I support the first sub-bullet. And I support the second sub-bullet which provide NES gain based on flexible necessity of amount of SSB bursts, thus the bracket can be removed. |
| CEWiT | Support |
| vivo | Regarding the 2nd bullet, if N value is used to indicate the OD-SSB ending time, it makes sense to indicate N in RRC and MAC CE. |
| OPPO | Support |
| InterDigital | We do not support the proposal. The motivation for dynamically signaling in MAC CE the SSB positions of OD-SSB burst is not clear to us. For the SCell activation scenarios discussed (e.g. #2, #2A), how much of an additional benefit and flexibility is achievable is also unclear when this parameter is signaled dynamically. In our view, since the SSB positions in OD-SSB burst are not expected to change frequently, it is sufficient to configure it semi-statically. |
| CMCC | We do not observe the strong motivation to introduce multiple values for N or duration. One value shall be enough. |
| Xiaomi | More clarification is needed. Why does gNB adjust SSB positions within a on-demand SSB burst? Is it on-demand SSB or SSB adaptation? |
| MTK | Generally fine with the proposal. |
| Fujitsu | Support |
| Nokia, Nokia Shanghai Bell | In general, RRC may contain the configuration information of one or more on-demand SSB transmissions and MAC CE can indicate which configuration is transmitted. |
| DCM | Support. |
| Apple | We agree with Xiaomi and thus we do not support the proposal #4-2. |

