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

**Maastricht, NL, August 19th – 23rd, 2024**

**Agenda Item:** 9.5.1

**Source:** Moderator (LG Electronics)

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

**Document for:** Discussion and decision

# Introduction

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

# General aspects (including use cases or scenarios)

## Scenarios and Cases

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| Company | Views |
| [1] Futurewei | **Observation 1:** The support of On-demand SSB for an activated SCell in cell DTX mode or in BWP level dormancy may be beneficial for NES.**Proposal 3:** 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 together with SCell activation command.
* Scenario #2: Deactivated SCell re-synchronization / measurement with on-demand SSB.
* Scenario #3A: OD-SSB after receiving SCell activation command and before SCell activation completion
* Scenario #3B: On-demand SSB for an activated SCell in cell DTX or cell dormancy.
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| [2] Huawei | **Proposal 1:** Support that on-demand SSB SCell operation can be triggered by gNB in* Scenario #3B and Case #1
* Scenario #3B and Case #2
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| [4] Spreadtrum | **Proposal 1:** Scenario #2 and Case #1 is supported in R19.**Observation 1:** When SCell is added to UE, UE can be configured with SSB by ServingCellConfigCommon, and UE can follow SMTC in ServingCellMO or in SCellConfig to perform serving cell measurement.**Proposal 2:** Scenario #2 and Case #2 can be supported in R19.**Proposal 3:** Scenario #2A and Case #1 is supported in R19.**Proposal 4:** Scenario #2A and Case #2 is supported in R19.**Proposal 5:** Whether to define on-demand SSB procedure dedicated for Scenario #3A/#3B and Case #1 depends on termination of on-demand SSB.**Proposal 6:** Whether to define on-demand SSB procedure dedicated for Scenario #3A/#3B and Case #2 depends on termination of on-demand SSB. |
| [6] 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, RRC signaling for SCell configuration or SCell activation command can be used to indicate on-demand SSB on NES SCell.**Proposal 7:** 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 9:** On-demand SSB SCell operation in Scenario #3A is not supported.**Proposal 10:** On-demand SSB SCell operation in Scenario #3B and Case #1/Case #2 can be supported. |
| [7] 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 4:*** 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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| [8] Nokia | **Observation-1:** Currently it is understood that the following two sub-cases are both included as part of Case#1:* Case#1-1: SSB-less SCell operation when the reference cell does not fulfill all the RAN4 requirements and on-demand SSB(OD-SSB) is needed to help with side conditions
* Case#1-2: Situations when legacy SSB-less operation is considered infeasible (e.g. non-collocated inter-band CA)

**Observation-2:** It is up to the network to decide when to configure SCell with OD-SSB for the UE and there is no need to discuss those details in RAN1.**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] China Telecom | **Observation1:** Scenario #2 and #2A are merged as one scenario if RRC based signalling for indicating on-demand SSB for Scell is adopted.**Proposal 1:** The parameter *sCellState* can also be used to indicate the on-demand SSB for SCell at the same time.**Proposal 3:** The scenario #3A and #3B can also be supported if the separate MAC CE activation of on-demand SSB is supported. |
| [10] vivo | **Proposal 1：**For on-demand SSB SCell operation, support Scenario #3A and it is up to gNB implementation to indicate on-demand SSB in Scenario #2A or Scenario #3A.**Proposal 2:** For on-demand SSB SCell operation, do not support Scenario #3B, i.e., on-demand SSB should not be indicated by gNB after SCell activation is complete.**Observation 1:** RAN4 input on the problem of SSB-less Scell is needed to verify the motivation to support on-demand SSB in SSB-less Scell.**Proposal 3:** Do not discuss support of on-demand SSB in SSB-less SCell where reference cell is configured until more RAN4 input is available. |
| [11] OPPO | **Proposal 1:** Support Case #1 and Case #2 for on-demand SSB SCell operation.**Proposal 3:** Transmit on-demand SSB indication in Scenario #3A is beneficial to fast SCell activation and can be supported. |
| [12] Xiaomi | **Proposal 2:** On-demand SSB can be triggered by gNB for the following scenarios/cases with the assumption that gNB indicates UE whether SSB is on or off:* Scenario #3A and Case #1
* Scenario #3A and Case #2
* Scenario #3B and Case #1
* Scenario #3B and Case #2

**Proposal 8:** For scell activation/deactivation signaling based SSB triggering, we need to first achieve common understanding on the relationship between on-demand SSB and Scell activation/deactivation signaling* Case1: Scell activation signalling based SSB triggering is only needed during SCell activation procedure. After SCell is activated, gNB has full power to control the SSB transmission
* Case2: SCell activation/deactivation signalling is reused as a mechanism to indicate UE SSB is on or off despite of scenario.
* Case3: On-demand SSB can be used to expedite SCell activation procedure. After SCell is activated, UE wake-up-signal can be used to trigger SSB.

