**3GPP TSG RAN WG1 #117 R1-240XXXX**

**Fukuoka City, Fukuoka, Japan, May 20th – 24th, 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 | **Proposal 1:** For the potential enhancements of on-demand SSB SCell operation for a UE in connected mode, consider the following scenarios and support at least Scenario #2A:* Scenario #2A: SCell activation based on OD-SSB indicated when receiving SCell activation command.
	+ Introduce a triggering/indication offset for receiving the OD-SSB to incorporate Scenario #3A, where the offset is the duration between receiving the OD-SSB indication and receiving the OD-SSB transmission, and the OD-SSB monitoring starts before the SCell activation completion.
* Scenario #2: Deactivated SCell re-synchronization / measurement with on-demand SSB.
* Scenario #3B: On-demand SSB for an activated SCell in cell DTX or cell dormancy.
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| [3] Huawei | **Proposal 1:** Support that on-demand SSB SCell operation can be triggered by gNB in* Scenario #3A and Case #2
* Scenario #3B and Case #1
* Scenario #3B and Case #2
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| [4] Intel | **Proposal 6:*** For on-demand SSB transmissions, support all scenarios #2, #2-A, #3-A, #3-B.
* Do not differentiate any scenario from specification framework perspective when on-demand SSB operation is triggered by gNB.
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| [5] Spreadtrum | **Proposal 1:** Scenario #2 and Case #1 is supported in R19.**Observation 1:** When SCell is configured for UE but UE does not receive SCell activation, UE performs measurement for SCell according to SMTC in *SCellConfig*.**Proposal 2:** Scenario #2 and Case #2 can be supported in R19.**Proposal 3:** Scenario #2A can be considered together with Scenario #2 for on-demand SSB operations for SCell.**Proposal 4:** Scenario #3A and Case #1 is supported in R19.**Proposal 5:** Scenario #3A and Case #2 can be supported in R19.**Proposal 6:** Scenario #3B and Case #1 is supported in R19.**Proposal 7:** Scenario #3B and Case #2 can be supported in R19. |
| [7] vivo | **Proposal 1:** For on-demand SSB SCell operation, 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 when SCell is activated. |
| [8] Nokia | **Proposal-1:** Investigate further the benefit and motivation of utilizing NW triggered on-demand SSB transmission with Scenario#3A and Scenario#3B for both Case#1 and Case#2.**Proposal-2:** Prioritize the specification work on Scenario#2 and Scenario#2A for both Case#1 and Case#2. |
| [9] Apple | **Proposal 1:** Prioritize Scenario #2/2A and deprioritize Scenario #3A/3B.**Proposal 2:** Case #2 (periodic always-on SSB) is to be discussed under objective 3 (Adaptation of SSB in time domain). |
| [10] InterDigital | **Observation 1:** Any issues (e.g. T/F sync) during the Scell activation procedure can be avoided by transmitting OD-SSB after sending Scell activation command to ensure sufficient measurements are made by UE before Scell activation is completed **Proposal 1:** Support on-demand SSB transmission in Scenario #3A for both Case #1 and Case #2**Observation 2:** 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 2:** Support on-demand SSB transmission in Scenario #3B for both Case #1 and Case #2 |
| [11] CATT | **Observation 1:** In the current system, after UE receives SCell activation command, for a known SCell, UE acquires SSB for fine time tracking. For an unknown SCell, UE acquires SSB to perform AGC, synchronization and L1 measurement report.**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
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| [12] China Telecom | **Observation 1:** The on-demand SSB indication and SCell activation should be transmitted at the same time point, but can be either together or separately.**Observation 2:** For scenario #2 and case #1, the SCell could either be SSB-less Cell or will transmit the SSB later, for the both cases, the separate configuration for on-demand SSB is needed.**Proposal 1:** Specific parameters for on-demand SSB Scell operation configuration should be introduced.**Observation 3:** Transmitting on-demand SSB configuration, indication and Scell activation in a single signal will cause too much spec impact on the legacy SCell Activation/Deactivation MAC CE.**Observation 4:** Transmitting on-demand SSB indication together with configuration and indication can be considered, but the negative impact should also be taken into consideration when the configuration is conduct before the SCell activation.**Observation 5:** The condition when the periodical SSB and on-demand SSB are to be transmitted in a very small margin of time should be taken into consideration. **Proposal 2:** The transmission of periodical SSB can be suspended when the on-demand SSB is transmitted along with periodical SSB.**Observation 6:** For situation #3 (Scenario #2A and Case #1), if on-demand SSB indication is transmitted together with the SCell activation, UE may receive the RRC signalling of on-demand SSB configuration later than on-demand SSB indication.**Proposal 3:** If on-demand SSB indication is transmitted with SCell activation, the on-demand SSB configuration should be pre-configured when SCell is configured or specified with a default value.**Proposal 4:** The on-demand SSB indication can be considered as an optional field to be transmitted in the on-demand SSB configuration network signalling.**Observation 7:** Supporting on-demand SSB for Sceanrio#3A with Case #1 wont’ have extra specs impact, but the motivation for supporting situation #5 is unclear.**Proposal 6:** There is no motivation to support on-demand SSB for scenario #3A specifically, but can be supported up to gNB’s implementation since such scenario doesn’t bring extra spec impact.**Observation 8:** Supporting situation #7 won’t cause extra spec impact compared with situation #1-4, and supporting such situation is needed from the perspective of signalling design.**Observation 9:** Supporting situation #8 can acquire the NES gain for all the CA scenario without extra spec impact.**Proposal 7:** Scenario #3B (and case #1/2) should be supported for on-demand SSB.**Observation 10:** Scenario #3B-2 should also be considered in on-demand SSB SCell operation.**Observation 11:** The proposed signalling design can also be applied to scenario #3B-2. |
| [13] 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.**Observation 3:** On-demand SSB SCell operation in Scenario #2A can accelerate SCell activation but has drawback on blind activation of SCell.**Proposal 6:** For on-demand SSB SCell operation in Scenario #2A, the on-demand SSB can be SSB with normal periodicity (e.g., 20ms) or SSB with dense periodicity (e.g., 5ms) followed by normal periodicity.**Proposal 8:** On-demand SSB SCell operation in Scenario #3A is not supported.**Proposal 9:** On-demand SSB SCell operation in Scenario #3B and Case #1/Case #2 can be supported. |
| [15] ZTE | **Proposal 1:** There is no need to support Scenario #3A.**Observation 1:** On demand SSB transmission in conjunction with case #1 can achieve a better tradeoff between network energy saving and system performance.**Proposal 2:** Scenario #3B in conjunction with case #1 should be supported. |
| [16] Honor | **Observation 1:** If always-on SSB is supported by the SCell, the gain of energy saving will be greatly reduced considering that there are still on-demand SSBs will be transmitted.**Proposal 1:** Support scenario #3A and case #1 and not support scenario #3B. |
| [17] 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
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| [18] Quectel | **Proposal 1:** Scenario #3B with Case #2 is the most energy-efficient, for which on-demand SSB should be triggered by gNB. |
| [19] Google | **Proposal 1:** Support the following scenarios and cases* Scenario #3A and Case #1
* Scenario #3A and Case #2
* Scenario #3B and Case #1
* Scenario #3B and Case #2
* Before the on-demand SSB for an SCell is transmitted, UE shall expect the NW configure SSB in at least one CC within the same band as the SCell
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| [21] Panasonic | **Proposal 1:** The support of Scenario #3A/3B and Case 1/2 should not be limited by the specification. |
| [22] 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. |
| [23] NEC | **Proposal 4:** the scenario#3B and both case#1 and case#2 can be precluded for further discussion in RAN1.**Proposal 5:** the scenario#3A and both case#1 and case#2 can be precluded for further discussion in RAN1. |
| [24] 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 keeping synchronization, RRM measurement and beam tracking.
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| [25] Transsion | **Proposal 1** It is recommended that at least scenarios 3A and Case #1 and Scenario #3B and Case #1 should be supported. |
| [26] OPPO | **Proposal 3:** On-demand SSB SCell operation in Scenario #3A is beneficial to fast SCell activation and can be supported.**Proposal 4:** On-demand SSB SCell operation for Scenario #3B and Case #1 is beneficial and can be supported.**Proposal 5:** There is no need to support on-demand SSB SCell operation for Scenario #3B and Case #2. |
| [28] NTT DOCOMO | **Proposal 6:** Support SCell activation command as a starting point for indication of on-demand SSB during SCell acti-vation procedure (in scenario#2A).* Not support indication of on-demand SSB in scenario#3A.

**Proposal 9:** Support at least one of the following options 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 (in scenario3B) 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 (in scenario3B).
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| [32] ITRI | **Observation 2:** For the identified scenarios Scenario #3A and Scenario #3B, on-demand SSB SCell operation can be supported for providing a reliable transmission.**Proposal 2:** For the identified scenarios Scenario #3A and Scenario #3B,* At least Case 1 can be supported for Scenario #3A.
* At least Case 1 can be supported for Scenario #3B.
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| [33] Mavenir | **Observation:** the scenario #3A and #3B are covered by scenario #2A.**Proposal 1:** if scenario #2A is supported, the scenario #3A and #3B could be supported in nature, thus not to be specified particularly. |
| [34] CAICT | **Proposal 1:** Scenario #3A case #1 and Scenario #3A case #B need to be supported for on-demand SSB Scell operation, and Scenario #3B is FFS. |

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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.
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## [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 Intel, Spreadtrum, vivo, InterDigital, CATT, Honor, Xiaomi, Google, Panasonic, ETRI, Transsion, OPPO, ITRI, CAICT, LGE, FW
	+ Objected by CMCC, ZTE, NEC, NTT DOCOMO
* Scenario #3A and Case #2
	+ Supported by Huawei, Intel, Spreadtrum, vivo, InterDigital, CATT, Xiaomi, Google, Panasonic, OPPO
	+ Objected by CMCC, ZTE, ETRI, NEC, NTT DOCOMO, CAICT, LGE, FW
* Scenario #3B and Case #1
	+ Supported by Huawei, Intel, Spreadtrum, InterDigital, CATT, China Telecom, CMCC, ZTE, Xiaomi, Google, Panasonic, Fujitsu, Transsion, OPPO, ITRI, LGE, FW
	+ Objected by vivo, Apple, Honor, ETRI, NEC
* Scenario #3B and Case #2
	+ Supported by Huawei, Intel, Spreadtrum, InterDigital, China Telecom, CMCC, Xiaomi, Quectel, Google, Panasonic, LGE, FW
	+ Objected by vivo, Apple, Honor, ETRI, NEC, OPPO

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 |
| LGE | Our views just were edited above.  |
| Futurewei | We support Scenario #3A Case #1 and Case #2 and Scenario #3B Case #1 and Case #2. Specifically for Scenario #3A, we think it can be fully incorporated into Scenario #2A when the SCell activation command is also accompanied with a time offset for the on-demand SSB transmission/monitoring. |
| Spreadtrum | After review other companies’ contributions, we think spec impact may be kept small, and then some scenarios can be combined, e.g. Scenario #2A and Scenario #3A. => Combine Scenario #2A and 3AOn the other hand, on-demand SSB can be kept unchanged when UE transits from Scenario #3A to Scenario #3B, since gNB may not know the level of DL sync at UE side. => Scenario #3B is FFS |
| Vivo | We support to start the design with the agreed scenarios.  |

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

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| Company | Views |
| [1] Futurewei | **Proposal 2:** Regarding the UE assumption on SSB transmission on a cell supporting on-demand SSB SCell operation, consider the following:* 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 excessively long periodicity.
	+ The cell is barred for legacy UEs.
* Prefer to support Case #1 and Case #2 with cell-defining SSB only.
* Further discussions should be scenario-specific.
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| [2] Tejas | **Proposal 1:** We are supporting Alt-2, i.e., on-demand SSB is limited to non-cell defining SSB. |
| [3] Huawei | **Observation 1:** The main differences between CD-/NCD-SSB, as summarized in the Table 1, are:* CORESET for Type0-PDCCH CSS set is present (i.e., SIB1 and its scheduling DCIs) for CD-SSB and not present for NCD-SSB.
* CD-SSB must be located on the synchronization raster when the serving cell is a PCell, and not restricted otherwise. NCD-SSB can be located either on or off the synchronization raster based on implementation.