# TX behavior of on-demand SSB burst

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| Company | Views |
| [1] Futurewei | **Proposal 1:** Confirm the working assumptions for the definition of T and T\_min in the definition of time instance A (Alt 3-1).  **Proposal 7:** For on-demand SSB transmission, UE expects that on-demand SSB burst(s) is transmitted N (≥0) times after the MAC CE or DCI indication, followed by periodic SSB transmission. |
| [2] Huawei | **Proposal 5:** Modify Alt 3-1 and confirm the working assumption of “at least” as:   * 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 which is at least T slots after the slot where UE receives a signalling from gNB to indicate on-demand SSB transmission.   **Proposal 6:** Denote T1 as the interval in between the time instance when UE receives the signalling indicating on-demand SSB and time instance A. The value of (T1- Tmin) is dynamically indicated to UE by the same MAC-CE indicating SSB. |
| [3] Spreadtrum | **Proposal 10:** For mechanism of on-demand SSB transmission, Option 1 and Option 1A should be excluded.  **Observation 7:** For Scenario #2, Option 2 can be supported.  **Observation 8:** For Scenario #2A, Option 2 can be supported.  **Proposal 11:** For mechanism of on-demand SSB transmission, at least Option 2 (i.e. 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) is supported in R19.  **Proposal 12:** For agreement of the time instance A, the content about square bracket is updated to “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. |
| [4] China Telecom | **Proposal 13:** The understanding of T should follow understanding #1, i.e., time instance can be after/at T slots since OD-SSB indication transmitted.  **Proposal 14:** Support to define time instance A as the beginning of the first slot containing candidate SSB index 0 or the first actual transmitted SSB index of on-demand SSB burst.  **Observation 8:** Adopt Option 1 for on-demand SSB brings no NES gain compared with legacy SSB.  **Observation 9:** Option 4 for on-demand SSB is more like SSB adaptation, which should be discussed in AI 9.5.3  **Proposal 15:** Time instance B should be defined as the ending of slot boundary containing the last on-demand SSB in the transmitted SSB burst before the receiving indication  **Observation 10:** From the perspective of gNB and UE’s behavior, there is no difference between Option 2 and Option 3, while Option 3 can be more straightforward for UE.  **Proposal 16:** For SSB burst(s) indicated by on-demand SSB SCell operation, down select among the the following options.   * 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. |
| [6] Nokia | **Proposal-7:** Confirm the working assumptions in the RAN1#118 agreement so that   * the time instance A is defined to be at least T slots after the UE receives signaling from gNB * T=T\_min   **Observation-2:** The numerology considered for the T\_min calculations are with respect to the carrier on which UE receives MAC-CE.  **Proposal-8:** RAN1 to confirm that the agreement on the T slots apply to the cell transmitting the MAC-CE signaling and applies irrespective of the SCell numerology.  **Observation-3:** UE cannot assume the time slot of RRC signaling reception as the time reference for the first OD-SSB time domain position.  **Proposal-9:** For RRC-based signaling to activate the on-demand SSB transmission, the time reference for the first SSB time domain position can be based on the slot and system frame number in PCell.  **Proposal-10:** Time instance A is always the slot/symbol boundary of the first SSB time domain position of the SSB burst.  **Proposal-11:** RAN1 to discuss the following options on how to stop UE monitoring of OD-SSB:   * Option-A: Stopping of UE monitoring of OD-SSB based on NW configuration. * Option-B: Stopping of UE monitoring of OD-SSB explicitly via MAC CE signaling. * Option-C: Stopping of UE monitoring of OD-SSB implicitly based on conditions, e.g. after NW receiving or UE sending measurement reporting.   **Observation-4:** Option 4 is intended for Case-2 with always-ON periodic SSB transmission in SCell, where the NW triggers on-demand denser SSB transmission with shorter SSB periodicity from time instance A, i.e. when NW sends SCell activation command, and later NW starts sending SSB with longer periodicity after time instance B, i.e. when NW has received UE measurement report.  **Proposal-12:** Option 4 can be jointly considered with the agreement from AI 9.5.3 about adaptation of SSB burst periodicity in time-domain. |
| [7] vivo | **Proposal 7:** For SSB burst(s) indicated by on-demand SSB SCell operation, UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted.  **Proposal 8:** The slot starting from the time instance A should include the first SSB of a complete actually transmitted on-demand SSB burst.  **Proposal 9：**Time instance A is the beginning of the first slot containing the first actually transmitted SSB index of a complete 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.  **Proposal 10:** When SCell with on demand SSB transmission and cell with signalling transmission have different numerologies, the value of T is determined with the numerology of the cell with signalling transmission. |
| [9] Xiaomi | **Proposal 3:** Confirm the working assumptions in the following agreement with modification.  **Proposal 3:** Time instance A and value of T can be defined as follows if on-demand SSB is triggered by UL WUS and DCI-based signalling.   * If on-demand SSB is triggered by UL WUS, time instance A could be defined as the first symbol of the candidate SSB index 0 of on-demand SSB burst. * If on-demand SSB is triggered by gNB, instance A could be defined as the slot of the first SSB time domain position of actually transmitted on-demand SSB burst   + If triggering message is carried by RRC signalling, instance A is the first slot containing candidate SSB index 0 of on-demand SSB burst after slot n, slot n is the last downlink slot overlaps with uplink slot on which UE transmit ACK for the RRC signalling. T at least includes the RRC processing delay.   + If triggering message is carried by DCI, instance A is the first slot containing SSB index 0 of on-demand SSB burst that is not earlier than T after slot n wherein UE receives the DCI. T at least includes processing time for the PDCCH which may be up to UE capability. |
| [10] Google | **Proposal 2:** For MAC CE based on-demand SSB indication, confirm the first working assumption that T is not less than T\_min and revert the second working assumption that T is T\_min. |
| [11] CATT | **Proposal 9:** For SSB burst(s) indicated by on-demand SSB SCell operation, the following options are preferred for further study:   * 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.   **Proposal 10:** Time instance A is defined as the slot boundary of the first slot containing candidate SSB index 0, regardless of how SSB positions within an on-demand SSB burst are configured to the UE.  **Proposal 11:** Time instance A is located after T, and the distance between slot n and time instance A can be greater than T, the wording ‘at least’ in the agreement should be kept.  **Proposal 12:** Confirm the working assumption T=T\_min.  **Proposal 13:** For SSB burst transmission, time instance B could be associated with predefined SSB termination events, e.g.   * SCell deactivation MAC-CE is received * Periodicity of always-on SSB is adjusted to smaller value * Cell is switched to non-active time |
| [12] ZTE | **Proposal 4:** For SSB burst(s) indicated by on-demand SSB SCell operation, the option 1 should be excluded.  **Proposal 5:** Confirm the working assumption that T = T\_min.  **Proposal 6:** For SSB burst(s) indicated by on-demand SSB SCell operation via RRC based signaling, an accurate application delay for determining the time instance A is needed.  **Proposal 7:** For the RRC based signaling or DCI based signaling (if supported), time instance A can be the first slot containing the on-demand SSB which is at least T slots after the slot where UE receives a RRC or DCI signalling from gNB to indicate on-demand SSB transmission.   * FFS values of T.   **Proposal 8:** Time instance B can be determined by a transmission duration after time instance A or N times SSB transmission after time instance A. |
| [13] Transsion | **Proposal 5** Similar to MAC CE, the application time T needs to be defined for RRC.  **Proposal 6** It is recommended that on-demand SSB burst(s) transmitted N times after time instance A can be supported. |
| [14] OPPO | **Proposal 5:** For both RRC and MAC CE based signaling to indicate OD-SSB transmission, the offset of the transmitted OD-SSB burst relative to the start of the SSB period can be configured by RRC signaling. |
| [16] InterDigital | **Proposal 3:** Confirm the following definition of time instance A for OD-SSB burst(s) transmitted:   * 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 which is at least T slots after the slot where UE receives a signalling from gNB to indicate on-demand SSB transmission   **Proposal 4:** Confirm the following working assumptions:   * Time instance A is at least T slots after the slot where UE receives a signalling from gNB to indicate on-demand SSB transmission * T=T\_min   **Proposal 7:** Support one of 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 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. FFS: value of N |