**Proposal 9:** For on-demand SSB triggering mechanism in different scenarios* gNB based SSB triggering can be used in scenario #2, #2A, and #3A to expedite SCell activation procedure
* After SCell is activated, i.e., scenario #3B, both gNB based SSB triggering signal and UE wake-up-signal can be used to trigger SSB.
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| [13] 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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| [14] 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 good tradeoff between network energy saving and system performance.**Proposal 2:** Scenario #3B in conjunction with case #1 should be supported. |
| [16] 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 |
| [17] Fujitsu | **Proposal 2.** Regarding the remaining scenarios/cases that can be considered for triggering on-demand SSB, support the following scenario/case.* Scenario #3B and Case #1: After SCell activation procedure is completed when there is no always-on SSB
	+ On-demand SSB can be used for maintaining synchronization, RRM measurement and beam tracking.
 |
| [21] NEC | **Observation 1:** For Scenario #3B and Case#2, on-demand SSB transmission can improve the beam management performance for an activated SCell when the always-on SSB is transmitted with longer periodicity.**Proposal 1:** Support on-demand SSB operation for Scenario #3B Case #1 and Scenario #3B Case#2. Further discuss the applicability of Scenario#3A.**Proposal 27:** Discuss other cases (e.g. RACH initiation upon TAT expiry) for which on-demand SSB transmission may be required. |
| [22] Transsion | **Proposal 1** Scenarios 3A and Case #1 and Scenario #3B and Case #1 should be supported. |
| [24] 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. |
| [26] Panasonic | **Proposal 1:** On-demand SSB triggering timing is up to network implementation irrespective of UE situation. Therefore, scenario #3A/3B and Case 1/2should be also supported for on-demand SSB. |
| [27] Apple | **Observation 1:** There is no clear use case for Scenario #3A/3B with both Case #1 and Case #2.**Proposal 1:** Scenario #3A and #3B for both Case #1 and Case #2 are deprioritized.**Proposal 2:** The following use cases are considered for OD-SSB SCell operation.* UC#1 SCell activation/deactivation for intra/inter-band CA with collocated/non-collocated CA
* UC#2 Handover to the cell which was SCell
* UC#3 SSB-less operation for collocated CA
* UC#4 SSB-less operation for non-collocated CA
* UC#5 OD-SSB transmissions from multiple neighboring cells on the same frequency as SCells
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| [29] NTT DOCOMO | **Proposal 6:** In scenario3A, we have a concern about indication on-demand SSB which may change SSB properties that a UE uses for SCell activation procedure and increase unnecessary complexity of UE behavior.**Proposal 7:** In scenario3B and case1 and case2 where periodic always-on or on-demand SSB that are not turned off during scenario3B, same indication mechanism as scenario2 and case1 and 2 respectively can be support-ed at least for L1/L3 measurement based on on-demand SSB.**Proposal 8:** In scenario3B and case#1 where there can be no periodic SSB, study and consider indication mechanism of on-demand SSB.**Observation 4:** On-demand SSB during activated SCell operation (in scenario #3B) can be used for normal SCell operation e.g., for monitoring PDCCH on SCell.**Proposal 15:** 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).
	+ The SSB with longer SSB can be on-demand SSB triggered in the former scenario(s).
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| [30] Sharp | **Proposal 1** Support Scenario 3B and Case #1 for on-demand SSB for SCell operation. |
| [31] Qualcomm | **Proposal 2:** For a cell supporting on-demand SSB Scell operation, UE expects on-demand SSB is transmitted at least in scenarios 2/3 for Case #1 and at least in scenario 3A for Case #2. |

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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, vivo, OPPO, Xiaomi, CATT, InterDigital, Transsion, Panasonic, ETRI
	+ Objected by CMCC, ZTE, NTT DOCOMO
* Scenario #3A and Case #2
	+ Supported by Intel, vivo, OPPO, Xiaomi, CATT, InterDigital, ETRI, Panasonic
	+ Objected by CMCC, ZTE, NTT DOCOMO
* Scenario #3B and Case #1
	+ Supported by Huawei, CMCC, Intel, Xiaomi, CATT, ZTE, InterDigital, Fujitsu, NEC, Transsion, Panasonic, Sharp
	+ Objected by vivo, ETRI, Apple
* Scenario #3B and Case #2
	+ Supported by Huawei, CMCC, Intel, Xiaomi, InterDigital, NEC, Panasonic
	+ Objected by vivo, ETRI, Apple

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 |
| ZTE, Sanechips | Additional scenarios/cases (e.g., Scenario #3B and Case #1) should not be excluded when consider to design signaling methods under specific scenarios.  |
| LGE | We think that on-demand SSB can be triggered on Scenario #3B |
| Spreadtrum | We can discuss when to terminate on-demand SSB at first, before having conclusion for Scenario #3A and 3B |

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

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| Company | Views |
| [1] Futurewei | **Proposal 4:** Regarding the UE assumption on SSB transmission on a cell supporting on-demand SSB SCell operation, consider supporting 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 very long periodicity.
	+ The cell is barred for legacy UEs.