**Proposal 2:** For on-demand SSB on the cell, support Alt-1, i.e., it is up to gNB implementation whether on-demand SSB is cell-defining SSB or not.**Proposal 3:** RAN1 to discuss proper on-demand SSB periodicities that can be beneficial to SCell activation/deactivation. |
| [4] Intel | **Proposal 3:** It is up to gNB implementation whether on-demand SSB is cell-defining SSB or not (Alt-1). |
| [5] Spreadtrum | **Proposal 14:** On-demand SSB can be limited to not cell-defining SSB, if the SCell can be a PCell for other UEs. |
| [7] vivo | **Proposal 4:** For on-demand SSB on the cell, support Alt-1 that it is up to gNB implementation whether on-demand SSB is cell-defining SSB or not. |
| [8] Nokia | **Proposal-8:** Whether on-demand SSB is cell-defining or non-cell-defining should be left to the network implementation. |
| [9] Apple | **Proposal 3:** Support Alt 1 (It is up to gNB implementation whether on-demand SSB is cell-defining SSB or not.)* The legacy UE can be barred by ‘cellBarred’ IE in MIB by network implementation but Rel-19 UE needs to understand the cell is not barred when UE is configured with OD-SSB SCell operation.
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| [10] InterDigital | **Proposal 3:** Support Alt-1 (it is up to gNB implementation whether on-demand SSB is cell-defining SSB or not) for the on-demand SSB transmitted on the cell |
| [11] CATT | **Proposal 2:** Regarding whether cell-defining SSB or non-cell-defining SSB applies for on-demand SSB* If the value in IE ‘cellBarrd’ in MIB is set to ‘barred’ for legacy UE in RRC IDLE/INACTIVE states, on-demand SSB can be cell-defining SSB or non-cell-defining SSB; Otherwise, on-demand SSB should be non-cell-defining SSB
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| [12] China Telecom | **Proposal 8:** It is up to gNB implementation whether on-demand SSB is cell-defining SSB or not. |
| [13] CMCC | **Proposal 1:** For NES SCell supporting on-demand SSB SCell operation, it is up to gNB implementation whether on-demand SSB is CD-SSB or not. If on-demand SSB is CD-SSB, legacy UEs should be barred on this SCell. |
| [14] Sony | **Proposal 3:** For on-demand SSB on SCell, Alt-1 (It is up to gNB implementation whether on-demand SSB is cell-defining SSB or not) should be supported.* If Alt-1 is supported, cell barring to legacy UEs should be also considered.
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| [15] ZTE | **Observation 5:** The impact of on-demand SSB operation on legacy UEs is manageable.**Observation 6:** The gNB can prevent the legacy UE from accessing the NES cell with on-demand SSB.**Proposal 9:** It is not necessary to restrict the SSBs on the on-demand SSB SCell to not cell-defining SSB. |
| [16] Honor | **Proposal 2:** Support Alt-1 whether the on-demand SSB is cell-defining SSB or non cell-defining SSB can be left to the network implementation. |
| [17] Xiaomi | **Proposal 1:** On-demand SSB can be either CD-SSB or NCD-SSB. |
| [21] Panasonic | **Proposal 2:** On-demand SSB is not cell-defining SSB. |
| [22] ETRI | **Proposal 5:** Regarding whether on-demand SSB is cell-defining or not, it prefers to leave it as gNB implementation, i.e., Alt-1. |
| [23] NEC | **Proposal 17:** On-demand SSB can be transmitted on synch-raster which can be either CD-SSB or non-CD-SSB as per Rel-15 RAN1 specification.**Proposal 18:** 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 19:** On-demand SSB is not 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 has triggered the on-demand SSB.**Observation 1:** 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 20:** 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 21:** support Alt.1 at least for case#1, i.e. on-demand SSB can be CD-SSB at least for case#1, on-demand SSB can be transmitted on synch-raster and associated with RMSI of the cell. |
| [24] Fujitsu | **Observation 1.** Whether the on-demand SSB is CD-SSB or not is irrelevant, as long as it is ensured that the on-demand SSB SCell is not used as PCell. **Proposal 1.** For on-demand SSB transmitted on the SCell, it is up to gNB implementation to determine the type of on-demand SSB (i.e., CD-SSB or not) and the approach to make sure that the cell is not used as PCell. |
| [25] Transsion | **Proposal 2** On-demand SSB is limited to non-cell-defining SSB can be supported. |
| [26] OPPO | **Proposal 6:** Support on-demand SSB being limited to non-cell-defining SSB.**Proposal 7:** Separate on-demand SSB and always-on SSB if the always-on SSB is cell-defining SSB. |
| [27] LG Electronics | **Proposal #7:** Discuss whether on-demand SSB can be NCD-SSB and clarify which one of the followings is defined as NCD-SSB. * Alt-1: NCD-SSB using Kssb values or ranges which is predefined for not configuring CORESET#0 and type0-PDCCH CSS set
* Alt-2: NCD-SSB configured as “NonCellDefiningSSB” IE in RRC message.
* Alt-3: SSB not on the sync raster.
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| [28] NTT DOCOMO | **Proposal 1:*** Support Alt-1 for a cell supporting on-demand SSB SCell operation.
	+ 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.
* Support at least on-demand SSB that can be transmitted on sync-raster if Alt-2 is adopted.
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| [30] 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:** The transmitted on-demand SSB would not fall on the synchronization raster defined in 38.101-1 [4] Clause 5.4.3.**Proposal 2:** The transmitted on-demand SSB is limited to non-cell-defining SSB (i.e., Alt-2 from RAN1 #116b agreement).**Proposal 3:** The cell barring (cellBarred) of the on-demand SSB in MIB is set to “barred” if there is no always-on SSB on the cell.* This is to prevent legacy UE doing initial attachment or camping on the cell using the on-demand SSB.
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| [31] Ericsson | **Observation 7** On-demand SSB that is not cell-defining is supported as per above agreement.**Proposal 8** Study whether off-raster placement or other approaches should be used to avoid impact of on-demand SSB transmissions on legacy UEs. |
| [34] CAICT | **Proposal 2:** For on-demand SSB on the cell, the SSB is limited to non-cell-defining SSB for on-demand SSB on the cell. |
| [35] 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 is only limited to non-cell defining SSB (i.e., SSB without associated SIB1). |

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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
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## [Moderator’s note] Regarding Alt-1 and Alt-2 in the above agreement, company views are summarized as follows.

* Alt-1 (It is up to gNB implementation whether on-demand SSB is cell-defining SSB or not)
	+ Supported by Huawei, Intel, vivo, Nokia, Apple, InterDigital, CATT, China Telecom, Sony, ZTE, Honor, Xiaomi, ETRI, NEC, Fujitsu, NTT DOCOMO
* Alt-2 (On-demand SSB is limited to non-cell-defining SSB)
	+ Supported by Tejas, Spreadtrum, Panasonic, Transsion, OPPO, LG Electronics, MediaTek, CAICT, Qualcomm
	+ Concern: If a CD-SSB is used for on-demand SSB, it can lead to the impact to idle/inactive UEs’ behaviors.

Although Alt-1 is supported by majority companies, the concern from proponents of Alt-2 doesn’t seem to be resolved. Proponents of Alt-1 suggested that gNB can avoid impact to idle/inactive UEs by setting *cellBarred* in MIB to *barred*. However, as pointed out in [35] Qualcomm, even if *cellBarred* in MIB is set to *barred*, some types of legacy UEs (e.g., UEs supporting NTN, Redcap, NES) are required to obtain barring information in SIB1. Thus, it would be safer to limit non-cell-defining SSB for on-demand SSB, in order to avoid any potential impacts to idle/inactive UEs.

### Proposal #2-2 (CD-SSB or not):

* For a cell supporting on-demand SSB SCell operation,
	+ On-demand SSB on the cell is limited to non-cell-defining SSB with which CORESET#0 and type0-PDCCH CSS set configurations are not associated.

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

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| Company | Views |
| InterDigital | We do not support the proposal. Limiting OD-SSB to NCD-SSB comes at the expense of NES gains and loss of flexibility at gNB to decide on the type of SSB applied for OD-SSB. Any NES gains by not transmitting RMSI with NCD-SSB are marginal anyways and thus, not preferred. Also, the impact to idle/inactive UE can be avoided without having to bar the UEs based on gNB implementation (e.g. NW can ensure that idle/inactive UEs can connect to an alternative coverage cell that is overlapped with the cell supporting OD-SSB).  |
| Xiaomi | We second the comment from IDC. For the WID, it is clearly said that on-demand SSB is considered for SCell for CONNECTED UE. For SCell operation, there is no need to put any restriction on SSB. It is fully up to gNB implementation.Actually this proposal is also highly relevant to the specific mechanisms for supporting on-demand SSB. If always-on SSB is assumed on SCell, it doesn’t matter on the SSB type for OD-SSB. If always-on SSB is not assumed, UE never accesses to this cell if on-demand SSB is NCD-SSB. For the second case, the impacts on legacy UE are already there.  |
| DCM | OK |
| LGE  | Support the proposal  |
| Futurewei | The proposal does not clarify whether the legacy UEs are in the SCell (such as camped under the cell, connected to the cell, attempting to camp/connect to the cell, etc.) and whether they require a legacy SSB transmission. In this case, how the on-demand SSB is justified from the energy saving point of view. In addition, if cell has no always-on SSB and the on-demand SSB is NCD, is it still considered as a ‘cell’? We prefer to clarify this issue first before agreeing with such a proposal. Also, it would be useful to focus the discussion on down-selected scenarios, otherwise the discussion may be difficult to converge. |
| Spreadtrum | On-demand SSB is at least not cell-defining SSB, and FFS: whether it can be cell-defining SSB. SCell for a UE may be PCell for anther UE. This case is FFS.Proposal #2-2 (CD-SSB or not):* For a cell supporting on-demand SSB SCell operation,

On-demand SSB on the cell can be ~~is limited to~~ non-cell-defining SSB with which CORESET#0 and type0-PDCCH CSS set configurations are not associated. FFS: on-demand SSB on the cell can be cell-defining SSB |
| Apple | Regarding “Concern: If a CD-SSB is used for on-demand SSB, it can lead to the impact to idle/inactive UEs’ behaviors.”, our understanding is that the impacts for NCD-SSB and CD-SSB are the same (and no negative impact) because of the following reasons:* NCD-SSB on sync raster vs. CD-SSB on sync raster
	+ IDLE/INACTIVE UE will search NCD-SSB or CD-SSB and realize the cell is not accessible by checking kssb value (for NCD-SSB) or by checking cellbarred in MIB. Both have no impact to legacy IDLE/INACTIVE UEs.
* NCD-SSB not on sync raster vs. CD-SSB not on sync raster
	+ IDLE/INACITVE UE will not see NCD-SSB or CD-SSB on sync raster.
 |
| ETRI | Not support. We can live with SPRD’s suggestion. |
| Huawei & Hisilicon | We do not support the proposal. Network deployment can make sure that no impact nor degradation of QoS of idle/inactive UEs initial access (including cell selection/resection). |
| OPPO | Support. |
| Qualcomm | Support |
| CATT | Not support |

## Others

|  |  |
| --- | --- |
| Company | Views |
| [4] Intel | **Proposal 1:** For OD-SSB discussion, the following term definitions are agreed:* Indication refers to an indication sent from network to UE of the required configuration to receive OD-SSB configuration.
* Triggering refers to the triggering event at the network side that leads the network to transmit OD-SSB. The RAN triggering for OD-SSB as already agreed by RAN1, gNB can trigger the transmission of OD-SSB upon reception of a UE’s request for OD-SSB or when required (i.e., triggering condition would be left up to network implementation).