| [17] Lenovo | **Proposal 6:** Confirm the working assumption “T=Tmin” for time instance A for MAC CE based on-demand SSB.  **Proposal 7:** Time instance A is the beginning of the first slot containing the first actually transmitted SSB index of 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. |
| [18] Panasonic | **Proposal 9:** 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 the beginning of the first slot containing candidate SSB index 0 of on-demand SSB burst.  **Proposal 10:** The texts of working assumptions in the above agreement should be confirmed. |
| [19] NEC | **Observation 2:** it does not matter whether time instance A is defined by SSB index 0 or the first transmitted SSB index as the existing requirement for SCell activation is defined by the end of the first complete SSB burst.  **Proposal 2:** RAN1 should strive to keep the SCell activation timeline as it is. In case any update is deemed necessary, impact on the existing timeline should be minimized.  **Observation 5:** On-demand SSB should be available for reception immediately after UE receives the SCell configuration which includes SCell activation to reduce the SCell activation delay specified by RAN4.  **Proposal 13:** Support the case where SCell with on-demand SSB transmission and cell with on-demand SSB indication have different numerology.  **Observation 7:** NR currently supports indication of smtc within *SCellConfig* during SCell addition which allows UE to optimise the SSB search. The *smtc* time reference is with respect to the PCell and contains the same periodicity value as *ssbperiodicityServingCell* indicated in *sCellConfigCommon*.  **Proposal 14:** For the case where SCell and the reference cell (where UE receives on-demand SSB indication) have different numerology, discuss further what time/numerology reference is used for the configuration of SSB time domain positions provided to the UE. |
| [22] Fujitsu | **Proposal 4.** The transmission of an on-demand SSB burst should follow the legacy constraint of being confined within a half-frame window.  **Observation 3.** If the transmission of an on-demand SSB burst is confined within a half-frame window as legacy, both UE and gNB can have a common understanding that the on-demand SSB will appear in the next half-frame after Tmin ends.  **Proposal 5.** Confirm the working assumption that T = T\_min.  **Proposal 6.** For the case that on-demand SSB transmission is indicated by RRC, the time instance A is at least T slots after the slot where UE receives the RRC.   * T = T\_min, where T\_min includes TRRC\_Process and T1 .   + TRRC\_Process is the RRC procedure delay defined in clause 12 of TS 38.331   + T1 is the delay from the slot until the transmission of *RRCReconfigurationComplete* message.   + RAN4 to confirm that Tmin=TRRC\_Process + T1.   **Proposal 7.** Time instance A is the beginning of the slot containing the first actual transmitted SSB index of on-demand SSB burst  **Observation 4.** Option 4 can be considered as a special case of option 1A. Specifically, on-demand SSB with one period value is initially triggering and transmitted for a certain time duration. After that, it is terminated, and the on-demand SSB with another period value is triggered.  **Observation 5.** From the perspective of network energy saving, it is beneficial that on-demand SSB can be stopped at certain time instance, when or after the SCell state is deactivated.  **Proposal 8.** For on-demand SSB transmission, support the following options that on-demand SSB transmission can be stopped after triggering.   * Option 1A. On-demand SSB transmission is stopped by explicitly indication from gNB * Option 2. On-demand SSB transmission is stopped at time instance B * The values of B can be provided by on-demand SSB configuration or the triggering signaling. * Option 3. On-demand SSB transmission is stopped after N transmission times have been completed.   + FFS how to define the value of N. |
| [23] ETRI | **Proposal 6:** 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.   * 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 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.   + Note: The value of T is not less than existing timeline required for UE’s MAC CE processing for SCell activation   **Observation 1:** The CSI reporting for the SCell can be used as the confirmation for the completion of SCell activation.  **Proposal 7:** For SSB burst(s) triggered by on-demand SSB SCell operation, it is proposed to support   * Option 3: UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted.   **Proposal 8:** For Option 3, it is proposed to introduce a mechanism for retransmission of on-demand SSB in order to handle the failure case of SCell activation according to the limited on-demand SSB transmission. |
| [24] Samsung | **Proposal 6:** The transmission of on-demand SSB is using a half frame as a transmission unit.  **Proposal 7:** For the transmission pattern of on-demand SSB:   * For Case 1, Option 1 can be supported as long as the SCell is active; * For Case 2, Option 2 and Option 3 can be supported.   **Proposal 8:** For MAC CE triggered on-demand SSB, time instance A shall be defined based on the first actually transmitted SSB index.  **Proposal 9:** For RRC triggered on-demand SSB, time instance A shall be defined in the same way by replacing Tmin to the minimum RRC processing delay. |
| [25] LG Electronics | **Proposal #4:** Prioritize Option 1A, Option 2 and Option 3 for on-demand SSB SCell operation.  **Proposal #10:** Time Instance A is the beginning of the first slot containing candidate SSB index 0 of 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 via MAC CE.  **Proposal #11:** When PDSCH including RRC for on-demand SSB transmission indication is received at slot n, UE can expect on-demand SSB is periodically transmitted from time instance A which is the beginning of the first slot containing candidate SSB index 0 of on-demand SSB burst from the slot that is after slot n + X.   * FFS: The value of X by taking 16+K(if additional consideration is not needed, K=0) as the starting point   **Proposal #12:** Discuss how to derive time instance B, depending on whether time instance B is determined by explicit deactivation signaling or by the indicated number of on-demand SSB bursts. |
| [27] NTT DOCOMO | **Proposal 2:**  On-demand SSB transmission can be started and stopped before SCell is activated (in scenario#2).   * Support on-demand SSB transmission of Opiton 1A and either one of Option 2 or 3 before SCell is activated. * Not support on-demand SSB transmission of Option1 and Option4 before SCell is activated.   **Proposal 3:**  On-demand SSB transmission can be started with SCell activation procedure and shall not be stopped during SCell activation (in scenario #2A/3A).   * Support on-demand SSB transmission either one of Option 2 or 3 during SCell activation. * Consider Option4 if scenario#3B with case 1 is not allowed   **Proposal 12:**  We prefer candidate SSB index 0 as for the reference point of time instance A. |
| [28] Ericsson | **Observation 1** When there is no always-on SSB, on-demand SSB needs to be provided while SCell is in an activated state.  **Observation 2** It is not known upon on-demand SSB transmission indication when SCell will be deactivated.  **Proposal 1** Support on-demand SSB provision from when NW signals that on-demand SSB is turned ON until NW signals that on-demand SSB is turned OFF.  **Observation 4** Exact time of SSB transmission cannot be based on when UE sends HARQ-ACK.  **Proposal 9** UE expects SSB transmission in the first configured or indicated SSB burst position that is at least *Tmin* slots after the slot where UE receives MAC CE indicating on-demand SSB transmission.  **Proposal 10** Time instance A is the beginning of the first slot containing the first transmitted SSB. |
| [30] Qualcomm | **Proposal 2:** For a cell supporting on-demand SSB Scell operation, UE expects on-demand SSB is transmitted at least in scenarios 2/3 for Case #1 and at least in scenario 3A for Case #2.  **Proposal 4:** Discuss whether to confirm the working assumptions in defining time instance A after receiving RAN4’s reply to RAN1 LS (R1-2407565)  **Proposal 5:** The previous RAN1 agreement made in RAN1#118 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   **Proposal 6:** For SSB burst(s) indicated by on-demand SSB SCell operation via RRC, the determination of time instance A should be similar to that for MAC-CE based indication with a difference that the value of T should be dependent on the RRC procedure delay or the timing that the UE receives the UL grant.   * FFS: details of T   **Proposal 7:** For SSB transmission case #1, further discuss the following options for the time instance B:   * Option 1: The time instance B is the time UE receives the Scell deactivation command or the time UE sends HARQ-ACK in response to the reception of Scell deactivation command. * Option 2: The time instance B is the time UE receives the signaling indicating unavailability of on-demand SSB transmission.   **Proposal 8:** For SSB transmission case #2, the time instance B is the time UE successfully completes Scell activation (e.g., transmitting the CSI report after UE receives the Scell activation command). |
| [33] CEWiT | **Proposal 4:** Support following alternatives for transmission of on-demand SSB burst(s).  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. |