**Proposal 5:** At least for Case #1 and Case #2 support cell-defining SSB only. |
| [2] Huawei | **Proposal 2:** For on-demand SSB on the cell, it is up to gNB implementation whether on-demand SSB is * CD-SSB transmitted off sync raster
* NCD-SSB transmitted off sync raster
* NCD-SSB transmitted on sync raster.
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| [4] Spreadtrum | **Proposal 13:** On-demand SSB can be limited to non-cell-defining SSB. |
| [6] 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. |
| [7] Intel | **Proposal 2:** It is up to gNB implementation whether on-demand SSB is cell-defining SSB or not (Alt-1). |
| [8] Nokia | **Proposal-15:** Whether on-demand SSB is cell-defining or non-cell-defining should be left to network implementation. |
| [10] vivo | **Proposal 4:** For on-demand SSB on the cell, support Alt-2, i.e. on-demand SSB is limited to non-cell-defining SSB. |
| [11] OPPO | **Proposal 4:** Support on-demand SSB being limited to non-cell-defining SSB.**Proposal 5:** Separate on-demand SSB and always-on SSB if the always-on SSB is cell-defining SSB. |
| [12] Xiaomi | **Proposal 1:** On-demand SSB can be either CD-SSB or NCD-SSB. |
| [13] 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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| [14] ZTE | **Observation 6:** The impact of on-demand SSB operation on legacy UEs is manageable.**Observation 7:** The gNB can prevent the legacy UE from accessing the NES cell with on-demand SSB.**Proposal 18:** It is not necessary to restrict the SSBs on the on-demand SSB SCell to not cell-defining SSB. |
| [15] Sony | **Proposal 4:** 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 and on-demand SSB is configured as CD-SSB, access barring to legacy UEs should be also considered.
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| [16] InterDigital | **Proposal 3:** For OD-SSB on the cell, it is up to gNB implementation whether on-demand SSB is cell-defining SSB or not |
| [17] 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. |
| [18] LG Electronics | **Proposal #2:** On-demand SSB is limited to non-cell-defining SSB and clarify which one of the followings is defined as non-cell-defining SSB. * Alt-1: SSB using k\_ssb values or ranges which is predefined for not providing CORESET#0 and type0-PDCCH CSS set configuration
* Alt-2: SSB configured as *NonCellDefiningSSB*
* Alt-3: SSB not on the sync raster
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| [19] Samsung | **Proposal 2:** On-demand SSB should not be located on synchronization raster entries. * On-demand SSB can be further restricted to non-cell-defining SSB if no motivation is observed to use it for CGI reporting.
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| [21] NEC | **Proposal 3:** If on-demand SSB is not a CD-SSB, it can be transmitted on synch-raster with valid MIB as specified in [5, TS 38.213].**Proposal 4:** For Case#1, gNB does not need to newly trigger on-demand SSB for a UE if the SCell is already active for another UE (FFS: indication).**Proposal 5:** For Case#1, on-demand SSB is not expected to be deactivated as long as at least one UE is active on the Cell even when the SCell is deactivated for a UE for which the network triggered the on-demand SSB.**Observation 2:** 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 6:** 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 7:** 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.**Proposal 8:** For case#2, on-demand SSB can be transmitted in the same frequency as always-on SSB. In this case, on-demand SSB can be CD-SSB. |
| [22] Transsion | **Proposal 2** It is recommended that on-demand SSB limited to non-cell-defined SSBs can be supported. |
| [24] ETRI | **Proposal 2:** Regarding whether on-demand SSB is cell-defining or not, it prefers to leave it as gNB implementation, i.e., Alt-1. |
| [25] 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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| [26] Panasonic | **Proposal 2:** On-demand SSB is limited to non-cell-defining SSB. |
| [27] Apple | **Observation 2:** CD-SSB should be precluded as OD-SSB SCell operation to avoid impact on initial cell selection for both legacy and Rel-19 UE.**Observation 3:** Among two options to bar legacy/Rel-19 UEs during initial access, using NCD-SSB as OD-SSB is the better solution than using CD-SSB with ‘cellbarred=true’ in MIB. The option of CD-SSB with ‘cellbarred=true’ can result in require unnecessary follow-up process and cause power consumption accordingly at UE side.**Proposal 3:** CD-SSB should not be supported for OD-SSB.**Proposal 4:** Only NCD-SSB should be supported for OD-SSB. |
| [29] 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.
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| [31] 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). |
| [32] 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. |

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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 CMCC, Intel, Nokia, Xiaomi, CATT, ZTE, Sony, InterDigital, Fujitsu, NEC, ETRI, NTT DOCOMO
* Alt-2 (On-demand SSB is limited to non-cell-defining SSB)
	+ Supported by Huawei, Spreadtrum, vivo, OPPO, LG Electronics, Samsung, Transsion, MediaTek, Panasonic, Apple, Qualcomm, Ericsson?
		- Huawei: CD-SSB transmitted off sync raster, NCD-SSB transmitted off sync raster, or NCD-SSB transmitted on sync raster
	+ Concern: If a CD-SSB is used for on-demand SSB, it can lead to the impact to idle/inactive UEs’ behaviors.
* Futurewei: At least for Case #1 and Case #2 support cell-defining SSB only and the cell is barred for legacy UEs.