**Proposal 2:** The agreement made during RAN#116-bis is modified (in red) in the following way:

|  |
| --- |
| For the identified scenarios and cases (as per RAN1#116 agreement), on-demand SSB can be ~~triggered~~ indicated 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~~indicated, its transmission is in a periodic manner.
	+ Note: This does not imply periodic on-demand SSB is transmitted indefinitely after ~~triggered~~indicated.
* 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~~indicated SSB starts and ends) will be separately discussed.
 |

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| [6] 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.**Proposal 1:** The transmission of on-demand SSB shall not impact the transmission of periodic SSB, if any. |
| [7] vivo | **Observation 1:** Spec effort is needed to support the SSB-less feature and on-demand SSB feature at the same time, and the benefit of supporting on-demand SSB in SSB-less SCell is not clear.**Proposal 3:** Do not support on-demand SSB in SSB-less SCell. |
| [9] Apple | **Proposal 4:** The following use cases (UCs) are considered to support 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
 |
| [17] Xiaomi | **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. |
| [23] NEC | **Proposal 13:** Discuss other cases (e.g. RACH initiation upon TAT expiry) for which on-demand SSB transmission may be required. |
| [27] LG Electronics | **Proposal #1:** For Case #1 (i.e., No always-on SSB on the SCell), discuss whether there is another feasible condition in addition to the conditions of legacy SSB-less SCell.* Before another feasible condition is identified in Case #1, Case #1 should be limited to legacy SSB-less SCell.
 |
| [29] Sharp | **Observation 1:** Before considering other aspects, it should be clarified which of following two options is available for SCell operation with on-demand SSB transmission. * Option A: For activated SCell operation, the SSB transmission is assumed to be same as legacy SCell operation with SSB
* Option B: For activated SCell operation, the SSB transmission can be stopped or with longer periodicity than legacy SCell operation with SSB

**Proposal 1:** For on-demand SSB SCell operation, the SSB transmission can be stopped or less periodicity than legacy SSB SCell operation after SCell activation completion (with possibility of re-triggering of on-demand SSB transmission after SCell activation completion). |

## [Moderator’s note] In RAN1#116bis meeting, it was discussed how to define Case #1. According to Tdoc, vivo and LG Electronics showed different views where one thinks on-demand SSB operation is not supported for SSB-less cell while the other thinks Case #1 should be limited to legacy SSB-less SCell. Thus, it would be good to clarify whether on-demand SSB can be supported for legacy SSB-less SCell.

### Q#2-3) Do you agree that Case #1 (i.e., No always-on SSB on the cell) is limited to SSB-less SCell that was introduced from Rel-15 or Rel-18? If not, provide your views on Case #1.

|  |  |
| --- | --- |
| Company | Views |
| Xiaomi | We are OK for further clarification. From our understanding, there is no limitation on SCell type in Rel-19 NES WID. |
| DCM | Strongly No. Case#1 of on-demand SSB operation should not be limited to SSB-less operation. CA scenarios other than SSB-less should be able to support case#1, otherwise, Rel-19 on-demand SSB offers no NES gain over legacy operation but just to offer some enhancements using on-demand SSB, e.g., fast measurements, fast SCell activation in SSB-less operation. Which case#1 or case#2 to be applied should be up to NW implementation considering deployment, required NES, complexity of on-demand SSB operation and so on, thus there should no restriction in spec.  |
| LGE | Case1 should be limited to SSB-less SCell for simplicity. If Case 1 can be operated without reference Cell for synchronization, what the situation is should be clarified.  |
| Futurewei | Suggest focus the discussion on down-selected scenarios, otherwise the discussion may be difficult to converge. |
| Spreadtrum | R15/R18 SSB-less is just for some configurations of CA, e.g. intra-band with co-location, inter-band with co-location. For R19, RAN1 does not limit the CA configurations and let the discussion happen in RAN4, which was general view in previous meetings. |
| Huawei & Hisilicon | We do not agree that Case #1 is limited to SSB-less Scell. Case #1 may or may not be combined with the concept of reference cell. For example, if the gNB expects that the time the Scell will be in Case#1 is relatively long such that the UE need to have reference synchronization, it could provide the UE with SSB-less configurations/operations, otherwise the gNB will not provide the UE(s) with such configurations/operations.  |
| OPPO | No. Case #1 can also be supported for non-co-located CA configurations. It can be further discussed how to associate the on-demand SSB with the reference cell. |
| CATT | No. |

# Signalling of on-demand SSB operation

|  |  |
| --- | --- |
| Company | Views |
| [1] Futurewei | **Proposal 4:** Consider the potential enhancements of indication/signaling mechanisms:* Scenario #2A: SCell activation based on OD-SSB indicated when receiving SCell activation command:
	+ Indicate the OD-SSB in a MAC CE sent at the same time as the SCell activation command.
	+ Leave the decision on separate or single signaling to RAN2.
* Scenario #2: Deactivated SCell re-synchronization / measurement based on OD-SSB:
	+ A new MAC CE to activate on-demand SSB on a deactivated SCell.
* 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] Tejas | **Proposal 2:** Use separate signaling for SCell activation/deactivation and on-demand SSB indication. **Proposal 3:** On-demand SSB can be indicated to the UE using dynamic signaling i.e., DCI. |
| [3] Huawei | **Proposal 9:** Support both of separate signalling or single signalling indication via RRC, MAC CE or DCI.* Details of new RRC parameters and enhanced MAC CE design can be up to RAN2.
 |
| [4] Intel | **Proposal 4:** Support both separate (Option 1) and combined (Option 2) signalling when providing indication of OD-SSB and SCell activation/deactivation.**Proposal 5:** Support both RRC and MAC CE based OD-SSB configuration indication. |
| [5] Spreadtrum | **Observation 2:** There could be two main directions for on-demand SSB for SCell, including UL WUS triggering and DL indication.**Proposal 8:** For Scenario #2, on-demand SSB indication is separate from SCell activation command.**Proposal 9:** For Scenario #2A and #3A, on-demand SSB indication and SCell activation command can be a single signaling.**Proposal 10:** For Scenario #3B, on-demand SSB indication may not be necessary. |
| [6] Samsung | **Proposal 3:** At least support separate signaling between legacy/existing signaling (e.g., RRC, MAC CE) providing SCell activation/deactivation and signaling providing On-demand SSB transmission indication (Option 1 in RAN1#116bis agreement). |
| [7] vivo | **Proposal 10:** The on-demand SSB indication signalling should be a UE-specific signalling.**Proposal 11:** MAC CE is selected to be the on-demand SSB indication signalling.**Proposal 12:** A separate MAC CE different from the SCell activation/deactivation MAC CE should be used to provide the on-demand SSB transmission indication. |
| [8] Nokia | **Proposal-3:** Regarding signaling for Scenario#2, the RRC message carrying SCell configuration can be enhanced to provide configuration of on-demand SSB and can be also used as the trigger to on-demand SSB transmission.**Proposal-4:** Regarding signaling for Scenario#2A, the SCell activation MAC-CE command can be considered as the triggering signaling and being utilized as a reference point of the start of on-demand SSB transmission if the on-demand SSB configuration is already provided by the RRC signaling. Alternatively, the SCell activation MAC-CE can be enhanced to include the configuration for on-demand SSB as well as being utilized as the triggering signal and reference point of the start of on-demand SSB transmission.**Proposal-5:** Regarding the signaling for on-demand SSB SCell operation, for the agreed Scenario#2 and Scenario#2A, the extension and enhancement of existing SCell configuration message and/or SCell activation signaling should be prioritized to be specified. |
| [9] Apple | **Proposal 5:*** For Case #1 (no always-on SSB), there is no need of separate RRC for OD-SSB from SCell configuration.
	+ Possibly candidate values for application time between OD-SSB indication for ON/OFF and OD-SSB ON/OFF time (to be determined by RAN4)
* For Case #2 (periodic always-on SSB), separate signaling is needed to be differentiated from always-on SSB, e.g.
	+ OD-SSB transmission pattern (SSB-positionsInBurst-r19 for OD-SSB, periodicity)
	+ OD-SSB frequency position
	+ Possibly candidate values for application time between OD-SSB indication for ON/OFF and OD-SSB ON/OFF time (to be determined by RAN4)
	+ Note: Preferably Case #2 is to be discussed under objective 3 (AI 9.5.3)

**Proposal 6:** As for indication of OD-SSB transmission/termination (MAC-CE)* Each bit to indicate OD-SSB ON/OFF for each SCell
	+ ON/OFF information can also refer to not only serving cell(s) but neighboring cell(s) in the same frequency.
* (If multiple application times are configured,) Selected application time between OD-SSB indication and OD-SSB transmission/termination.
* Note: There is no need to combine SCell activation/deactivation command with this new OD-SSB indication into the same MAC-CE since several MAC-CEs can be carried by a PDU (Section 6.1.3 of TS38.321) for Scenario #2A (When UE receives SCell activation command).

**Proposal 8:** The signaling for indication of OD-SSB transmission/termination is based on MAC-CE. Details are FFS. |
| [10] InterDigital | **Proposal 5:** Support Option 1 (Separate signaling between legacy/existing signaling providing SCell (de)activation and signaling providing on-demand SSB transmission indication) |
| [11] CATT | **Proposal 7:** Support a single signaling in which both SCell activation/deactivation and on-demand SSB transmission indication are provided (Option 2).**Proposal 8:** In Rel-19, MAC-CE should at least be supported to trigger on-demand SSB.**Proposal 9:** In Rel-19, RRC triggering on-demand SSB is only limited to Scenario#2A.**Proposal 10:** The following contents need to be included in the signalling that triggers on-demand SSB:* SSB indexes within *ssb-PositionsInBurst*
* Transmission time N of on-demand SSB burst, if supported
* On-demand SSB transmission for multiple SCells
 |
| [12] China Telecom | **Proposal 5:** Support the following features for on-demand SSB design in order to strive a common signalling design:* On-demand SSB configuration: transmitted via new RRC parameter, also includes the on-demand SSB indication optionally if the SCell has been activated.
* SCell activation: no enhancement on the Scell activation, still via MAC CE.
* On-demand SSB indication: if not included in the on-demand SSB configuration, transmitted separately no earlier than the SCell activation and on-demand SSB configuration, via MAC CE or DCI.

**Proposal 9:** Support Option 1, i.e., Separate signaling between legacy/existing signaling (e.g., RRC, MAC CE) providing SCell activation/deactivation and signaling providing On-demand SSB transmission indication. |
| [13] CMCC | **Proposal 2:** For on-demand SSB SCell operation in Scenario #2, a separate DL signaling from SCell activation command can be used to indicate on-demand SSB on NES SCell.**Proposal 5:** For on-demand SSB SCell operation in Scenario #2A, RRC signaling for SCell configuration or SCell activation command can be used to indicate on-demand SSB on NES SCell.**Proposal 10:** For on-demand SSB SCell operation in Scenario #3B, a separate DL signaling from SCell activation command (e.g. group common DCI) can be considered to indicate on-demand SSB on NES SCell. |
| [14] Sony | **Proposal 2:** For signalling for gNB triggering on-demand SSB, 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) should be supported.* Detailed design on On-demand SSB transmission indication is left to RAN2.
 |
| [15] ZTE | **Observation 2:** Option 2 can reduce the signaling overhead and SCell activation latency for scenario #2A.**Proposal 3:** For on-demand SSB triggering signaling, Option 2 is preferred.**Proposal 4:** The triggering signaling can be a MAC CE indicating both SCell activation/deactivation and on-demand SSB transmission.**Proposal 5:** The target SCell index and target on-demand SSB transmission pattern can be indicated by the triggering signaling. |
| [16] Honor | **Proposal 5:** Support option 1 which separate signaling between SCell activation/deactivation and On-demand SSB transmission indication and define a new MAC CE to indicate the on-demand SSB transmission. |
| [17] Xiaomi | **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.