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| **Agreement (RAN1#116)**   * 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)   **Agreement (RAN1#118)**  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=+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 is as defined in current specification.     - RAN4 to confirm that T\_min can be equal to +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. |

## [Moderator’s note] Companies’ preference among five options captured in the above RAN1 agreement (RAN1#116) is as follows.

* Option 1
  + Supported by InterDigital, Samsung (for Case #1), Ericsson (for Case #1), Qualcomm (for Case #1)
  + Objected by Spreadtrum, China Telecom, ZTE
* Option 1A
  + Supported by China Telecom, CATT, InterDigital, Fujitsu, LG Electronics, NTT DOCOMO (for Scenario #2), Qualcomm (for Case #1), CEWiT
  + Objected by Spreadtrum
* Option 2
  + Supported by Spreadtrum, China Telecom, CATT, Fujitsu, Samsung (for Case #2), LG Electronics, NTT DOCOMO (for Scenario #2/2A/3A), Qualcomm (for Case #2, with modification that the time instance B is the time UE successfully completes Scell activation), CEWiT
* Option 3
  + Supported by Futurewei, China Telecom, vivo, CATT, Transsion, InterDigital, Fujitsu, ETRI, Samsung (for Case #2), LG Electronics, NTT DOCOMO (for Scenario #2/2A/3A), CEWiT
* Option 4
  + Supported by

In addition, company views regarding time instance A are as follows.

* Candidate index 0 or first actually transmitted index
  + Candidate index 0: Huawei, Spreadtrum, Nokia, Xiaomi, CATT, Panasonic, ETRI, LG Electronics, NTT DOCOMO
  + Actually transmitted index: vivo, InterDigital, Lenovo, Fujitsu, Samsung, Ericsson, Qualcomm
* At least
  + Confirm WA: Futurewei, China Telecom, Nokia, vivo, CATT, InterDigital, Lenovo, Panasonic, ETRI, LG Electronics, Ericsson
* T = T\_min
  + Confirm WA: Futurewei, Nokia, Xiaomi, CATT, ZTE, InterDigital, Lenovo, Panasonic, Fujitsu, Ericsson
  + Revert: Google, OPPO (configurable)
* Numerology to determine T
  + Nokia, vivo: Based on MAC CE transmitting cell
  + Xiaomi: Based on PUCCH transmission cell
* RRC based time instance A
  + Nokia: the time reference for the first SSB time domain position can be based on the slot and system frame number in PCell.
  + Xiaomi: instance A is the first slot containing candidate SSB index 0 of on-demand SSB burst after slot n, slot n is the last downlink slot overlaps with uplink slot on which UE transmit ACK for the RRC signalling. T at least includes the RRC processing delay.
  + Samsung, LG Electronics, Qualcomm: Similar to MAC CE, by replacing T\_min as RRC processing time
  + Fujitsu: RAN4 to confirm that Tmin=TRRC\_Process + T1

In addition, company views regarding time instance B are as follows.

* China Telecom
  + the ending of slot boundary containing the last on-demand SSB in the transmitted SSB burst before the receiving indication

Based on the above issues and majority views, the following proposal can be made.

### Proposal #5-1 (Time instance A for MAC CE):

The previous RAN1 agreement is further revised and two working assumptions are confirmed 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 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.
  + 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=+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 is as defined in current specification.
    - RAN4 to confirm that T\_min can be equal to +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.

Companies are encouraged to provide views on Proposal #5-1.

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| Company | Views |
| Google | We think the two working assumptions are not quite aligned. One says T is not less than T\_min, the other one says T=T\_min. We need to confirm one and revert the other one. |
| Spreadtrum | Fine. Candidate SSB index 0 is straightforward. |
| ZTE, Sanechips | Supportive. |
| vivo | “Time instance A is the beginning of the first slot containing or the first actually transmitted SSB index of on-demand SSB burst” is more general solution. With this solution, gNB can indicate OD-SSB T time unit before the SSB index 0, to achieve the solution in current proposal. |
| OPPO | We suggest to add a note:  Note: the candidate locations of the on-demand SSB burst are determined by the RRC configuration for Time domain location of on-demand SSB burst (e.g., *sfn-SSB-Offset*, *halfFrameIndex*). |
| CMCC | In current spec, time offset of SSB is not configured and it is blindly detected by UE.  Similarly, we do not need to define Time instance A here, UE starts to detect OD-SSB based on SSB pattern after the slot receiving MAC-CE + T, until UE finds the first actually transmitted SSB index. It can up to gNB implementation to ensure the OD-SSB can be transmitted ASAP. |
| Xiaomi | Agree with Google. |
| MTK | We slightly prefer to use the actually transmitted SSB index to save UE power but can live with the proposal. |
| Fujitsu | We are fine with the proposal except for the candidate SSB index part. We prefer that time instance A is based on the actually transmitted SSB index. In this way, the UE can receive on-demand SSB at an earlier time. |
| Nokia, Nokia Shanghai Bell | We support the proposal. |
| Apple | We are fine with proposal except to make working assumption of T=Tmin to be agreement. We would need to discuss again once we receive LS from RAN4. |

### Proposal #5-2 (Time instance A for RRC):

* For SSB burst(s) indicated by on-demand SSB SCell operation via RRC, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.
  + 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 which is at least T\_RRC 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.
  + RAN2/RAN4 to confirm the minimum value for T\_RRC
* Above applies at least for the case where SCell with on demand SSB transmission and cell with signalling transmission have the same numerology.