Company views seem to be evenly distributed. As pointed out by [32] Ericsson, it is observed that non-cell-defining on-demand SSB is already supported since this is the common factor of Alt-1 and Alt-2 of the above agreement. Furthermore, as stated in [19] Samsung, in order to avoid any potential confusion of UEs prior to Rel-19 or Rel-19 UEs without capability of supporting on-demand SSB, restricting on-demand SSBs from being located in the synchronization raster would be a safer choice.

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

* For a cell supporting on-demand SSB SCell operation,
	+ On-demand SSB on the cell is not located on synchronization raster.

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

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| Company | Views |
| Google | Support |
| DCM | Not support. The current spec. does not define any restrictions on SSBs which are used only for SCell (not for PCell). NW implementations can properly avoid any negative impacts, which are not acceptable by NW, on irrelevant UEs. |
| ZTE, Sanechips | Not support.From network perspective, if on-demand SSB is restricted to off-sync raster, the real use cases of applying on-demand SSB would be limited. And the NES gain of that NES cell would be questionable. In our view, we should aim at a trade-off mechanism.  |
| CMCC | Not support. If on-demand SSB is NCD-SSB located on synchronization raster, it can also avoid the negative impact on initial access of legacy UEs and R19 idle UEs. |
| LGE | Support  |
| Sharp | Do not support. We think the NW is responsible for avoiding ambiguity by NW implementation. There is no need to put such restriction. |
| Spreadtrum | Reasonable, but as legacy the specification may not mention it. |
| OPPO | Support |
| Xiaomi | We also think such kind of restriction is too much. Besides the approach proposed by CMCC, network can bar the legacy UE if CD-SSB is a concern for long latency. |

# Signalling methods for on-demand SSB TX indication

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| Company | Views |
| [1] Futurewei | **Proposal 2:** Support MAC CE signaling for OD SSB at the same or an earlier time as the MAC CE SCell activation.**Proposal 7:** Support DCI indication of OD SSB at least for SCell DTX operation.**Proposal 8:** Consider the potential 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 a 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] Huawei | **Proposal 3:** Both MAC CE and RRC based signalling are applicable to all the scenarios, i.e., scenario #2, #2A, and #3B. |
| [3] Tejas | **Proposal 1:** Use group common DCI signaling when a separate signal is used for SCell activation/deactivation and on-demand SSB transmission indication. |
| [4] Spreadtrum | **Proposal 7:** For Scenario #2, on-demand SSB indication can be separate from SCell activation command.**Proposal 8:** For Scenario #2A, on-demand SSB indication and SCell activation command can be a single signaling. |
| [5] Google | **Proposal 1:** Support group-cast DCI based on-demand SSB indication. |
| [6] CMCC | **Proposal 2:** For on-demand SSB SCell operation in Scenario #2, a separate MAC CE from SCell activation command or group common DCI can be used to indicate on-demand SSB on NES SCell.**Proposal 11:** For on-demand SSB SCell operation in Scenario #3B, group common DCI or UE-specific DCI can be considered to indicate on-demand SSB on NES SCell. |
| [7] Intel | **Proposal 3:** Further discuss scenarios where DCI indication of OD-SSB transmission is beneficial. |
| [8] Nokia | **Observation-3:** The wording “indicate” in the agreement is ambiguous, where the NW signaling indication of on-demand SSB transmission can be either the “configuration” message of on-demand SSB transmission or the “activation” message of on-demand SSB transmission. So far, it is still unclear what exactly the word “indicate” means.**Proposal-3:** The NW signaling indication of on-demand SSB transmission can be either the “configuration” or “activation” or both “configuration and activation” of on-demand SSB transmission.**Proposal-4:** The RRC signaling can be considered as the extension of the existing SCell configuration message which may include new parameters required for the on-demand SSB.* The RRC signaling may contain the configuration information of one or more the on-demand SSB transmissions and may also include the activation information of the on-demand SSB transmission pattern.
* The RRC signaling may be provided during time instance T1 and it may be applied for Scenario#2 and/or Scenario#2A.

**Proposal-5:** For Scenario#2, considering the on-demand SSB transmission is triggered by gNB at the time instance T1 as shown in Figure-1(a), * The RRC signaling may carry the configuration as well as the activation information of the on-demand SSB transmission.

**Proposal-7:** For Scenario#2A, considering the on-demand SSB transmission is triggered by gNB at the time instance T2 (i.e. at the time instance when UE receives SCell activation via MAC CE command) as shown in Figure-1(b), * The design of the MAC CE command can be considered either as an extension/enhancement of legacy SCell activation MAC CE command or a new dedicated MAC CE command.
* The MAC CE signaling can support both SCell activation and on-demand SSB operations.
* The design of MAC CE for Scenario#2A can be jointly considered with the MAC CE utilized in Scenario#2, T1-T2.