**Observation 2:** No matter which mechanism is adopted for SSB triggering, UE may not be able to recognize SSB transmission status.**Proposal 9:** 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

**Proposal 10:** Further study whether/how to optimize SCell release procedure with taking SSB ON/OFF into consideration. |
| [19] Google | **Proposal 2:** Support the NW to configure the activation/deactivation status on-demand SSBs by a group-cast DCI* The UE should assume the activation/deactivation status for the on-demand SSB is based on the indicated status after the action time of the DCI until it receives another signaling to update such status
 |
| [20] Lenovo | **Proposal 4:** Support following signalling options to indicate on-demand SSB transmission for Scenario #2 and Scenario #2A,* For Scenario #2, support option 1 of using a separate signaling to indicate on-demand SSB transmission.
* For Scenario #2A, support option 2 of using a single signaling to indicate both on-demand SSB transmission and SCell activation/deactivation.
 |
| [21] Panasonic | **Proposal 5:** RRC-based on-demand SSB ON/OFF should at least be supported. In addition, DCI-based on-demand SSB triggering indication is supported. By RRC configuration, joint or separate bits for SSB ON/OFF and SCell activation/deactivation can be used. |
| [22] ETRI | **Observation 1:** Triggering method(s) for on-demand SSB transmission is out of RAN1 work scope.**Proposal 2:** It is proposed to support Option 1 as an indication method for on-demand SSB transmission.* For separate signaling, common PDCCH, MAC CE, and RRC signaling can be considered for further discussion.

**Proposal 6:** It is proposed to report additional information for proper configuration for on-demand SSB transmission.* Details of additional information can be discussed further.

**Proposal 7:** It is proposed to provide the configuration information for on-demand SSB transmission to the UE to help SSB reception.* Details of configuration information and related procedure(s) can be discussed further.
 |
| [23] NEC | **Proposal 1:** On-demand SSB for SCell may be enabled via dedicated RRC signalling on PCell. **Proposal 2:** 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.**Proposal 3:** Configuration of on-demand SSB for SCell may be provided via dedicated RRC messages and shall indicate the following* Information of associated serving cells
* Resources for UE request for UE-initiated on-demand SSB
* SSB transmission parameters

**Proposal 10:** Upon SCell activation, on-demand SSB transmission can be initiated based on one of the following options:* Option-1: gNB indicates within SCell activation command or any other message that on-demand SSB transmission shall be initiated. After receiving this indication, UE may start monitoring the SSB transmission.
* Option-2: UE autonomously determines that on-emand SSB transmission shall be initiated immediately after receiving SCell activation command (i.e. no explicit indication of on-demand SSB).
 |
| [24] Fujitsu | **Proposal 5.** For the option of separate signaling to provide SCell activation/deactivation indication and on-demand SSB transmission indication, group common DCI can be considered to reduce signaling overhead.**Proposal 6.** For the option of a single signaling to provide both SCell activation/deactivation indication and on-demand SSB transmission indication, the following can be considered as starting point. * RRC
	+ Details should be discussed by RAN2.
* MAC-CE
	+ The Rel.17 enhanced SCell activation/deactivation MAC-CE can be considered as the starting point.
	+ Details should be discussed by RAN2.
 |
| [25] Transsion | **Proposal 5** Separate signaling between scell activation/deactivation and on-demand SSB transmission indication can be supported. |
| [26] OPPO | **Proposal 8:** Including on-demand SSB indication in SCell activation command.**Proposal 9:** Support GC-PDCCH for on-demand SSB indication. |
| [27] LG Electronics | **Proposal #2:** Discuss how to signal SSB-related parameters and SMTC configuration for Case #1 (i.e., No always-on SSB on the cell).**Proposal #3:** New RRC parameter is adopted to enable on-demand SSB operation for an SCell. FFS any other information that can be signaled with the new RRC parameter (e.g., SSB location/transmission pattern, etc.)**Proposal #4:** For the on-demand SSB operation triggered by gNB’s SCell activation/deactivation signaling, the signaling at least includes whether SSB will be transmitted on the SSB-less SCell or not. * Discuss further other contents (e.g., SSB transmission pattern, reference cell) to be included in the SCell activation/deactivation signaling and signaling details.

**Proposal #6:** Consider the following signalling methods to indicate on-demand SSB transmission, corresponding to two options in previous agreement.* MAC CE and/or DCI for Option 1 (i.e., separate signaling between legacy/existing signaling providing SCell activation/deactivation and signaling providing On-demand SSB transmission indication)
* RRC and/or MAC CE for Option 2 (i.e., single signaling in which both SCell activation/deactivation and On-demand SSB transmission indication are provided)

**Proposal #17:** Consider to inform whether SSB on the SCell is transmitted or not, via group-common signaling. |
| [28] NTT DOCOMO | **Proposal 3:** Support both 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) and Option 2 (A single signaling in which both SCell activation/deactivation and On-demand SSB trans-mission indication are provided) for signaling on-demand SSB transmission indication.* Support enhancement of MAC CE signaling for indication of on-demand SSB transmission together with SCell activation (e.g., for scenario2A)
* Support RRC signaling for indication of on-demand SSB transmission together with SCell activation (e.g., for scenario2A)
* Support new MAC CE or DCI signaling for indication of on-demand SSB transmission separately from SCell activation/deactivation indication (e.g., for Scenario#2).

**Proposal 4:** For indication of on-demand SSB, consider group-common DCI signalling before SCell is activated (in scenario#2). |
| [29] Sharp | **Proposal 2:** A single signaling in which both SCell activation/deactivation and On-demand SSB transmission indication should be considered for scenario 2A. |
| [30] MediaTek | **Proposal 4:** For on-demand SSB triggering, use DL MAC-CE to inform UE the time/frequency domain properties of the to-be-transmitted on-demand SSB. The DL MAC-CE can be used together with the SCell activation/deactivation (i.e., Option 2 from RAN1 #116b agreement).**Proposal 5:** The DL MAC-CE should include the following time domain properties of the to-be-transmitted on-demand SSB:* SSBs (beams) to be transmitted in one SSB burst (Ex. using similar structure as ssb-PositionsInBurst)
* Number of SSB bursts
* Gap length between SSB bursts
* Triggering offset
* Number of SSB burst clusters (one cluster includes multiple SSB burst)
* Number of SSB bursts in one cluster
* Gap length between SSB burst clusters

**Proposal 6:** The DL MAC-CE should include the following frequency domain properties of the to-be-transmitted on-demand SSB (s):* Absolute frequency position(s) of the SSB (Ex. using similar definition as absoluteFrequencySSB)

**Proposal 7:** If multiple SSB bursts are triggered on one SCell, all bursts in the SCell share the same configurations including antenna port index, OFDM symbol location, and PRB location. |
| [31] Ericsson | **Observation 1** To support Scenario #2, signaling for informing UE of on-demand SSB provision and SCell activation/deactivation must be sent at different time instances.**Observation 2** To support Scenario #2A, signaling for informing UE of on-demand SSB provision and SCell activation/deactivation must be sent at the same time instance.**Observation 3** Repurposing of existing SCell activation/deactivation MAC CE for on-demand SSB transmission indication does not support Scenario #2.**Proposal 1** On-demand SSB for SCell is configured via RRC and is, by default, not transmitted upon SCell configuration.**Proposal 2** UEs are informed of on-demand SSB transmissions, at least, via new MAC CE signaling that supports one or more of SCell activation/deactivation and on-demand SSB transmission indication, respectively.**Proposal 3** Support mechanisms to start on-demand SSB transmissions on an SCell and to stop an ongoing on-demand SSB transmission.**Proposal 4** Support mechanism to switch on-demand SSB periodicity.**Proposal 5** Support indication of on-demand SSB periodicity via MAC CE.**Proposal 6** NW can switch on-demand SSB periodicity while UE’s SCell is in an activated state.**Observation 5** Once SSB is provided, it may be used by all UEs served in the same SCell. However, the SCell may not be activated for all UEs at the same time. |
| [32] ITRI | **Observation 1:** For a cell supporting on-demand SSB SCell operation, Option 1 may provide higher scheduling flexibility than Option 2.**Proposal 1:** For a cell supporting on-demand SSB SCell operation, at least Option 1 can be supported. |
| [33] Mavenir | **Proposal 4:** for the trigger signaling of on-demand SSB burst transmission, the Option 1 should be selected considering both Scenario #2 and #2A to be supported. |
| [34] CAICT | **Proposal 3:** Separate signaling between legacy/existing signaling providing SCell activation/deactivation and signaling providing On-demand SSB transmission indication. |
| [35] Qualcomm | **Proposal 3:** The configuration of on-demand SSB transmission is provided in RRC. The configuration includes at least the following information for a cell supporting on-demand SSB Scell operation:* Frequency where the on-demand SSB is transmitted (e.g., ARFCN)
* The SCS of on-demand SSB if the band supports multiple SCSs for SSB
* Periodicity of the on-demand SSB burst
* A bitmap of the actually transmitted on-demand SSBs.

**Proposal 4:** If adapting on-demand SSB configuration (e.g., SSB burst periodicity and/or bitmap of transmitted SSBs) is supported, introduce a new MAC-CE for joint Scell activation and OD-SSB configuration indication update. |
| [36] ASUSTeK | **Proposal 3:** RAN1 further consider to use DCI as a candidate for On-demand SSB transmission indication. |
| [37] Fraunhofer | **Proposal 1:** When the gNB activates a SCell, it also sends an indication to temporarily activate SSB on that SCell. |

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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
 |

##  [Moderator’s note #1] Regarding Option 1 and Option 2 in the above agreement, company views are summarized as follows.

* Option 1 (separate signaling)
	+ Supported by Futurewei, Tejas, Huawei, Spreadtrum, Samsung, vivo, Apple, InterDigital, China Telecom, CMCC, Sony, Honor, Lenovo, ETRI, Fujitsu, Transsion, LG Electronics, NTT DOCOMO, Ericsson, ITRI, Mavenir, CAICT
		- For Scenario #2: Furutrewei, Spreadtrum, CMCC, Lenovo, NTT DOCOMO, Ericsson
* Option 2 (single signaling)
	+ Supported by Futurewei, Huawei, Spreadtrum, Nokia, CATT, CMCC, ZTE, Lenovo, Panasonic, Fujitsu, OPPO, LG Electronics, NTT DOCOMO, Sharp, MediaTek, Ericsson, Qualcomm
		- For Scenario 2A: Futurewei, Spreadtrum, CATT, CMCC, Lenovo, NTT DOCOMO, Ericsson

The following is the summary of company views on signaling container:

* RRC: ETRI, CATT, RRC, Fujitsu, LG Electronics, NTT DOCOMO
* MAC CE: Futurewei, Apple, ETRI, LG Electronics, NTT DOCOMO, Ericsson, CATT, ZTE, Fujitsu, MediaTek, Qualcomm
* DCI: Tejat, ETRI, Fujitsu, LG Electronics, NTT DOCOMO, CATT, OPPO, NEC, ASUSTeK, Google
	+ Group common DCI: Fujitsu, OPPO, LG Electronics, NTT DOCOMO, Google
	+ DCI format 1\_x on PCell: NEC

In addition, at least three companies (including Huawei, China Telecom, and Ericsson) proposed to introduce a signaling to deactivate on-demand SSB transmission. With those regards, the following proposal can be made.