Companies are encouraged to provide views on Proposal #5-2.

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| Company | Views |
| Google | Support |
| ZTE, Sanechips | Supportive. The value of T\_RRC should be further studied also in RAN1. |
| OPPO | We suggest to add a note:  Note: the candidate locations of the on-demand SSB burst are determined by the RRC configuration for Time domain location of on-demand SSB burst (e.g., *sfn-SSB-Offset*, *halfFrameIndex*). |
| CMCC | Similar as our comment to proposal 5-1, we do not need to define Time instance A. |
| Xiaomi | Fine with the proposal. |
| MTK | We slightly prefer to use the actually transmitted SSB index to save UE power but can live with the proposal. |
| Fujitsu | Similar comment as that for Proposal #5-1, the candidate SSB index part needs further discussion. |
| Nokia, Nokia Shanghai Bell | Considering timing uncertainty of RRC signaling explicit slot/frame number of the first OD-SSB could be included in the RRC signaling. |
| Apple | A minor suggestion to rename “Time instance A” to “Time instance A\_RRC”. |

# L1/L3 measurement based on on-demand SSB

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| Company | Views |
| [2] Huawei | **Proposal 10:** RAN1 to consider the needed modification on existing L3 measurement procedure/requirement. |
| [6] Nokia | **Observation-5:** RAN4 has agreed to discuss OD-SSB based deactivated SCell measurement and SCell activation requirements, meaning that the OD-SSB operation and corresponding measurements applied to the SCell (de)activation is to be considered and discussed in RAN4.  **Proposal-15:** RAN1 confirms that the L1 measurement based on OD-SSB is performed by UE after the SCell activation procedure.  **Observation-6:** The CSI resources are associated with a DL BWP. As per the current specification, UE has only one SSB resource configuration for a given DL BWP.  **Observation-7:** For the SSB-based L1 measurement, when both always-on and on-demand SSBs are configured, UE will measure and trigger L1 report based on one of the SSB configuration either always-on SSB or on-demand SSB but not both. Further UE could prioritize measuring activated on-demand SSB, over the always-on SSB.  **Proposal-16:** RAN1 to confirm that for the SSB-based L1 measurement, there is only one active SSB resource configuration either always-on SSB or on-demand SSB and not both.  **Observation-8:** L1 measurement based on OD-SSB for the activated SCells, the periodic or semi-persistent reporting may be configured with the OD-SSB that is periodically available.  **Proposal-17:** The ongoing specified MAC CE triggering command for OD-SSB transmission can be used for enabling the CSI reporting associated with OD-SSB resources.  **Proposal-18:** Considering the SCell activation scenario as agreed in RAN4, RAN1 to discuss on how to apply the aperiodic reporting for L1 measurement based on OD-SSB.  **Proposal-19:** Considering of Case 2 with OD-SSB on top of always-on SSB on SCell, RAN1 shall discuss on how to handle the CSI reporting when both always-on SSB and OD-SSB are applied, i.e. shall the UE reporting of both reports, or UE reporting only one of the CSI reports.  **Proposal-20:** On-demand SSB work is intended to enhance SCell operation and we propose to keep mobility measurements and LTM out of scope of on-demand SSB. |
| [7] vivo | **Proposal 5:** Support indication of the resource type for SSB(s) associated with a CSI report configuration.  **Proposal 6:** Deprioritize the discussion on support of LTM based on OD-SSB before OD-SSB for Scell measurement and activation is finalized. |
| [8] CMCC | **Proposal 10:** UE behavior, resource configuration and reporting configuration (e.g. reporting periodicity) of L1 measurement of on-demand SSB can be further studied. |
| [10] Google | **Proposal 9:** Support to configure the on-demand SSB for RLM/BFD/CBD.  **Proposal 10:** For L1-RSRP/L1-SINR report based on on-demand SSB, support the UE to report the SSBRI based on the activated SSBs. |
| [11] CATT | **Proposal 14:** Deprioritize the discussion of LTM based on on-demand SSB in Rel-19.  **Proposal 15:** Consider two candidate solutions to add on-demand SSB resource configuration to existing CSI resource configuration.   * Alt-1: The existing IE *CSI-ResourceConfig* should include the on-demand SSB resource configuration information. * Alt-2: A new dedicated resource configuration IE for on-demand SSB resource configuration should be introduced, e.g. *CSI-ResourceConfig-NES*.   **Proposal 16:** Consider two candidate solutions to add on-demand SSB reporting configuration to existing CSI reporting configuration.   * Alt-1: The existing IE *CSI-ReportConfig* should include the on-demand SSB reporting configuration information. * Alt-2: A new dedicated reporting configuration IE for on-demand SSB reporting configuration should be introduced, e.g. *CSI-ReportConfig-NES*.   **Proposal 17:** Consider two candidate solutions to activate and deactivate semi-persistent L1 measurement reporting on PUCCH for on-demand SSB.   * Alt-1: The existing *SP CSI reporting on PUCCH Activation/Deactivation* MAC CE should include the activation and deactivation of SP CSI reporting on PUCCH for on-demand SSB, e.g., one of the reserved bits can be used to indicate whether the MAC CE applies to SP CSI reporting on PUCCH Activation/Deactivation for on-demand SSB or not. * Alt-2: A new dedicated MAC CE should be introduced for activation and deactivation of semi-persistent L1 measurement reporting on PUCCH for on-demand SSB.   **Proposal 18:** Consider two candidate solutions to trigger semi-persistent L1 measurement reporting on PUSCH for on-demand SSB.   * Alt-1: The existing DCI field CSI request is reused to trigger semi-persistent L1 measurement reporting on PUSCH for on-demand SSB, and the existing DCI field Transform precoding indicator is used to indicate the DCI is used to trigger semi-persistent L1 measurement reporting on PUSCH for on-demand SSB, or for legacy MIMO/LTM. * Alt-2: A new dedicated RNTI (e.g., OD-SSB-SP-Reporting-RNTI) for DCI format 0\_1 and 0\_2 should be introduced for triggering of semi-persistent L1 measurement reporting on PUSCH for on-demand SSB.   **Proposal 19:** Consider two candidate solutions to support the semi-persistent L1 measurement reporting on PUSCH for multiple on-demand SSBs from multiple SCells.   * Alt-1: The existing IE *CSI-SemiPersistentOnPUSCH-TriggerState* should include multiple *CSI-ReportConfigIds*. Each *CSI-ReportConfigId* is associated with one on-demand SSB resource configuration information. * Alt-2: A new dedicated trigger state IE for on-demand SSB should be introduced, e.g. *CSI-SemiPersistentOnPUSCH-TriggerState-NES*.   **Proposal 20:** Consider the following solution to trigger aperiodic L1 measurement reporting on PUSCH for on-demand SSB.   * A new dedicated RNTI (e.g., OD-SSB-Aperiodic-Reporting-RNTI) for DCI format 0\_1 and 0\_2 should be introduced for triggering of aperiodic L1 measurement reporting on PUSCH for on-demand SSB. |
| [12] ZTE | **Proposal 17:** For L1 measurement, the enhancements of the SSB resources and/or the on-demand SSB resources for CSI report configuration should be supported.  **Proposal 18:** For Rel-19, support LTM for on-demand SSB SCells should be deprioritized. |
| [14] OPPO | **Proposal 1:** Perform L1 and/or L3 measurement based on on-demand SSB after SCell activation command is received, no matter the on-demand SSB indication is received in Scenario #2 or Scenario #2A. |
| [16] InterDigital | **Proposal 9:** Support configuring CSI-SSB resources based on OD-SSB that are separate from those of always-on SSB |
| [18] Panasonic | **Proposal 3:** L3 measurement based on on-demand SSB should be supported at least for Scenario #2. To facilitate the SCell deactivation and on-demand SSB ON/OFF, other scenarios can also be supported.  **Proposal 4:** L1 measurement when on-demand SSB is ON should be supported at least for Scenario 2A, 3A and 3B i.e., after the SCell is activated. On Scenario 2, further clarification is needed on whether to support on-demand SSB based L1 measurement for LTM and the supported type of CSI.  **Proposal 5:** For RRC triggered/indicated on-demand SSB, the periodic, semi-persistent and aperiodic CSI report should be supported with current CSI mechanism.  **Proposal 6:** For MAC CE triggered/indicated on-demand SSB, semi-persistent and aperiodic CSI report should be supported with enhancement that on-demand SSB is expected to be available when CSI report is active. On periodic CSI report, although our first preference is not to support, we can be flexible if the specification impact can be minimized.  **Proposal 7:** For group common DCI triggered/indicated on-demand SSB, only semi-persistent and aperiodic CSI report should be supported. |
| [19] NEC | **Proposal 19:** The on-demand SSB indication shall be provided to the UE before the start of the corresponding CSI report transmissions.  **Proposal 20:** For aperiodic CSI reporting based on on-demand SSB consider one of the following options:   * Option-1: Support group-common based DCI indication for on-demand SSB indication * Option-2: Support indication of on-demand SSB within the CSI report trigger indication |
| [21] Apple | **Observation 3:** UE behavior for BFD/R using OD-SSB needs to be defined. Particularly for Case #2 (always-on SSB), we should avoid to combine the ‘always-on SSB’ with OD-SSB for measurements.  **Proposal 7:** 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. |
| [22] Fujitsu | **Proposal 9.** RAN1 to discuss whether a single CSI report or separate CSI reports can be configured with always-on SSB and on-demand SSB.  **Proposal 10.** CSI resource configuration enhancement for on-demand SSB associated with CSI report configuration is necessary.   * Option 1: CSI resource enhancement at the level of the resource set list   + To specify a dedicated resource set list for on-demand SSB. * Option 2: CSI resource enhancement at the level of CSI-SSB resource set   + To introduce an on-demand SSB indicator within the *CSI-SSB-ResoureSet*.   **Proposal 11.** If a newly defined resource set parameter, e.g., *CSI-OD-SSB-ResourceSet*, is supported, the corresponding enhancement in aperiodic trigger state list should be considered as well.   * *CSI-OD-SSB-ResourceSet* should be included in *CSI-AperiodicTriggerStateList*.   **Proposal 12.** The periodicity of on-demand SSB configured in CSI resource configuration refers to the periodicity indicated by MAC CE.  **Proposal 13.** At least in case#1, BFD based on on-demand SSB can be supported. |
| [24] Samsung | **Proposal 11:** For Case 2 (with periodic SSB), RAN1 shall clarify the relationship between periodic SSB and on-demand SSB at least for the physical cell ID and the SSB index, in order to consider whether any enhancement is needed for L1 measurement based on on-demand SSB. |
| [25] LG Electronics | **Proposal #13:** Discuss how to configure on-demand SSB as the measurement resource for CSI report configuration for L1 measurement.  **Proposal #14:** Discuss the relationship between the frequency position of on-demand SSB and the frequency range of the first active BWP given by the higher layer parameter *firstActiveDownlinkBWP-Id*.  **Proposal #15:** Discuss UE behaviour to perform the measurement/report based on on-demand SSB after the on-demand SSB is deactivated. |
| [27] NTT DOCOMO | **Observation 4:**  In order for NW to know which configured SCell and beam is best to be activated with minimizing NW TX, L1 meas. based on OD-SSB is beneficial.  **Proposal 13:**  Support L1 meas. based on OD-SSB in scenario #2/case #1 by reusing the existing LTM mechanism.  **Proposal 14:**  Study restriction on time domain behavior of OD-SSB and L1 reporting   * It can be considered to follow the legacy CSI framework, e.g., Periodic L1 meas. should be associated with periodic on-demand SSB only.   + FFS: relationship of indication signaling and time domain behavior of OD-SSB for L1 meas..   **Proposal 15:**  For triggering/activation mechanism, support reuse of the existing behavior, i.e.,   * periodic reporting triggered by RRC * Semi-Persistent reporting on PUCCH triggered by MAC CE, on PUCH triggered by DCI * Aperiodic reporting on PUSCH triggered by DCI, additionally activated by MAC CE |
| [31] Sharp | **Proposal 2** Support L3 measurement based on on-demand OD-SSB for SCell operation in Scenario 3B and Case #1.  **Observation 1** The UE cannot receive OD-SSB if the OD-SSB is outside the UE’s active DL BWP in scenario 3B, i.e., SCell activation has been completed.  **Proposal 3** RAN1 to study whether and how to support OD-SSB-based L1-RSRP measurement in scenario 3B, taking BWP aspects into account.  **Proposal 4** RAN1 to study the following options for OD-SSB-based L1-RSRP measurement in scenario 3B in the cases where the triggered OD-SSB is outside the active DL BWP:   * Solution #1: Ignoring the triggered OD-SSB * Solution #2: Using measurement gap to perform OD-SSB-based L1-RSRP measurement * Solution #3: Supporting BWP change due to OD-SSB triggering * Solution #4: Supporting BWP-specific OD-SSB configuration |

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| **Agreement (RAN1#118)**   * 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 (RAN1#118)**  Support L3 measurement based on on-demand SSB   * Further work on L3 measurement is up to RAN2/RAN4 |

## [Moderator’s note] Below are company views on L1/L3 measurement based on on-demand SSB.

* Scenario where L1 measurement based on on-demand SSB is performed
  + Confirm L1 measurement based on on-demand SSB is for Scenario #3B: Nokia
  + OPPO: Perform L1 and/or L3 measurement based on on-demand SSB after SCell activation command is received, no matter the on-demand SSB indication is received in Scenario #2 or Scenario #2A.
  + Panasonic: Scenario #2A/3A/3B
* Whether to use one of always-on SSB and on-demand SSB or both of them
  + Use only one of always-on SSB and on-demand SSB, but not both: Nokia
* Deprioritize LTM: Nokia, vivo, CATT, ZTE
* How configure/indicate on-demand SSB as a measurement resource for L1 measurement reporting
  + CATT, ZTE, Fujitsu (CSI report level, resource set level, resource set list level), LG Electronics
  + Support differentiation of AO-SSB and OD-SSB for CSI report config: vivo, InterDigital
* In addition,
  + Panasonic and NTT DOCOMO suggested the relation between on-demand SSB indication signal and CSI reporting type
  + Reuse and on-demand SSB MAC-CE for SP-CSI: Nokia
  + CATT suggested further details on CSI reporting mechanism
    - How to activate and deactivate semi-persistent L1 measurement reporting on PUCCH for on-demand SSB
    - How to trigger semi-persistent L1 measurement reporting on PUSCH for on-demand SSB
    - How to support the semi-persistent L1 measurement reporting on PUSCH for multiple on-demand SSBs from multiple SCells
* Whether to configure the on-demand SSB for BFD/CBD
  + Supported by Google, Apple, Fujitsu
* Google suggested to support SSBRI based on on-demand SSB
* LG Electronics and Sharp (for Scenario #3B) suggested to clarify the relationship between BWP of always-on SSB and BWP of on-demand SSB
* How to handle CSI reporting if the corresponding on-demand SSB is absent: LG Electronics
* Enhancement for L3 measurement: Huawei

It seems that the first issue to be resolved is whether both of on-demand SSB and always-on SSB can be used for a measurement and reporting for Case #2.