**Proposal-8:** Based on the agreed Scenario#2 and Scenario#2A, the NW indication procedure shall be clarified in RAN1 for assisting RAN2 for further signaling related design. |
| [9] China Telecom | **Observation 2:** Preconfiguring the on-demand SSB for SCell can be beneficial to enhance the efficiency of on-demand SSB indicated by RRC**Proposal 2:** At least the separate MAC CE for indicating on-demand SSB should be supported.* The MAC CE indicating on-demand SSB for SCell and corresponding SCell activation can also be supported.

**Proposal 4:** For scenario #2 and #2A, DCI based signalling is unnecessary from perspective of enhancing the indication efficiency.**Observation 3:** DCI based signalling can be beneficial if scenario #3A and/or #3B are/is supported. |
| [10] vivo | **Proposal 14:** The on-demand SSB indication signalling should be a UE-specific signalling.**Proposal 15:** MAC CE is selected to be the on-demand SSB indication signalling.**Proposal 16:** A separate MAC CE different from the SCell activation/deactivation MAC CE should be used to provide the on-demand SSB transmission indication. |
| [11] OPPO | **Proposal 6:** Including on-demand SSB indication in SCell activation command.**Proposal 7:** For Scenario #2 and #3A, support GC-PDCCH for on-demand SSB indication. |
| [13] CATT | **Proposal 5:** MAC-CE based signalling should be applied to both Scenario#2 and Scenario#2A. Information on whether to activate/deactivate SCell simultaneously is needed in the signalling.**Proposal 6:** A unified group-common DCI could be designed to indicate either on-demand SSB transmission or SSB adaptation. |
| [14] ZTE | **Observation 2:** The RRC based signaling can be applicable for scenario #2 and scenario #2A.**Observation 3:** If there is no enhancement on the SSB transmission pattern, the existing RRC configuration can be reused for scenario #2 and scenario #2A, and further spec impact is not observed.**Proposal 3:** The RRC based signaling can be applicable for the scenario #2 and scenario #2A, and on-demand SSB pattern such as time instant B can be introduced in the RRC configuration for activating SCell.**Observation 4:** A single signaling to provide both SCell activation/deactivation indication and on-demand SSB transmission indication can reduce the signaling overhead and SCell activation latency for scenario #2A.**Observation 5:** The MAC CE based signaling can be applicable for the scenario #2A.**Proposal 4:** The MAC CE based signaling is applicable for all scenarios which support the on-demand SSB.**Proposal 5:** The MAC CE based signaling should contain two independent indication fields to indicate the SCell activation/deactivation and on-demand SSB transmission respectively.**Proposal 6:** Discuss whether the DCI based signaling is applicable to scenario #3B. |
| [15] Sony | **Proposal 2:** For signalling for gNB triggering on-demand SSB, option 1 (Separate signaling between legacy/existing signaling 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.

**Proposal 3:** DCI based signalling to indicate on-demand SSB transmission on the cell should be de-prioritized in Rel-19. |
| [16] InterDigital | **Proposal 8:** DCI based signaling to indicate OD-SSB transmission is not introduced in Rel-19**Observation 4:** Discussions on whether a single or separate signaling is used for the MAC CE for indicating OD-SSB transmission and SCell (de)activation is left to RAN2 |
| [17] Fujitsu | **Proposal 3.** 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. |
| [18] LG Electronics | **Proposal #3:** Consider the following signalling methods to indicate on-demand SSB transmission, corresponding to two options in previous agreement.* MAC CE and/or DCI (if introduced) 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 #4:** Consider to inform whether on-demand SSB on the SCell is transmitted or not, via group-common L1 DCI signaling. |
| [19] Samsung | **Proposal 4:** Design details of RRC and MAC CE based indication of on-demand SSB shall be up to RAN2.* RAN1 can revisit the need of DCI format based indication of on-demand SSB later after design details of RRC and MAC CE are more clear.
 |
| [20] Lenovo | **Proposal 4:** For Scenario #2, support option 1 of using a separate signaling to indicate on-demand SSB transmission. The candidate signaling can be either an MAC CE, a UE specific DCI or a group-common DCI.**Proposal 5:** For Scenario #2A, support option 2 of using a single signaling to indicate both on-demand SSB transmission and SCell activation/deactivation. |
| [21] NEC | **Observation 3:** Using MAC CE or RRC based indication for on-demand start indication is expected to increase signalling overhead when indication is sent for scenarios not involving SCell activation.**Proposal 9:** Support on-demand SSB indication via group-common DCI for Scenario#2 and Scenario#3.**Proposal 10:** 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 11:** Support joint MAC CE signalling of on-demand SSB transmission indication and SCell activation/deactivation. |
| [22] Transsion | **Proposal 3** DCI based signaling to indicate on-demand SSB transmission can be supported.**Proposal 4** If DCI based signaling support on-demand SSB transmission, DCI is UE-specific. |
| [23] ASUSTeK | **Observation 1:** Fixing on-demand SSB transmission with a single periodicity for an SCell whenever there is at least one UE consider the SCell as activated is harmful to the network energy saving gain of on-demand SSB.**Observation 2:** there are be two cases where a group common DCI could be utilized to indicate on-demand SSB transmission:1. when the on-demand SSB on a SCell is triggered due to activation of the SCell to other UEs2. when the periodicity of on-demand SSB is adjusted**Proposal 1:** RAN1 further discuss whether using group common DCI to indicate on-demand SSB transmission for the case of :1. when the on-demand SSB on a SCell is triggered due to activation of the SCell to other UEs2. when the periodicity of on-demand SSB is adjusted**Proposal 2:** If group common DCI indicating on-demand SSB transmission is supported, RAN1 further investigate whether there is any misalignment issue between UE and gNB. |
| [24] ETRI | **Proposal 3:** In addition to RRC based and MAC CE based signaling to indicate on-demand SSB transmission, it is proposed to support DCI based signaling to indicate on-demand SSB transmission.* RRC based and MAC CE based signaling are single signaling for both SCell activation and on-demand SSB transmission.
* DCI based signaling is separate signaling and only applicable to indicate on-demand SSB transmission.
	+ Details can be discussed further.
 |
| [26] Panasonic | **Proposal 10:** In addition to RRC and MAC CE based SSB trigging, DCI-based on-demand SSB triggering indication is supported. By RRC configuration, separate bits for SSB ON/OFF of each SCell and joint indication for each SCell group can be supported. |
| [27] Apple | **Proposal 5:** RRC based signaling for OD-SSB indication and for SCell configuration should be able to be sent separately.* How to design RRC signaling for RRC based OD-SSB indication is up to RAN2.