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

* For a cell supporting on-demand SSB SCell operation,
	+ Support RRC based signaling to activate on-demand SSB transmission on the cell.
		- This RRC signaling also provides SCell activation (i.e., the parameter *sCellState* is set to *activated*).
	+ Support MAC CE based signaling to activate on-demand SSB transmission on the cell.
		- It is up to RAN2 whether this MAC CE can be also used for SCell activation/deactivation.
		- From RAN1 perspective,
			* Separate signaling between legacy/existing SCell activation/deactivation MAC CE and this MAC CE providing on-demand SSB transmission indication, is beneficial when on-demand SSB transmission needs to be indicated before the UE receives SCell activation command and after the SCell is configured to the UE.
			* A single signaling in which both SCell activation/deactivation and on-demand SSB transmission indication are provided, is beneficial when SCell activation and on-demand SSB transmission need to be indicated at the same time.
	+ Support DCI based signaling to activate 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.
	+ Send an LS to RAN2 to inform above the first and second bullets.

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

|  |  |
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| Company | Views |
| InterDigital | In general, we are supportive of the intent of the proposal. For single signaling, at least RRC based signaling is fine and can be supported (first sub-bullet). But it is not clear the need/benefit to support both MAC CE and DCI for separate signaling. We think for separate signaling, down-selection is needed between MAC CE and DCI for indicating the OD-SSB transmission. Based on the outcome of the down-selection discussion, Proposal #3-1 can be revised (for second and third sub-bullets).  |
| Xiaomi | We are generally fine with the proposal.Clarification question: does the proposal imply that different solution is applied to different scenarios? If so, it is complex and segmental specification is inevitable. |
| DCM | Support |
| LGE | Our view is that it is better to include the agreement on what Option1 and Option 2 imply, when sending LS to RAN2 |
| ZTE, Sanechips | We think that MAC CE based signaling should be baseline mechanism, and we are open to further study RRC based/ DCI based methods. And regarding the second sub-bullet, we prefer to have an unified signalling for multiple scenarios, thus original option 2 seems makes more sense. Moreover, we’d like to suggest to revise the wording a bit for clarification.* A single signaling in which both SCell activation/deactivation and on-demand SSB transmission (fields)indication are provided, is beneficial when SCell activation and on-demand SSB transmission need to be indicated at the same time.

As for LS, we support to send LS to RAN2 regarding the details of signaling. |
| Futurewei  | Support |
| Apple | Separate sigaling for OD-SSB indication is essential for Scenario 2 whereas both Separate and single signaling are possible for Scenario 2A. Given we strive for the common design to the different scenarios, we think separate signaling is the way to go. |
| vivo | Down-selection between MAC CE and DCI should be done by RAN1, since MAC CE and DCI are both dynamic indication, we should avoid redundant design. Our preference is MAC CE for its simplicity. |
| ETRI | Support |
| Huawei & Hisilicon | We are OK to discuss RRC/ MAC CE and DCI based indications of the activation/deactivation of OD-SSB. Particularly, regarding MAC CE based signaling, we would like to point out that it is reasonable to use a unified signal for both on-demand SSB transmission together with / ahead of SCell activation. There may exist two fields, indicating on-demand SSB transmission and SCell activation separately in the MAC CE, and UE obviously could interpret the functionality correctly w.r.t. different scenarios. The signaling design effort and redundancy is lessened consequently. |
| OPPO | Support |
| Qualcomm | We prefer discussing Proposal #3-2 before going into this proposal. Our understanding is that UE should first get configuration of OD-SSB transmission (Proposal #3-2) from RRC. Then we could discuss whether some additional signaling is needed to provide UE with additional OD-SSB Tx configuration to support OD-SSB operation. We don’t think there is need to have the additional signaling to **activate** on-demand SSB transmission on the cell. Instead, we should discuss whether only one or both of the following aspects to be supported:* Aspect #1: OD-SSB transmission configuration configured by RRC is not dynamically adapted/updated
	+ The signaling is only needed for L1/L3 RRM measurement which can be performed before and after Scell activation. For other connected mode operations, the UE expects OD-SSB (configured by RRC) is periodically transmitted on the cell in Scenarios 3A and 3B for SSB Tx Case 1, and at least in Scenario 3A for SSB Tx Case 2 – for this we don’t need to have an additional signaling to inform UE on OD-SSB transmission.
* Aspect #2: OD-SSB transmission configuration configured by RRC can be dynamically updated/adapted
	+ We may need two signalings: one for L1/L3 measurement (similar to Aspect #1) and the other to dynamically adapt OD-SSB Tx configuration for other connected mode operations.
 |
| CATT | Can consider all options now but discuss down selection in the next step |

**\\**

## [Moderator’s note #2] As contents of triggering signalling, the followings are suggested by companies.

* Futurewei: MAC CE/DCI selects options configured in RRC for at least the availability of on-demand SSB (time offset, number of bursts, beam, etc.)
* CATT: SSB indexes within *ssb-PositionsInBurst*, Transmission time N of on-demand SSB burst, if supported, On-demand SSB transmission for multiple SCells
* ZTE: target SCell index and target on-demand SSB transmission pattern
* ETRI: cell ID, numerology, time/frequency resources, number of SSB burst sets or time duration
* MediaTek
	+ SSBs (beams) to be transmitted in one SSB burst (Ex. using similar structure as *ssb-PositionsInBurst*)
	+ Number of SSB bursts
	+ Gap length between SSB bursts
	+ Triggering offset
	+ Number of SSB burst clusters (one cluster includes multiple SSB burst)
	+ Number of SSB bursts in one cluster
	+ Gap length between SSB burst clusters
	+ Absolute frequency position(s) of the SSB (Ex. using similar definition as *absoluteFrequencySSB*)
* Ericsson: Periodicity indication
* Qualcomm
	+ Frequency where the on-demand SSB is transmitted (e.g., ARFCN)
	+ The SCS of on-demand SSB if the band supports multiple SCSs for SSB
	+ Periodicity of the on-demand SSB burst
	+ A bitmap of the actually transmitted on-demand SSBs.

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

* For a cell supporting on-demand SSB SCell operation, at least the followings for on-demand SSB are provided with higher layer parameters.
	+ Frequency of the on-demand SSB (e.g., *absoluteFrequencySSB*)
	+ SSB indexes within an on-demand SSB burst (e.g., *ssb-PositionsInBurst*)
	+ Periodicity of the on-demand SSB (e.g., *ssb-periodicityServingCell*)
	+ Sub-carrier spacing of the on-demand SSB (e.g., *subcarrierSpacing*)
	+ FFS: other contents including
		- Offset between on-demand SSB transmission indication signaling and on-demand SSB transmission
		- Time window for which indicated on-demand SSB is transmitted (i.e., interval between time instance A and time instance B in previous agreement)
		- How many on-demand SSB burst(s) are transmitted once indicated

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

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| Company | Views |
| InterDigital | Support Proposal #3-2 |
| Xiaomi | Support. |
| DCM | Generally OK but at least, the wording “(e.g., *ssb-periodicityServingCell*)” should be removed because it may imply on-demand SSB is CD-SSB. |
| LGE  | As for us, it is positive to start discussing parameters to be provided by L3 RRC message for indication of On-demand SSB |
| ZTE, Sanechips | We are generally fine with this proposal, and the target SCell index which sends on-demand SSB should also be configured/indicated.In addition, the Time window/time instance B can be indicated either via higher layer parameter or MAC CE. |
| Futurewei | We are OK in principle, however, would be good to clarify whether the CD SSB or NCD SSB are considered. |
| Spreadtrum | R17 NCD-SSB for RedCap UE can be start point. For Case #2 (there is always-on SSB), some parameters are reusing that of always-on SSB (maybe CD-SSB). For Case #1, on-demand SSB is newly configured. |
| ETRI | Support |
| Huawei & Hisilicon | We support the current proposal and we would like to add the following- Gap length between SSB bursts- Gap length between SSB blocksIf is also fine to add the above under FFS.  |
| OPPO | Support |
| CATT | OK |

# TX behavior of on-demand SSB burst

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| Company | Views |
| [1] Futurewei | **Proposal 5:** For on-demand SSB transmission, at least support 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. |
| [3] Huawei | **Proposal 6:** Support the options that can cover on-demand SSB activation/deactivation indication (i.e., Option 2 and 4). Meanwhile, further discuss the details of the definition of time instances A and B.**Proposal 7:** Regarding the definition of time instance A, Alt 1-1 and Alt 3-1 are more preferred.**Proposal 8:** The time instance B to be defined as the time when either a UE receives an on-demand SSB deactivation indication, or a UE receives new on-demand SSB activation indication of which carried information is different with the prior one, or a pre-defined timer has expired. |
| [5] Spreadtrum | **Proposal 11:** For mechanism of on-demand SSB transmission, Option 1 and Option 1A should be excluded.**Observation 3:** For Scenario #2, Option 2 can be supported.**Observation 4:** For Scenario #2A, Option 2 can be supported.**Observation 5:** For Scenario #3A, Option 2 or Option 3 can be supported.**Observation 6:** For Scenario #3B, Option 2 can be supported.**Proposal 12:** 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. |
| [6] Samsung | **Proposal 5:** The transmission of on-demand SSB is using a half frame as a transmission unit. **Proposal 6: F**or the transmission pattern of on-demand SSB: * For Case 1, support Option 1;
* For Case 2, prioritize Option 2 and Option 3 and further discuss their details.
 |
| [7] vivo | **Proposal 7:** A unified design of on-demand SSB transmission in Scenario #2 and Scenario #2A is preferred.**Proposal 22:** 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:** Time instance A on the active SCell would be a processing time T after the slot where UE transmits HARQ-ACK corresponding to the indication signalling.**Proposal 9:** The starting position on on-demand SSB SCell is the slot whose starting boundary is overlapping with time instance A. |
| [8] Nokia | **Proposal-6:** Option 1, Option 2 and Option 3 are supported for further detailed discussions. The value of Instance B and/or N and/or Instance A can be configurable via the SCell configuration. The Instance B can also be configurable or implicitly derived based on transmission/reception of corresponding UE measurement report.**Observation-1:** The time instance when the on-demand SSB burst transmission is started may depend on the signalling used to indicate/trigger on-demand SSB, e.g. RRC, MAC-CE or L1 signalling.**Proposal-7:** Alt 3-1 or Alt 1-1 is preferable as these may work with more than one type of triggers used. Alt 2 can be also considered. FFS: the value of starting offset T is included in on-demand-SSB activation signaling. |
| [9] Apple | **Proposal 7:** Agree Option 1A for OD-SSB bursts assumed by UE with the following modifications:* Option 1A: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A until time instance B ~~gNB turns OFF the on demand SSB~~
	+ Time instance A is T1 [slots or symbols] after the [slot or symbol] where UE receives a signalling of indication of OD-SSB transmission.
	+ Time instance B is T2 [slots or symbols] after the [slot or symbol] where UE receives a signaling of indication of OD-SSB termination.
	+ The value or candidate values of T1 and T2 should consider UE’s preparation time which is up to RAN4.
 |
| [10] InterDigital | **Proposal 4:** RAN1 to prioritize the following options for OD-SSB transmission:* 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: A, N values.
 |
| [11] CATT | **Proposal 11:** 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 12:** For SSB burst(s) triggered by on-demand SSB SCell operation, if MAC-CE is supported as the triggering signalling, UE expects that on-demand SSB burst(s) is transmitted from time instance A determined by Alt 3-2: * Time instance A is the first transmission occasion of on-demand SSB burst T [slots or symbols] after the [slot or symbol] where UE transmits HARQ-ACK corresponding to a signalling from gNB to trigger on-demand SSB