### Proposal #6-1 (Measurement based on on-demand SSB):

* 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/L3 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.

Companies are encouraged to provide views on Proposal #6-1 and preference between two options.

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| Company | Views |
| Google | From configuration perspective, we failed to see the necessity to introduce the constraints. But relevant UE capability can be introduced. |
| ZTE, Sanechips | Supportive. We can focus on Case #2. Regarding case #1, it seems has minor/no spec impact. |
| vivo | we are fine to discuss this issue, |
| OPPO | Support option 2. |
| CMCC | We are fine with both options. |
| Xiaomi | We prefer option 1 for L1/L3 measurement based on on-demand SSB. CSI report associates with an actually transmitted SSB, not matter it is OD-SSB or always on SSB. |
| MTK | Support. We prefer Option 2 but are open to discuss. |
| Fujitsu | We prefer option 2 but we are open for discussion. |
| Nokia, Nokia Shanghai Bell | We assume this proposal is related to scenario #2A. When UE receives Scell activation and OD-SSB activation simultaneously, the activation delay or capability to send valid CSI report should be defined based on OD-SSB at least when OD-SSB and always-on SSB are in the same frequency and always-on SSBs overlap with some of the OD-SSBs. RAN1 should discuss if OD-SSB and always-on can be in different frequencies and if they can be configured in time domain to not overlap. |
| DCM | Clarification question: Does this proposal focus on L1 measurement only?  We think it is up to RAN2 (or RAN4) whether AO-SSB and OD-SSB can be jointly used for L3 measurements. |
| Apple | We would like to first understand the proposal if measurement is based on one out of two types of SSB or if CSI report configuration is based on one out of two types of SSB. |

# UE-triggered on-demand SSB operation

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| Company | Views |
| [3] Spreadtrum | **Observation 3:** UL WUS to SCell may be feasible, if UL WUS is a PRACH (preamble).  **Observation 4:** UL WUS to SCell may not be necessary.  **Observation 5:** UL WUS to PCell is feasible.  **Observation 6:** Whether UL WUS to PCell is necessary should be further studied.  **Proposal 9:** If triggering method of UL WUS is supported, UE should transmit UL WUS to PCell. |
| [4] China Telecom | **Proposal 3:** Support to specify UE uplink wake-up-signal using an existing signal/channel transmitted to PCell as a trigger method for on-demand SSB SCell operation. |
| [8] CMCC | **Observation 2:** Compared with “SR/BSR + gNB indication”, the scheme “UL WUS + gNB confirmation” can save UL grant and BSR transmission and reduce total latency of SCell activation procedure.  **Proposal 3:** For on-demand SSB SCell operation in Scenario #2, UL WUS can be used to request on-demand SSB and subsequent gNB confirmation indicates on-demand SSB on NES SCell. |
| [9] Xiaomi | **Observation 1:** Different triggering method for on-demand SSB has diverse impacts on UE:   * WUS based SSB triggering fully take the requirement at UE side into consideration. * Cell on/off indication based SSB triggering is transparent to UE. * SCell activation/deactivation based SSB triggering is fully gNB implementation while non-transparent to UE.   **Proposal 4:** The wake-up-signal is at least used to request the resume of SSB transmission.   * FFS: whether wake-up-signal can be used to carry other relevant information of SSB.   **Proposal 5:** For UE wake-up-signal, reusing existing uplink channel or uplink signal as much as possible. At least the following channel/signal can be considered as starting point:   * Option 1: WUS is carried by PRACH * Option 2: WUS is carried by PUCCH * Option 3: WUS is carried by CG PUSCH   **Proposal 6:** Further study how to send WUS requesting SSB on a SCell, i.e., UE sends WUS to PCell/PSCell or UE sends WUS to target SCell. |
| [10] Google | **Proposal 5:** Support UE to request the SSBs for an SCell if one of the followings occurs:   * The UE declares beam failure and cannot identify a candidate beam for the SCell * The UE declares MPE event for the SCell * The UE declares the L1-RSRP variation for the SSB associated with active TCI is above a threshold   **Proposal 6:** Support to transmit the UE request of SSB for SCell by MAC CE   * Support the UE transmits a dedicatedly configured SR to request the uplink resource for the MAC CE * UE reports at least the SCell index and the event to trigger the SSB in the MAC CE |
| [11] CATT | **Proposal 21:** Support on-demand SSB SCell operation triggered by UE.   * If gNB decides to transmit on-demand SSB upon UE’s request, UE will be notified by on-demand SSB transmission indication signaling.   **Proposal 22:** The following existing channels should be considered as the candidate UE UL WUS to support on-demand SSB SCell operation for UE in connected mode configured with CA.   * PRACH on PCell/SCell * PUCCH on PCell * PUSCH on PCell   **Proposal 23:** The conditions for a UE to send UL WUS to a Cell for triggering on-demand SSB transmission at least include:   * The channel quality of the communication link between the UE and its serving cells (including PCell and activated SCell(s)) is below a (pre)-configured threshold.   + The metrics of the channel quality can be RSRP, RSRQ and SINR. * There is uplink data that needs to be transmitted for the UE.   **Proposal 24:** Both of the following options should be supported for the cell UE may send UL WUS to:   * Option-1: PCell (PCell needs to further trigger the on-demand SSB transmission of potential SCell to be activated). * Option-2: Potential SCell to be activated (SCell may start to send the on-demand SSB after receiving the UL WUS). |
| [14] OPPO | **Proposal 6:** Support on-demand SSB SCell operation triggered by UE. |
| [15] Mavenir | **Proposal 3:** it is preferred UE-triggered on-demand SSB transmission can be supported. |
| [16] InterDigital | **Observation 2:** Transmitting OD-SSB in the time occasions expected by the UE (e.g. for making timely measurements and reporting) can reduce the SCell activation delay  **Proposal 10:** Support UL WUS for requesting on-demand SSB transmission at SCell  **Proposal 11:** Support using PRACH preamble on the PCell as UL WUS for requesting OD-SSB on the SCell |
| [17] Lenovo | **Proposal 1:** On-demand SSB of an SCell can be triggered by UE wake up signal/channel for Scenario #3B and Case #2.  **Proposal 2:** gNB can adapt one or more of SSB parameters such as transmitted SSBs in a SSB burst and a SSB periodicity for on-demand SSB of an SCell triggered by UE.  **Proposal 3:** On-demand SSB of an SCell can be triggered by UE wake up signal/channel for Scenario #2 and Case #1. The UE wake-up signal/channel may carry an event-triggered measurement report of a PCell (or another serving cell). |
| [19] NEC | **Proposal 15:** Specify UE-triggered on-demand SSB request for SCell operation.  **Proposal 16:** UE request for on-demand SSB on SCell may be sent via configured PUCCH resources.   * FFS whether PUCCH resources are configured only in PCell or can SCell resources be used |
| [20] Sony | **Proposal 1:** RAN1 should support on-demand SSB Scell operation triggered by UE. |
| [21] Apple | **Proposal 6:** If UE triggered OD-SSB SCell operation is justified, the following should be considered:   * After UE sends WUS, there is still need from gNB’s confirmation (similar to OD-SSB indication for transmission/termination). * RACH Msg1 or MAC-CE for WUS is a good starting point. |
| [24] Samsung | **Proposal 5:** Support UE triggered on-demand SSB based on an UL WUS. |
| [25] LG Electronics | **Proposal #16:** For the on-demand SSB operation triggered by UE uplink wake-up-signal for an SCell, discuss first the triggering conditions, including the following example conditions.   * When the received signal strength from the reference cell(s) (determined by the pre-defined rule or explicitly configured by higher layer parameter) associated with SCell becomes lower than a given threshold * When DL reception timing difference between SCell and its associated reference cell(s) becomes larger than a given threshold   **Proposal #17:** Consider at least one of the following candidates as UE’s uplink wake-up-signal to trigger on-demand SSB.   * UL WUS candidate #1: PRACH (+ msg3 PUSCH) * UL WUS candidate #2: SR PUCCH (+ followed by PUSCH) * UL WUS candidate #3: Periodic/semi-persistent PUCCH/PUSCH   **Proposal #18:** Discuss how to handle the case where UE does not receive gNB’s response corresponding to UE’s uplink wake-up-signal or UE does not detect the SSB on an SCell after UE transmits uplink wake-up-signal. |
| [27] NTT DOCOMO | **Observation 2:**   * For UE triggering method, gNB may fall into transmitting SSB frequently on SCell to meet all UE’s re-quest and requirements on SCell, which is not desirable for NES operation. * The required SSB properties such as when/how frequent/how many SSB is required by the UE could be statically determined e.g., as UE capability or UE assistance information, and hence a mechanism for dy-namic request of SSB transmission from UE would be unnecessary.   **Proposal 5:**   * Not support UE triggering mechanism for on-demand SSB transmission * If needed, some reporting from UE e.g., as UE capability or UE assistance information is enough. |
| [30] Qualcomm | **Observation 2:** Compared to network coordination based on-demand SSB triggering, the on-demand SSB based on UE triggering leads to   * Higher UE power consumption and complexity due to uplink WUS transmission for requesting SSB. In particular, UE may have to beam-sweep WUS transmission to a cell in multi-beam systems and/or send SSB request to multiple Scells. * Higher NW energy consumption due to monitoring the uplink WUS transmissions from UEs.   **Proposal 9:** Wake-up signal from the UE to trigger on-demand SSB transmission is not supported. |
| [33] CEWiT | **Observation 1:** On-demand SSB triggering from the gNB is not optimal in the case of non co-located PCell and SCell, particularly when the backhaul between them is non-ideal.  **Proposal 1:** Support UE-triggered on-demand SSB SCell operation.  **Proposal 2:** Support the use of RACH as the UL WUS triggered by the UE.  **Proposal 3:** Following alternatives can be considered to provide resources of the trigger.  Alt.1. Configured by PCell  Alt.2. Predefined in specification. |