**Proposal 6:** How to design MAC-CE signaling for MAC-CE based OD-SSB indication is up to RAN2. RAN1 is also to inform RAN2 that RAN1 agreed to strive for a common design for different scenarios. |
| [28] Mavenir | **Proposal 1:** it is preferred supporting group-common DCI, and such DCI content can include periodicity and optionally the repetition number of on-demand SSB transmission.**Proposal 2:** new RRC signalling would be introduced if both Scenario 2 and 2A need to be supported so that gNB could trigger the on-demand SSB transmission before the UE receives the SCell activation command. |
| [29] NTT DOCOMO | **Proposal 4:** In scenario2A, support RRC and MAC CE signaling for indication of on-demand SSB transmission to-gether with SCell activation.**Proposal 5:** In scenario2, support group-common DCI signaling for indication of on-demand SSB transmission sepa-rately from SCell activation/deactivation indication.* Besides, support RRC and MAC CE signaling for indication of on-demand SSB transmission sepa-rately from SCell activation/deactivation indication.
 |
| [31] Qualcomm | **Proposal 3:** DCI based signaling to indicate on-demand SSB transmission on the cell is not supported.**Proposal 4:** Support * Option 1 when Scell activation/deactivation and signaling to indicate on-demand SSB transmission on the cell are based on MAC-CE for SSB transmission case #1.
* Option 2 when Scell activation/deactivation and signaling to indicate on-demand SSB transmission on the cell are based on RRC, or Scell activation/deactivation and signaling to indicate on-demand SSB transmission on the cell are based on MAC-CE for SSB transmission case #2.
 |
| [32] Ericsson | **Proposal 1** Support MAC CE signaling for both Scenario #2 and Scenario #2A.**Observation 1** To support Scenario #2 with MAC CE, on-demand SSB transmission indication and SCell activation/deactivation must be sent at different time instances.**Observation 2** To support Scenario #2A with MAC CE, on-demand SSB transmission indication 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. |

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| **Agreement (RAN1#116bis)**For a cell supporting on-demand SSB SCell operation, further study the following options.* Option 1: Separate signaling between legacy/existing signaling (e.g., RRC, MAC CE) providing SCell activation/deactivation and signaling providing On-demand SSB transmission indication.
* Option 2: A single signaling in which both SCell activation/deactivation and On-demand SSB transmission indication are provided.
	+ FFS: Details of the signaling
* Other options are not precluded.
* FFS: Details on On-demand SSB transmission indication

**Agreement (RAN1#117)*** For a cell supporting on-demand SSB SCell operation,
	+ Support RRC based signaling to indicate on-demand SSB transmission on the cell.
	+ Support MAC CE based signaling to indicate on-demand SSB transmission on the cell.
	+ FFS: Whether to support DCI based signaling to indicate on-demand SSB transmission on the cell.
		- This DCI signaling does not provide SCell activation/deactivation.
		- If supported, details on DCI including UE-specific or group-common DCI, DCI contents, etc.
	+ FFS: Scenarios where the above signalings are applicable
 |