**Proposal 13:** For SSB burst transmission, the time instance B could be associated with predefined SSB termination events. |
| [12] China Telecom | **Observation 12:** The termination mechanism of on-demand SSB is needed to balance the performance and energy consumption.**Proposal 10:** Support to introduce a new signal and mechanism to terminate the transmission of on-demand SSB. |
| [13] CMCC | **Proposal 4:** Regarding the options for SSB burst(s) indicated by on-demand SSB SCell operation in Scenario#2, Option 2 and Option 3 can be considered.**Proposal 7:** Regarding the options for SSB burst(s) indicated by on-demand SSB SCell operation in scenario#2A, Option 1A and Option 4 can be considered.**Proposal 11:** Regarding the options for SSB burst(s) indicated by on-demand SSB SCell operation in scenario#3B, Option 1A and Option 4 can be considered. |
| [15] ZTE | **Observation 3:** If the on-demand SSB is periodically transmitted from time instance A without stopping, the gNB might hardly harvest network energy saving gain considering that multiple UEs may be served by a cell.**Proposal 6:** For timing for on-demand SSB transmission (e.g. when the triggered SSB ends), Option 1 should be excluded for all scenarios that support on-demand SSB.**Proposal 7:** For timing for on-demand SSB transmission (e.g. when the triggered SSB ends), Option 1A, Option 2 and option 3 can be considered for further discussion.**Observation 4:** Transmitting on-demand SSB and the triggering signaling at the same time brings a limitation for implementation of gNB.**Proposal 8:** On-demand SSB can be transmitted T [slots or symbols] after the triggering signaling is received or the HARQ-ACK corresponding to the triggering signaling is transmitted. |
| [16] Honor | **Proposal 4:** Support option 3 that on-demand SSB burst(s) is transmitted N times for both scenario #2, #2A and scenario #3A. |
| [17] Xiaomi | **Proposal 3:** Defer the following discussion until triggering message is nailed down.* Application timing between NW triggering message and on demand SSB transmission
* SSB transmission behaviour after on-demand SSB is triggered.
 |
| [18] Quectel | **Proposal 2:** Time instance B can be decided implicitly by gNB based on the measurement result reported by UE. |
| [19] Google | **Proposal 3:** Support Option 1A for on-demand SSB SCell operation* 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
 |
| [20] Lenovo | **Proposal 5:** Support either option 2 or option 3 for SSB burst(s) triggered by on-demand SSB SCell operation.* 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: 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 6:** The time instance A from which on-demand SSB is transmitted depends on which signaling (e.g., RRC, MAC CE or DCI) is used for triggering the SSB transmission. **Proposal 7:** UE assume that the time positions of on-demand SSBs are aligned with legacy, i.e., in the predefined time positions in a 5ms half-frame. |
| [21] Panasonic | **Proposal 4:** 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. |
| [22] ETRI | **Proposal 3:** It is proposed to discuss further the following options for on-demand SSB transmission:* ~~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.

**Observation 2:** The CSI reporting for the SCell can be used as the confirmation for the completion of SCell activation.**Proposal 4:** If Option 2 or Option 3 is adopted for on-demand SSB transmission, 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] Fujitsu | **Observation 2.** 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 on-demand SSB with another period value is triggered.**Observation 3.** From the perspective of network energy saving, it is beneficial that periodic on-demand SSB can be stopped at certain time instance, when or after the SCell state is deactivated.**Proposal 3.** For periodic on-demand SSB transmission, support the following options.* Option 1A. On-demand SSB is periodically transmitted from time instance A until stopped by explicitly indication from gNB
* Option 2: On-demand SSB is transmitted from time instance A to time instance B and not transmitted after time instance B.
* Time instance A can be determined by the periodicity and offset provided by on-demand SSB configuration or triggering signaling
* Time instance B can be defined by the ending time of a time window provided by on-demand SSB configuration or triggering signaling.

**Observation 4.** In Scenario #2A and Case #2 (i.e., when the SCell activation command is received in the case where there is periodic always-on SSB), aperiodic SSB transmission is beneficial to enable faster SCell activation.**Proposal 4.** in scenario #2A and Case #2, support aperiodic SSB transmission with the following option.* Option 3. On-demand SSB is transmitted N times after time instance A and then not transmitted after N transmission times have been completed.
* Time instance A can be determined by a (pre-)configured time offset after the on-demand SSB triggering signaling.
* FFS how to define the value of N.
 |
| [25] Transsion | **Proposal 3** It is recommended that on-demand SSB should be a periodic signal.**Proposal 4** It is recommended that on-demand SSB burst(s) transmitted N times after time instance A can be supported. |
| [26] OPPO | **Proposal 11:** Consider Option 2 or Option 3 for SSB burst(s) triggered by on-demand SSB SCell operation. |
| [27] LG Electronics | **Proposal #8:** Consider the following alternatives to define time instance A. * Alt-1 : N slot(or symbol or frames) after the slot/symbol where UE receives a signaling to trigger on-demand SSB or transmits HARQ-ACK as a response to the signaling. (e.g. N = 1 or N > 1)
* Alt-2: The first pre-configured SSB transmission occasion after UE receives a signaling to trigger on-demand SSB or transmits HARQ-ACK as a response to the signaling

**Proposal #9:** Consider the following alternatives to define time instance B. * Alt-A: N slot(or symbol or frames) after the slot/symbol where UE receives a signaling to disable on-demand SSB or transmits HARQ-ACK as a response to the signaling. (e.g. N = 1 or N > 1)
* Alt-B: The slot where on-demand SSB burst(s) transmission is completed N times or a time window starting from time instance A ends (where N or duration of time window can be configured by gNB, N=1 or N>1)
* Alt-C: The time when the present Scenario(e.g. Scenario#2)is transited to the next Scenario(e.g. Scenario# 2A)

**Proposal #10:** Options 2 and 3 should be prioritized for On-demand SSB TX behavior, * Option 1 is not suitable for Network Energy Saving
 |
| [28] NTT DOCOMO | **Proposal 5:** On-demand SSB transmission can be started and stopped before SCell is activated (in scenario#2).* Support on-demand SSB transmission of Option 1A and either one of Option 2 and 3 before SCell is activated (in scenario#2).
* Not support on-demand SSB transmission of Option1 and Option4 before SCell is activated (in sce-nario#2)

**Observation 2:** On-demand SSB is beneficial during SCell activation procedure to avoid both long activation delay and high NW energy consumption.**Proposal 7:** On-demand SSB transmission can be started with SCell activation procedure and shall not be stopped during SCell activation (in scenario #2A)* Support on-demand SSB transmission either one of Option2 and 3 during SCell activation (in sce-nario #2A).
	+ FFS: Option4 if scenario#3B with case 1 is not allowed
* Not support on-demand SSB transmission of Option1 and 1-A during SCell activation (in scenario #2A).
 |
| [29] Sharp | **Observation 2:** Before discussing the duration of triggered on-demand SSB transmission, the applicable (on-demand) SSB transmission after SCell activation completion needs to be clarified. |
| [30] 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. |
| [31] Ericsson | **Observation 4** Regarding SSB burst(s) triggered for on-demand SSB SCell operation, all the patterns listed in the past agreement (Options 1, 1A, 2, 3, 4) can be implemented with mechanisms to start/stop on-demand SSB with a specified periodicity and with mechanisms to switch periodicity. |
| [33] Mavenir | **Proposal 2:** for on-demand SSB burst transmission, the Option 1 and 1A could be supported as default.**Proposal 3:** for on-demand SSB burst transmission, the Option 2 and 3 could better be supported, while Option 4 is not preferred. |
| [35] Qualcomm | **Observation 2:** When/how gNB triggers on-demand SSB transmission is transparent to the UE. However, the gNB should indicate the configuration of on-demand SSB transmission to the UE.**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. |
| [38] CEWiT | **Proposal 4:** Support gNB transmitting the on demand SSB for a duration of time after receiving the UL WUS.**Proposal 6:** 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 SSBOption 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)
 |

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

* Option 1
	+ Supported by Samsung (for Case #1), Nokia, InterDigital, Mavenir
	+ Objected by ZTE, ETRI, LG Electronics, NTT DOCOMO
* Option 1A
	+ Supported by Apple (with some modification), InterDigital, CATT, CMCC (for Scenario #2A), ZTE, Google, Fujitsu (for Scenario #2), NTT DOCOMO (for Scenario #2), Mavenir, CEWiT
* Option 2
	+ Supported by Huawei, Spreadtrum, Samsung (for Case #2), Nokia, CATT, CMCC (for Scenario #2), ZTE, Fujitsu (for Scenario #2), OPPO, LG Electronics, NTT DOCOMO (for Scenario #2/2A), Mavenir, CEWiT
* Option 3
	+ Supported by Samsung (for Case #2), vivo, Nokia, InterDigital, CATT, CMCC (for Scenario #2), ZTE, Honor, Fujitsu (for Scenario #2A), Transsion, OPPO, LG Electronics, NTT DOCOMO (for Scenario #2/2A), Mavenir, CEWiT
* Option 4
	+ Supported by Futurewei, Huawei, CMCC (for Scenario #2A)
	+ Objected by Mavenir

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| **Proposal #4-1b (Time instance A) from R1-2403765:*** For SSB burst(s) triggered by on-demand SSB SCell operation, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined by one of the followings.
	+ Alt 1-1: Time instance A is T [slots or symbols] after the [slot or symbol] where UE receives a signalling from gNB to trigger on-demand SSB
	+ Alt 1-2: Time instance A is T [slots or symbols] after the [slot or symbol] where UE transmits HARQ-ACK corresponding to a signalling from gNB to trigger on-demand SSB
	+ Alt 2: Time instance A is the [frame or slot or symbol] where gNB indicates/configures with a signalling from gNB to trigger on-demand SSB
	+ Alt 3-1: Time instance A is the first transmission occasion of on-demand SSB burst T [slots or symbols] after the [slot or symbol] where UE receives a signalling from gNB to trigger on-demand SSB
		- The candidate transmission occasions of on-demand SSB burst are provided by gNB in advance.
	+ Alt 3-2: Time instance A is the first transmission occasion of on-demand SSB burst T [slots or symbols] after the [slot or symbol] where UE transmits HARQ-ACK corresponding to a signalling from gNB to trigger on-demand SSB
		- The candidate transmission occasions of on-demand SSB burst are provided by gNB in advance.
	+ The value of T (≥ 0) in Alts 1-1, 1-2, 3-1, and 3-2 is up to RAN4
	+ 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”
 |

In addition, companies’ preference among above alternatives is as follows.

* Alt 1-1
	+ Huawei, Nokia, Fujitsu
* Alt 1-2
	+ vivo, ZTE
* Alt 2
	+ Fujitsu
* Alt 3-1
	+ Huawei, Nokia
* Alt 3-2
	+ CATT

It seems better to discuss first how to define time instance A which is the common factor of five options in the previous agreement. In this sense, Proposal #4-1b in R1-2403765 could be taken as a starting point.