## [Moderator’s note] Below are company views on UE-triggered on-demand SSB operation.

* Positive view: China Telecom, CMCC, Xiaomi, Google, CATT, OPPO, Mavenir, InterDigital, Lenovo, NEC, Sony, Samsung, LG Electronics, CEWiT
* Negative view: Spreadtrum?, NTT DOCOMO, Qualcomm

### [LOW] Proposal #7-1 (UE-triggering):

* Support on-demand SSB SCell operation triggered by UE.
  + It is up to gNB whether to transmit on-demand SSB after receiving UE’s request.
  + FFS on details of UL signaling to trigger on-demand SSB

Companies are encouraged to provide views on Proposal #7-1.

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| --- | --- |
| Company | Views |
| Google | Support |
| CEWiT | SUpport |
| Vivo | We are fine to deprioritize this topic, since the motivation to support this solution is still not validated yet. |
| OPPO | Support |
| CMCC | Support. UE triggered OD-SSB may have benefits when UE aware-only traffic is coming (e.g. UL service or Mobile Originate downlink service). |
| Xiaomi | Fine with the proposal. |
| MTK | Generally fine. |
| Sony | Support. |
| Nokia, Nokia Shanghai Bell | We do not support introduction of UE triggered OD-SSB in Rel-19. |
| DCM | The scenarios identified in the previous meetings where UE requesting OD-SSB are useful are more like UE-initiated new procedures which are beyond this objective. |

# Further details on on-demand SSB operation

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| --- | --- |
| Company | Views |
| [1] Futurewei | **Proposal 4:** For a connected UE, all the functionalities and operations defined for always-on SSB can be fulfilled using on-demand SSB.   * E.g., on-demand SSB can be an interchangeable QCL source as always-on SSB. * FFS whether to introduce new functionalities and operations only for on-demand SSB. |
| [2] Huawei | **Proposal 7:** RAN1 to consider the collision handling between on-demand SSB and always-on SSB on a cell.  **Proposal 8:** RAN1 to consider the collision handling between on-demand SSB and other common/dedicated signals on a cell under Obj3 due to similarity with SSB adaptation.  **Proposal 9:** RAN1 to consider potential enhancement w.r.t. the cell-edge scenarios, e.g., inter-cell rate-matching mechanism to lessen inter-cell interference introduced by the dynamic ON/OFF/adaptation of on-demand SSB. |
| [4] China Telecom | **Proposal 18:** To save more energy sand solve the conflict between legacy SSB and on-demand SSB for Case #2, support to introduce a time interval, within which only one SSB can be transmitted. |
| [7] vivo | **Proposal 16:** To support on-demand SSB operation, further discuss the collision between on-demand SSB transmission and other transmissions. |
| [9] Xiaomi | **Proposal 13:** Further study whether/how to optimize SCell release procedure with taking SSB ON/OFF into consideration |
| [10] Google | **Proposal 7:** For non-UE dedicated signals, the rate matching pattern should be based on the activated SSBs.  **Proposal 8:** For UE-dedicated signals, the rate matching pattern should be based on SSB configured in *ssb-positionInBurst*.  **Proposal 11:** UE does not transmit PRACH and receive on-demand SSB in the same slot   * FFS: how to handle the collision between PRACH and on-demand SSB |
| [11] CATT | **Proposal 25:** From UE’s perspective, multiple configuration of on-demand SSBs activated at the same time for a cell should not be allowed.  **Proposal 26:** When multiple MAC-CE based signallings indicating on-demand SSB transmission are received successively, time instance A is decided only by the first MAC-CE signalling. |
| [13] Transsion | **Proposal 7** It is recommended that the feasibility of joint use of on-demand SSB transmission and cell DTX can be studied. |
| [18] Panasonic | **Proposal 8:** For time/frequency synchronization and TCI state using on-demand SSB as reference resource, only Scenario #3B is supported.  **Proposal 14:** When always-on SSB and on-demand SSB are both transmitted within the same SCell or in different cells, the relation and the QCL should be further discussed and clarified. |
| [19] NEC | **Proposal 17:** For Case#2, when on-demand SSB and always-on SSB overlap in time domain, consider always-on SSB is given higher priority than on-demand SCell SSB request.  **Proposal 18:** For Case#1 and Case#2, within a time window, combine multiple on-demand SSB transmissions due to multiple on-demand SSB requests into one in order to maximize network energy saving.  **Proposal 22:** Discuss the UE behaviour for the case of failure to receive or detect the on-demand SSB. The following options can be considered:   * On-demand SSB failure indication may be sent to the network. * UE can reinitiate the on demand SSB procedure by sending the UE request for on-demand SSB   **Proposal 23:** RAN1 to discuss UE behaviour on PDSCH rate matching around on-demand SSB. |
| [22] Fujitsu | **Proposal 14.** On-demand SSB and always-on SSB can be configured in the same BWP. |
| [24] Samsung | **Proposal 1:** The transmission of on-demand SSB shall not impact the transmission of periodic SSB, if any.   * Time domain and frequency domain resources for on-demand SSB shall not overlap with time domain and frequency domain resources for the periodic SSB, if any.   **Proposal 3:** SSB structure and SSB mapping pattern in a half frame for the on-demand SSB maintain the same as legacy. |
| [25] LG Electronics | **Proposal #19:** Discuss how to utilize SSB transmitted after on-demand SSB procedure, for the purposes of time/frequency synchronization, path-loss estimation, QCL reference signal, and so on.  **Proposal #20:** Discuss how to handle collision cases between SSB and other signals/channels, if the SSB transmission can be (de)activated based on on-demand SSB procedure.  **Proposal #21:** Consider to deactivate SSB transmitted based on on-demand SSB procedure during cell DTX non-active period. |
| [28] Ericsson | **Proposal 7** On-demand SSB patterns are restricted to legacy SSB patterns. |
| [33] CEWiT | **Proposal 5 :** Support handling of the case where no UE camps on the SCell within the fixed duration after on-demand SSB operation.  **Observation 2:** UE not receiving the SSB after on-demand SSB operation leads to unnecessary monitoring by the UE and negative impacts on performance.  **Proposal 6:** Support handling of the case where the UE cannot receive SSB after the on-demand SSB operation.  **Observation 3:** On-demand SSB impacts the need and validity of periodic RACH occasions and their association with SSBs, requiring adjustments to ensure efficient RRC connection establishment.  **Proposal 7:** Support handling the impacts of on-demand SSB on RACH occasions for RRC connection establishment. |