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

* For MAC CE
	+ Up to RAN2: Futurewei, InterDigital, Samsung, Apple
	+ Option 1: China Telecom, vivo, Sony, CMCC
	+ Option 2: OPPO, CATT, NEC, ETRI
	+ Both: Huawei, Lenovo, LG Electronics, Qualcomm, Spreadtrum
* For RRC
	+ Option 1 should be allowed: Apple
	+ Only Option 2: LG Electronics, ETRI, Qualcomm
	+ Both: Huawei, Lenovo
* For DCI
	+ Supported by Futurewei (at least for SCell DTX operation), CMCC (UE-specific or GC), NEC (UE-specific DCI, from PCell), ETRI, Panasonic
	+ GC-DCI: Tejas, Google, CMCC (for Scenario #2/3B), OPPO, CATT, Fujitsu, LG Electronics, Lenovo, NEC, ASUSTeK, Mavenir, NTT DOCOMO (for Scenario #2)
	+ Negative: Intel, Sony, InterDigital, Qualcomm

### Proposed Conclusion #3-1 (Signalling):

* For a cell supporting on-demand SSB SCell operation,
	+ It is up to RAN2 to decide between Option 1 and Option 2 or both for RRC and MAC CE signaling to indicate on-demand SSB transmission.
	+ Send an LS to RAN2 to inform above, including relevant RAN1 agreements.

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

|  |  |
| --- | --- |
| Company | Views |
| Google | In our view, RAN1 can decide the information to be conveyed first. Then we can let RAN1 decide whether to use option 1 or option 2. |
| DCM | We are OK with the direction that RAN2 will decide both or either of option1/2 for RRC and MAC CE respectively.One question is that, both RRC and MAC CE were agreed to be supported in both scenario2 and scenario2A? |
| ZTE, Sanechips | RAN1 can further discuss DCI based signaling. Regarding RRC/MAC CE, we can discuss proposal #4-1 firstly. |
| CMCC | Fine to left to RAN2 to decide between Option 1 and Option 2.The feasibility and applicable scenario of DCI can be discussed in RAN1. |
| LGE | It is preferred to send an LS to RAN2 for RRC and MAC CE signaling to indicate on-demand SSB transmission.  |
| Sharp | Support the conclusion. |
| Spreadtrum | OK |
| OPPO | In our view, different options can be applied for different scenarios. Potential down selection between option 1 and option 2 as well as the indication content can be decided in RAN1, and the detailed design can be left to RAN2.  |
| Xiaomi | We share same views with OPPO. For example, option 2 is a straightforward solution for scenario 2A. While for the other scenarios, option 1 is a more promising direction. |

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

* For a cell supporting on-demand SSB SCell operation,
	+ For Scenario #2 (SCell is configured to a UE but before the UE receives SCell activation command (e.g., as defined in TS 38.321)),
		- Support RRC based signaling to indicate on-demand SSB transmission on the cell.
			* 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.) is applied.
		- Support MAC CE based signaling to indicate on-demand SSB transmission on the cell.
			* 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.) is applied.
	+ For Scenario #2A (When UE receives SCell activation command (e.g., as defined in TS 38.321)),
		- Support RRC based signaling to indicate on-demand SSB transmission on the cell.
			* Option 2 (A single signaling in which both SCell activation/deactivation and On-demand SSB transmission indication are provided.) is applied.
		- Support MAC CE based signaling to indicate on-demand SSB transmission on the cell.
			* Option 2 (A single signaling in which both SCell activation/deactivation and On-demand SSB transmission indication are provided.) is applied.

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

|  |  |
| --- | --- |
| Company | Views |
| Moderator | Instead of being left to RAN2, at least RAN1 seem to discuss which scenario(s) is applicable to agreed signaling methods and options. |
| Xiaomi | Support. As this proposal only mentions scenario#2 and scenario#2A, our understanding is that scenario#3A and scenario#3B are separate discussion. |

# Contents of on-demand SSB configuration/indication

|  |  |
| --- | --- |
| Company | Views |
| [2] Huawei | **Proposal 4:** For on-demand SSB, the followings can be explicitly configured to UE via higher layer RRC signalling: The frequency, sub-carrier spacing, downlink transmit power, physical cell identity.**Proposal 5:** To enable more efficient on-demand SSB operation for SCell, time-domain configuration including new SSB periodicities and flexible SS/PBCH block positions within an on-demand SSB burst, e.g., configurable gap length between SS/PBCH blocks should be further considered in the configuration signalling.**Proposal 6:** Multiple on-demand SSB candidate configurations per Scell can be provided to the UE e.g., through *RRCReconfiguration* message. At a given time, one of the candidate configurations can be activated by gNB and indicated as active through MAC CE indication signalling.**Proposal 7:** For on-demand SSB deactivation indication, RAN1 to support new RRC , new MAC CE based signalling, and/or timer-based indication. |
| [3] Tejas | **Proposal 2:** Use the legacy SSB periodicity values, for the SSB burst periodicity. The legacy SSB periodicity values are 5,10,20,40,80 and 160 msec. **Proposal 3:** Supporting more than one on-demand SSB configuration to the UE.**Proposal 4:** Two SSB configurations can be used. One SSB configuration with longer SSB periodicity and always on. Another SSB configuration with shorter periodicity and can be enabled/disabled based on the network sustainability requirement. **Proposal 5:** Further study on, how to change the on-demand SSB configuration. For example: Updating the SSB periodicity value.**Observation 1:** In SSB, each of the PSS, SSS, PBCH, and PBCH DMRS is given with different power levels. Each of the signal/channel power values will need to be known at the UE side. **Observation 2:** The parameters SCS, Cell ID, time and frequency location of SSB burst, and SSB transmit power are useful for generating the reference signal (SSS, PSS and PBCH DMRS) at the UE side. **Proposal 6:** The parameter SCS, Cell ID, time-frequency location of on-demand SSB burst and downlink transmit power (Each of PSS, SSS, PBCH and PBCH DMRS power is known at UE side) should be sufficient to know at the UE side for detecting the SSB. |
| [4] Spreadtrum | **Proposal 13:** At least for Case #1, SCS of the on-demand SSB should be configured to UE via RRC signaling.**Proposal 14:** at least for Case #1, PCI of the on-demand SSB should be configured to UE via RRC signaling. |
| [5] Google | **Proposal 2:** Support the MAC CE based on-demand SSB indication for Scell to provide the following information:* Scell index
* Activation/deactivation status for each SSB for the Scell
* The value of the action delay T