### Proposal #4-1 (Time instance A):

* For SSB burst(s) triggered by on-demand SSB SCell operation, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined by one of the followings.
	+ Alt 1-1: Time instance A is T [slots or symbols] after the [slot or symbol] where UE receives a signalling from gNB to trigger on-demand SSB
	+ Alt 1-2: Time instance A is T [slots or symbols] after the [slot or symbol] where UE transmits HARQ-ACK corresponding to a signalling from gNB to trigger on-demand SSB
	+ Alt 2: Time instance A is the [frame or slot or symbol] where gNB indicates/configures with a signalling from gNB to trigger on-demand SSB
	+ Alt 3-1: Time instance A is the first transmission occasion of on-demand SSB burst T [slots or symbols] after the [slot or symbol] where UE receives a signalling from gNB to trigger on-demand SSB
		- The candidate transmission occasions of on-demand SSB burst are provided by gNB in advance.
	+ Alt 3-2: Time instance A is the first transmission occasion of on-demand SSB burst T [slots or symbols] after the [slot or symbol] where UE transmits HARQ-ACK corresponding to a signalling from gNB to trigger on-demand SSB
		- The candidate transmission occasions of on-demand SSB burst are provided by gNB in advance.
	+ The value of T (≥ 0) in Alts 1-1, 1-2, 3-1, and 3-2 is up to RAN4
	+ 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”

Companies are encouraged to provide views on Proposal #4-1 and preference among listed alternatives.

|  |  |
| --- | --- |
| Company | Views |
| InterDigital | Open to any of Alt 1-1 and Alt 1-2 |
| Xiaomi | We are generally fine with the proposal. However, it should be clarified that the proposal is specific for on-demand SSB triggered by gNB.If this proposal is intended for gNB-trggered OD-SSB, it highly depends on the triggering signal. For example, it is typical that HARQ-ACK feedback is only for PDSCH not for PDCCH. Hence, it may be better to defer this proposal until we have big picture on triggering signaling. |
| LGE  | Prefer Alt 1-2, Alt 3-2 to Alt 1-1, Alt 3-1. We think that T in Alt1 or Alt3 can be configurable, and T is more than or equal to the minimum requirement by RAN4  |
| ZTE, Sanechips | We prefer Alt 1-1 and Alt 1-2. |
| Futurewei | We prefer Alt 2 |
| Vivo | if we assume different numerology for the SCell with on-demand SSB transmission and a cell transmitting the indication signaling, the time instant A should be described based on SCell’s numerology. Based on this, we think the time instance A is the first slot/symbol overlapped with time instant A’, where the time instant A’ is described as in Alt 1 or Alt 2. |
| ETRI | We prefer Alt 3-1 and Alt 3-2 |
| Huawei & Hisilicon | We support narrowing down the options to Alt 1-1 and/or Alt 3-1. Alt 2 should be excluded, since the signaling/processing delay between the indication and SSB transmission will definitely cause the failure of receiving some SSB bursts. In regard to Alt 1-2 and Alt 3-2, there is no need for UE to wait for HARQ-ACK transmission timing if the signaling indicating the activation of on-demand SSB is successfully decoded by the UE, once the gNB receive the ACK form the UE it will know for sure that the UE has already started receiving OD-SSBs and then judge the reliability of the UE reports.  |
| OPPO | We prefer Alt 1-1 and Alt 1-2. |
| CATT | OK |

# L1/L3 measurement based on on-demand SSB

|  |  |
| --- | --- |
| Company | Views |
| [1] Futurewei | **Proposal 6:** For on-demand SSB based L1 and/or L3 measurement, reuse existing L1 and L3 measurement and reporting mechanisms designed for always-on SSB. |
| [3] Huawei | **Proposal 4:** On-demand SSB-based L1/L3 measurement procedure on configured or activated SCell can follow legacy procedure.**Proposal 5:** Measurement requirements of on-demand SSB-based L3 measurement on neighbour cells for SCell change needs to be discussed in RAN4. |
| [4] Intel | **Proposal 7:** On-demand SSB should enable or aid (at least) RRM measurement for Scells after Scell configuration. |
| [7] vivo | **Proposal 5:** L3 measurement based on on-demand SSB should be supported in Scenario #2. Both L1 measurement and L3 measurement based on on-demand SSB should be supported in Scenario #2A.**Observation 2:** UE cannot report the measurement result based on on-demand SSB when the configured threshold is not satisfied if the report configuration is set as ‘event trigger’.**Proposal 6:** How to avoid the problem that UE cannot report the measurement result based on on-demand SSB should be further studied. |
| [8] Nokia | **Observation-2:** Practically, for SSB-less SCell operation with co-located FR1 Inter-band CA scenario, the receive time difference (RTD) requirement between the reference cell and SSB-less Scell may not always be fulfilled, even if the UE is reporting its capability of supporting SSB-less SCell operation with co-located Inter-band CA scenario.**Observation-3:** Currently the network blindly configures the SSB-less SCell to the UE, where the NW does not have the prior-knowledge of whether or not the UE is able to operate properly on the SSB-less SCell with respect to the RTD requirement.**Observation-4:** UE measurements, such as RTD evaluation based on NW triggered on-demand SSB transmission in SSB-less SCell, can be quite important, where the corresponding UE measurement reporting may assist the network decision to configure or not for UE operation in such an SSB-less SCell.**Proposal-9:** RAN1 to clarify the motivation of utilizing on-demand SSB before specifying the details on L1 and/or L3 measurement. |
| [11] CATT | **Proposal 14:** For L1 and/or L3 measurement based on on-demand SSB, RAN1 should focus on L1 measurement while let RAN2/RAN4 take the lead on the requirement for L3 measurement.**Proposal 15:** For L1 measurement/report based on on-demand SSB, legacy SS-RSRP, SS-RSRQ, SS-SINR procedure can be reused. CSI framework can be used to configure additional measurement.**Proposal 16:** Both semi-persistent report and aperiodic report could be considered for on-demand SSB. |
| [16] Honor | **Proposal 3:** De-prioritize to discuss of L1 and/or L3 measurement based on on-demand SSB after the scenarios and transmission pattern is agreed. |
| [21] Panasonic | **Proposal 3:** Before both before and after SCell activation, on-demand SSB based L1/L3 measurement should be supported and follow legacy procedure as much as possible. |
| [23] NEC | **Proposal 11:** Send LS to RAN2 asking the requirements for SCell SSB measurements for RRM considering both periodic and event-triggered reporting.**Proposal 12:** Discuss how/whether to enable on demand SSB transmission on a cell for RRM which is yet to be configured as a serving cell. |
| [26] OPPO | **Proposal 2:** L1 and/or L3 measurement based on on-demand SSB should be performed in Scenario #3A phase no matter the on-demand SSB indication is received in Scenario #2 or Scenario #2A. |
| [27] LG Electronics | **Proposal #11:** Discuss the following aspects to support L1 and/or L3 measurement based on on-demand SSB. * Which one of L1 and L3 measurements can be applicable to each of Scenarios/Cases
* Whether both always-on SSB and on-demand SSB are utilized for measurement or not
* How to configure and trigger/activate CSI reporting for L1 measurement based on-demand SSB
 |
| [28] NTT DOCOMO | **Observation 3:** On-demand SSB during activated SCell operation (in scenario #3B) is used for normal SCell operation e.g., for monitoring PDCCH on SCell and L1/L3 measurement.**Proposal 8:** Support indication and transmission of on-demand SSB for efficient L1/L3 measurement after SCell is activated (in scenario#3B). * At least case#2 to be supported, FFS: case#1.
* Consider group-common DCI signalling for indication of on-demand SSB for better NES operation same as scenario#2.
 |
| [31] Ericsson | **Observation 6** Current minimum measurement cycle for deactivated SCell (160 ms) results in slow SCell activation for Scenario #2.**Proposal 7** Study faster deactivated SCell measurement mechanism and reporting upon on-demand SSB transmission indication. |
| [35] Qualcomm | **Proposal 5:** Reuse the existing L1/L3 SSB-based measurement and reporting framework for the L1/L3 measurement and reporting based on on-demand SSB.* UE expects that on-demand SSBs for cells configured for L1/L3 measurements are periodically transmitted.
* FFS: whether to define a duration in which the UE is expected to perform L1/L3 measurement.
 |

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

* Reuse existing L1/L3 measurement/reporting mechanisms
	+ Futurewei, Huawei, CATT, Panasnoic, Qualcomm
* vivo: L3 measurement for Scenario #2 and L1/L3 measurement for Scenario #2A
* Ericsson: Faster measurement mechanism for deactivated SCell
* Panasonic: L1/L3 measurement before/after SCell activation
* Huawei: Measurement requirement up to RAN4
* Nokia: RTD measurement report

Several companies pointed out that legacy mechanisms for L1/L3 measurement can be reused as much as possible. Having this in mind, the following proposal can be made.

### Proposal #5-1 (L1/L3 measurement):

* Support L3 measurement based on on-demand SSB which is transmitted before the UE receives SCell activation command and after the SCell is configured to the UE.
* Support L1 and L3 measurement based on on-demand SSB which is transmitted after the UE receives SCell activation command.
	+ 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

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

|  |  |
| --- | --- |
| Company | Views |
| InterDigital | Support Proposal #5-1 |
| Xiaomi | OK with the proposal. At this stage, it may be safer to delete the sub bullets under second bullet. |
| LGE | Support the proposal. And, it should be considered that on-demand SSB is not always transmitted differently form always-on SSB. For instance, if UE assumes that on-demand SSB is not transmitted any more, UE can automatically stop measuring on-demand SSB  |
| Futurewei | OK with L1 measurement, L3 measurement can be left for higher layers definition or reuse existing mechanism. |
| Spreadtrum | L3 measurement for SCell has been widely discussed in RAN2. RAN1 focuses on L1 measurement, e.g. RLM/BFD/BM, and RAN2 focuses on L3 measurement. |
| Vivo | For L3 measurement, RAN1 can further study the measurement reporting method, e.g., reporting resource. |
| Huawei & Hisilicon | Okay with the Proposal. |
| OPPO | Before the UE receives SCell activation command and after the SCell is configured to the UE, legacy UE behaviour should be maintained, i.e., the UE can perform L3 measurement based on on-demand SSB if it is within a SMTC window. |
| CATT | Agree with spreadstrum that we need to let ran2 lead on L3 measurement |

# UE-triggered on-demand SSB operation

|  |  |
| --- | --- |
| Company | Views |
| [5] Spreadtrum | **Observation 7:** UL WUS to SCell may be feasible, if UL WUS is a PRACH (preamble).**Observation 8:** UL WUS to SCell may not be necessary.**Observation 9:** UL WUS to PCell is feasible.**Observation 10:** Whether UL WUS to PCell is necessary should be further studied.**Proposal 13:** If triggering method of UL WUS is supported, UE should transmit UL WUS to PCell. |
| [6] Samsung | **Proposal 4:** Support UE triggered on-demand SSB based on UL WUS. |
| [9] Apple | **Proposal 9:** 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.
 |
| [10] InterDigital | **Observation 3:** Transmitting OD-SSB in time occasions expected by the UE (e.g. for making timely measurements and reporting) can reduce the Scell activation delay**Proposal 6:** Support UL WUS for requesting on-demand SSB transmission at SCell**Proposal 7:** Support using PRACH preamble on the PCell as UL WUS for requesting OD-SSB on the SCell**Observation 4:** For OD-SSB SCell operation, the conditions for triggering UL WUS can be initially discussed in RAN2. Any L1-related triggering conditions can be discussed in RAN1 |
| [11] CATT | **Proposal 3:** 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 4:** 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 5:** 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 6:** 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).
 |
| [13] CMCC | **Observation 2:** Compared with “SR/BSR + gNB triggered on-demand SSB”, the scheme “UL WUS + on-demand SSB with or w/o gNB confirmation” may save UL transmission and BSR transmission and provide lower total SCell activation latency, but the additional network power saving gain is uncertain.**Proposal 3:** For on-demand SSB SCell operation in Scenario #2, the motivation and potential NES gain should be clarified for UL WUS triggered on-demand SSB. |
| [14] Sony | **Proposal 1:** RAN1 should support on-demand SSB Scell operation triggered by UE. |
| [16] Honor | **Proposal 6:** Support UE triggered on-demand SSB SCell operation.Observation 2: One way for UE triggered on-demand SSB SCell operation is to send the on-demand request via PCell.**Proposal 7:** UCI, such as new SR or MAC CE can be used as on-demand request sent to the PCell.**Observation 3:** UE directly sending WUS to the SCell is another possible way for UE triggered on-demand SSB SCell operation.**Proposal 8:** Dedicated PRACH or SRS can be considered as the WUS sent to the SCell. |
| [17] 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. |
| [19] Google | **Proposal 4:** 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 5: 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
 |
| [20] 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). |
| [23] NEC | **Proposal 6:** Specify on-demand SCell SSB request based on the cause of UE request. **Proposal 7:** UE request for on-demand SSB on SCell may be sent via PCell dynamically via configured PUCCH or SR resources.**Proposal 9:** Define dropping rule for multiple UEs’ on-demand SSB requests to maximize network energy saving.**Proposal 14:** UE may repeat the on-demand SSB request a configurable number of times before triggering the SCell On-demand SSB Failure indication. |
| [24] Fujitsu | **Proposal 7.** For UE uplink wake-up-signal, further clarification on useful use case(s) is needed. |
| [26] OPPO | **Proposal 10:** Support on-demand SSB SCell operation triggered by UE. |
| [27] LG Electronics | **Proposal #12:** For the on-demand SSB operation triggered by UE uplink wake-up-signal for an SSB-less 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 SSB-less SCell becomes lower than a given threshold
* When DL reception timing difference between SSB-less SCell and its associated reference cell(s) becomes larger than a given threshold