## [Moderator’s note] Further details on on-demand SSB operation from above proposals can be summarized as below.

* Issue 1) Whether/how to allow overlapping of always-on SSB and on-demand SSB
  + Huawei, China Telecom, NEC, Samsung
* Issue 2) Whether/how to handle collision issue between SSB and other signals/channels
  + Huawei, vivo, Google, LG Electronics
* Issue 3) Whether/how to handle rate-matching issue
  + Huawei (from the perspective of inter-cell interference), Google, NEC
* Issue 4) Whether/how to allow overlapping of multiple on-demand SSBs
  + CATT, NEC
* Issue 5) Whether/how to use on-demand SSB for time/frequency synchronization and TCI state/QCL
  + Panasonic, LG Electronics
* Issue 6) Joint operation of cell DTX and on-demand SSB
  + Transsion, LG Electronics
* Issue 7) Whether to change the structure of SSB triggered by on-demand SSB operation
  + NO: Samsung, Ericsson
* Issue 8) Whether/how to handle the case where UE cannot receive SSB after on-demand SSB operation
  + LG Electronics, NEC, CEWiT
* Issue 9) Relation between always-on SSB and on-demand SSB
  + Futurewei
* Issue 10) Whether/how to optimize SCell release procedure with taking SSB ON/OFF into consideration
  + Xiaomi
* Issue 11) Whether on-demand SSB and always-on SSB can be configured in the same BWP
  + Fujitsu
* Issue 12) Whether/how to define gNB’s behavior when no UE camps on the SCell within the fixed duration after on-demand SSB operation
  + CEWiT
* Issue 13) Whether/how to handle the impacts to RACH procedure from on-demand SSB operation
  + CEWiT

Please provide views on what topics among ones listed up above, if any, can be treated as high priority in this meeting.

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| Company | Views |
| Moderator | It would be helpful if you could share views on **Issues 1 to 7** for which at least two companies suggested. |
| CEWiT | Atleast issue 8 should be adressed, for which at least 3 companies suggested. |
| Nokia, Nokia Shanghai Bell | Issue 7) Our view is that SSB structure of OD-SSB should be the same as legacy SSB structure. |
| DCM | We’re OK to consider issue 8. We hope that this might address some concerns raised in the discussion on time instance A (whether to include the wording “at least” as working assumption).  We support issue 6 in scenario3B, which can make OD-SSB operation more useful. |

# Reference

1. R1-2407619 Discussion of on-demand SSB Scell operation FUTUREWEI
2. R1-2407685 On-demand SSB SCell operation for eNES Huawei, HiSilicon
3. R1-2407711 Discussion on on-demand SSB SCell operation Spreadtrum Communications
4. R1-2407738 Discussion on on-demand SSB operation for SCell China Telecom
5. R1-2407757 On demand SSB Tejas Network Limited
6. R1-2407792 On-demand SSB SCell Operation Nokia, Nokia Shanghai Bell
7. R1-2407866 Discussions on on-demand SSB Scell operation vivo
8. R1-2407910 Discussion on on-demand SSB SCell operation CMCC
9. R1-2407974 Discussion on on-demand SSB SCell operation Xiaomi
10. R1-2407995 On-demand SSB SCell Operation Google
11. R1-2408052 Discussion on on-demand SSB SCell operation CATT
12. R1-2408071 Discussion on on-demond SSB for NES ZTE Corporation, Sanechips
13. R1-2408121 Discussion on On-Demand SSB SCell operation Transsion Holdings
14. R1-2408132 Discussion on the enhancement to support on demand SSB SCell operation OPPO
15. R1-2408248 Discussion of On-demand SSB SCell operation Mavenir
16. R1-2408311 Discussion on on-demand SSB SCell operation InterDigital, Inc.
17. R1-2408326 On-demand SSB SCell operation Lenovo
18. R1-2408342 Discussion on on-demand SSB SCell operation Panasonic
19. R1-240376 Discussion on on-demand SSB for SCell operation NEC
20. R1-2408413 On-demand SSB SCell operation Sony
21. R1-2408473 On-demand SSB SCell Operation Apple
22. R1-2408503 Discussion on on-demand SSB SCell operation Fujitsu
23. R1-2408572 Discussion on On-demand SSB SCell operation ETRI
24. R1-2408651 On-demand SSB SCell operation Samsung
25. R1-2408676 On-demand SSB SCell operation LG Electronics
26. R1-2408706 On-demand SSB SCell operation MediaTek Inc.
27. R1-2408791 Discussion on on-demand SSB SCell operation NTT DOCOMO, INC.
28. R1-2408817 On-demand SSB SCell operation Ericsson
29. R1-2408830 Discussion on on-demand SSB SCell operation ITRI
30. R1-2408855 On-demand SSB operation for Scell Qualcomm Incorporated
31. R1-2409009 Discussion on details of on-demand SSB operation on SCell SHARP Corporation
32. R1-2408909 DCI based signaling for on-demand SSB ASUSTeK
33. R1-2408934 Discussion on on-demand SSB Scell operation CEWiT

# Appendix: 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=+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 is as defined in current specification.
    - RAN4 to confirm that T\_min can be equal to +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.