**Proposal #13:** 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 #14:** 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 SSB-less SCell after UE transmits uplink wake-up-signal. |
| [28] NTT DOCOMO | **Observation 1:*** 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 2:*** 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.
 |
| [33] Mavenir | **Proposal 5:** UE-triggered method of on-demand SSB transmission should also be supported. |
| [35] Qualcomm | **Observation 3:** 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 6:** Wake-up signal from the UE to trigger on-demand SSB transmission is not supported. |
| [36] ASUSTeK | **Observation 1:** On-demand SSB is beneficial for the scenarios for turn-off SCell and SSB-less SCell.**Proposal 1:** On-demand SSB is supported for turn-off SCell and SSB-less SCell.**Proposal 2:** On-demand SSB is provided when SCell turns on for turn-off SCell. On-demand SSB is provided upon request from a UE for SSB-less SCell.**Observation 2:** To support a unified triggering method for on-demand SSB, uplink wake up signal from UE is used to trigger on-demand SSB.**Proposal 4:** On-demand SSB on SCell is triggered by uplink wake up signal on PCell from UE. |
| [37] Fraunhofer | **Observation 1:** In some cases, an uplink trigger for on-demand SSB is preferred. In other cases, a downlink trigger can be used.**Proposal 2:** RAN1 should consider and evaluate uplink triggering for on-demand SSB (uplink wake-up signal), in addition to the already agreed downlink triggering. |
| [38] CEWiT | **Observation 1:** Triggering method depends on the separation between Pcell and Scell and the assumption on backhaul link.**Proposal 1:** Support UE UL WUS as a trigger for on demand SSB.**Proposal 2:** Following alternatives can be considered for the signals to be used as UL WUS by UEAlt.1. an UL signal configured by PCellAlt.2. a predefined sequence.**Proposal 3:** Following alternatives can be considered to provide resources of the trigger.Alt.1. Configured by PCellAlt.2. Predefined in specification.**Proposal 5:** Support study on UE behavior in case of no response from gNB after UL WUS transmission. |

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

* Positive view: Samsung, InterDigital, CATT, CMCC?, Sony, Honor, Xiaomi, Google, Lenovo, NEC, Mavenir, ASUSTeK, Fraunhofer, CEWiT
* Negative view: Spreadtrum?, Fujitsu, NTT DOCOMO, Qualcomm

The main argument of opponents seems to be that more information is known to the gNB than to the UE, so UE-triggered on-demand SSB operation may not be needed. However, proponents identified at least the following cases where UE has more knowledge than the gNB or UE-triggered on-demand SSB could benefit.

* Samsung
	+ Example 1: For an activated SCell, a UE may experience beam failure and initiate a beam failure recovery (i.e., on-going Rel-19 MIMO feature), and for such scenario, the UE could request the proper SSB beam or report the improper SSB beam since it has better knowledge other than the gNB. For this scenario, the supporting of on-demand SSB can be an accompany feature to facilitate fast beam failure recovery initiated by the UE, observing that the legacy failure recovery procedure relying on periodic SSB may have much longer delay.
	+ Example 2: For a configured but not activated SCell, a UE may have overloaded UL traffic which may not be known by the gNB yet (e.g., by UL MAC CE to report the buffer status), and requires the activation of the SCell to offload the UL traffic. For this scenario, triggering on-demand SSB for fast SCell activation can be a more efficient procedure than reporting the uplink buffer to the gNB and waiting for the gNB to trigger the SCell activation.
	+ Example 3: For an activated SCell, a UE may lose its synchronization after a long duration without receiving data from the gNB. For this scenario, triggering on-demand SSB for fast SCell re-synchronization can be a more efficient procedure than utilizing the periodic SSB with long periodicity (assuming CSI-RS/TRS is not implemented in the cell), since typically multiple SSB bursts are needed for the re-synchronization procedure which leads to a longer delay.
* InterDigital
	+ Such conditions can include those related to UL data arrival, measurements of pathloss RS, DL synchronization with Scell and timing alignment with Scell.
* Google
	+ 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
* OPPO
	+ in case of non-ideal backhaul, on-demand SSB SCell operation triggered by UE can reduce the impact of backhaul delay and speed up SCell activation procedure.
* LG Electronics
	+ 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 SSB-less SCell becomes lower than a given threshold
	+ When DL reception timing difference between SSB-less SCell and its associated reference cell(s) becomes larger than a given threshold. It is noted that for Rel-18 SSB-less SCell (i.e., inter-band CA case), gNB may not be able to know whether DL reception timing related condition (i.e., RTD ≤ 3 usec) is satisfied at UE side or not.
* Mavenir
	+ the gNB triggers the transmission of on-demand SSB but UE doesn’t receive it.

### Proposal #6-1 (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 #6-1.

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| --- | --- |
| Company | Views |
| InterDigital | Support Proposal #6-1 |
| Xiaomi | Support. |
| LGE | Support the proposal |
| Futurewei | We think that UE trigger/request is not necessary to be defined. The above cases may be covered using BFR / BSR mechanisms unless proponents can provide justifications. Note that R19 MIMO has an objective on UE initiated BM for BFR related enhancements. |
| Spreadtrum  | UE triggered on-demand is not suitable for Scenario #2 or 2A or 3A, since these scenario has DL based event hidden in the back (gNB wants to activate SCell for UE as soon as possible). For Scenario #3B, PDCCH-order command means UE out of UL sync and then CFRA-based PRACH may be UL triggering signaling (UE tells gNB that DL sync is problematic). It may be feasible. Anyway, we can only study UL triggering of on-demand SSB for Scenario #3B. |
| Vivo | No, gNB knows UE’s information and decides when to trigger on-demand SSB, there is no need for UE to send the request. |
| Huawei & Hisilicon | We do not support UE triggering for OD-SSB. The different reports the gNB receive from the UE(s) are sufficient for the gNB to take a decision for activation/deactivation of OD-SSB. An additional form of feedback/report (in the form of explicit UE demand for OD-SSB) does not seems to be necessary.  |
| OPPO | Support. |
| CATT | OK |

# Further details on on-demand SSB operation

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| --- | --- |
| Company | Views |
| [1] Futurewei | **Proposal 3:** Clarify the relation between the always-on SSB and on-demand SSB for the same cell:* 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.
 |
| [6] Samsung | **Proposal 2:** SSB structure and SSB mapping pattern in a half frame for the on-demand SSB maintain the same as legacy. |
| [7] vivo | **Proposal 13:** To support on-demand SSB operation, further discuss the collision between on-demand SSB transmission and other transmissions. |
| [11] CATT | **Proposal 17:** From UE’s perspective, multiple activated on-demand SSBs being effective at the same time for a cell should not be allowed. |
| [19] Google | **Proposal 6:** For non-UE dedicated signals, the rate matching pattern should be based on the activated SSBs.**Proposal 7:** For UE-dedicated signals, the rate matching pattern should be based on SSB configured in *ssb-positionInBurst*. |
| [23] NEC | **Proposal 8:** For collision handling between always-on and on-demand SSB burst(s), consider always-on SSB may have higher priority than on-demand SCell SSB request.**Proposal 15:** 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 16:** RAN1 to discuss PDSCH rate matching around on-demand SSB. |
| [25] Transsion | **Proposal 6** It is recommended that the feasibility of joint use of on-demand SSB transmission and cell DTX can be studied. |
| [26] LG Electronics | **Proposal #5:** Discuss how to handle the case where synchronization acquisition is problematic after UE receives SCell activation/deactivation signaling.**Proposal #15:** 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 #16:** 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 #18:** Consider to deactivate SSB transmitted based on on-demand SSB procedure during cell DTX non-active period. |

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

* Relation between always-on SSB and on-demand SSB
	+ Futurewei
* Whether to change the structure of SSB triggered by on-demand SSB operation
	+ NO: Samsung
* Whether/how to handle collision issue between SSB and other signals/channels
	+ vivo, LG Electronics
* Whether/how to handle rate-matching issue
	+ Google, NEC
* Whether/how to allow overlapping of always-on SSB and on-demand SSB
	+ NEC
* Whether/how to allow overlapping of multiple on-demand SSBs
	+ CATT
* Whether/how to handle the case where UE cannot receive SSB after on-demand SSB operation
	+ NEC, LG Electronics
* Joint operation of cell DTX and on-demand SSB
	+ Transsion, LG Electronics

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 |
| LGE | If there are enough time in this meeting, we are open to discuss the further details.  |
|  |  |

# Reference

1. R1-2403869 Discussion of on-demand SSB Scell operation FUTUREWEI
2. R1-2403896 On-demand SSB SCell operation Tejas Networks Limited
3. R1-2403960 On-demand SSB SCell operation for eNES Huawei, HiSilicon
4. R1-2403978 Design of on-demand SSB SCell operation Intel Corporation
5. R1-2404032 Discussion on on-demand SSB SCell operation Spreadtrum Communications
6. R1-2404121 On-demand SSB SCell operation Samsung
7. R1-2404183 Discussions on on-demand SSB Scell operation vivo
8. R1-2404223 On-demand SSB SCell Operation Nokia, Nokia Shanghai Bell
9. R1-2404293 On-demand SSB SCell Operation Apple
10. R1-2404332 Discussion on on-demand SSB SCell operation InterDigital, Inc.
11. R1-2404407 Discussion on on-demand SSB SCell operation CATT
12. R1-2404433 Discussion on on-demand SSB operation for SCell China Telecom
13. R1-2404462 Discussion on on-demand SSB SCell operation CMCC
14. R1-2404506 On-demand SSB SCell operation Sony
15. R1-2404560 Discussion on on-demond SSB for NES ZTE, Sanechips
16. R1-2404577 Discussion on on-demand SSB SCell operation HONOR
17. R1-2404624 Discussion on on-demand SSB SCell operation Xiaomi
18. R1-2404648 On-demand SSB Scell operation Quectel
19. R1-2404689 On-demand SSB SCell Operation Google
20. R1-2404697 On-demand SSB SCell operation Lenovo
21. R1-2404757 Discussion on on-demand SSB SCell operation Panasonic
22. R1-2404779 Discussion on On-demand SSB SCell operation ETRI
23. R1-2404795 Discussion on on-demand SSB for SCell operation NEC
24. R1-2404807 Discussion on on-demand SSB SCell operation Fujitsu
25. R1-2404819 Discussion on On-Demand SSB SCell operation Transsion Holdings
26. R1-2404858 Discussion on the enhancement to support on demand SSB SCell operation OPPO
27. R1-2404894 On-demand SSB SCell operation LG Electronics
28. R1-2405048 Discussion on on-demand SSB SCell operation NTT DOCOMO, INC.
29. R1-2405070 Discussion on on-demand SSB SCell operation Sharp
30. R1-2405084 On-demand SSB SCell operation MediaTek Inc.
31. R1-2405105 On-demand SSB SCell operation Ericsson
32. R1-2405114 Discussion on On-demand SSB SCell operation ITRI
33. R1-2405126 Discussion of On-demand SSB SCell operation Mavenir
34. R1-2405127 Discussion on on-demand SSB SCell operation CAICT
35. R1-2405161 On-demand SSB operation for Scell Qualcomm Incorporated
36. R1-2405201 On-demand SSB for SCell ASUSTeK
37. R1-2405211 On-demand SSB SCell operation for NES Fraunhofer IIS, Fraunhofer HHI
38. R1-2405246 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