**Proposal 3:** Support the NW configures one on-demand SSB configuration and introduce new RRC parameters for the agreed configuration for on-demand SSB including * Frequency of the on-demand SSB
* SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*
* Periodicity of the on-demand SSB
 |
| [6] CMCC | **Proposal 12:** The SCS and Physical Cell ID of on-demand SSB is the same as that of always-on SSB.**Proposal 13:** The parameters to determine the location of on-demand SSB burst, e.g. time gap, transmission duration or the number N of transmissions, are configured by RRC.**Proposal 14:** The downlink transmit power of on-demand SSB is configured by RRC if it is different type of SSB from always-on SSB, otherwise it is the same as that of always-on SSB. |
| [7] Intel | **Proposal 7:** Derive OD-SSB RRC Ies from existing information fields defining Rel-15 SSBs. |
| [8] Nokia | **Proposal-6:** For Scenario#2, considering the on-demand SSB transmission is triggered by gNB during the time period between T1 and T2 as shown in Figure-1(a),* The MAC CE signaling may be a new MAC CE for on-demand SSB operation that is operated independently from the Scell (de-)activation operation.
* The MAC CE signaling, may indicate the index of the on-demand SSB configurations to be applied.

**Observation-4:** Some of the parameters like absolute frequency, ssb-PositionsInBurst, ss-PBCH-BlockPower may be referenced from legacy configuration if not explicitly provided with the on-demand SSB configuration.**Proposal-9:** RAN1 to clarify if some of the parameters for on-demand SSB may be reused/referenced from the legacy SSB configuration for assisting RAN2 discussion. |
| [9] China Telecom | **Proposal 5:** The on-demand SSB for Scell can be pre-configured with RRC parameter before indicating the transmission.**Observation 4:** Reusing the RRC parameters of periodical SSB for on-demand SSB can be confused for UE to distinguish the configuration is for on-demand SSB or legacy periodical SSB.**Proposal 5:** New RRC parameters to configure the on-demand SSB should be introduced.**Observation 5:** If the configuration of on-demand SSB and always-on SSB are same, network can consider not to configure such parameters for on-demand SSB, and the corresponding configuration for SSB can be reused.**Proposal 6:** Time offset for the first transmission of on-demand SSB should be introduced.**Proposal 7:** The transmission time margin of SSB can be introduce to restrict the minimum transmission interval of two SSBs.**Observation 7:** The termination mechanism of on-demand SSB is needed to balance the performance and energy consumption.**Proposal 8:** Support to introduce a new signal and mechanism to terminate the transmission of on-demand SSB.**Observation 9:** The indication of on-demand SSB transmission to UE can also be reused as the indication of on-demand SSB termination for UE. |
| [10] vivo | **Proposal 17:** The following parameters are configured to UE:* Sub-carrier spacing of the on-demand SSB
* Location of on-demand SSB burst
* Downlink transmit power of on-demand SSB
* Frequency of the on-demand SSB
* SSB positions within an on-demand SSB burst
* Periodicity

**Proposal 18:** The following parameters could be explicitly indicated to UE through the on-demand SSB triggering MAC CE:* Physical Cell ID of the on-demand SSB
* SSB positions within an on-demand SSB burst
* Periodicity

**Proposal 19:** The location of on-demand SSB burst is indicated by the parameter *periodicityandoffset* similar to the SMTC indication. The first subframe of each potential SSB time domain position in every period is determined according to a predefined rule. |
| [11] OPPO | **Proposal 10:** Support indicating the value of T together with the on-demand SSB indication. |
| [13] CATT | **Proposal 3:** For RRC based signalling, a new RRC parameter is employed for each Scell to indicate whether on-demand SSB is transmitted.**Proposal 4:** RRC based signalling could be applied to both Scenario#2 and Scenario#2A. |
| [14] ZTE | **Proposal 7:** More than one on-demand SSB patterns/configurations can be configured for the Scell to UE.**Proposal 8:** The target Scell index and target on-demand SSB transmission pattern index can be indicated by the triggering signaling.**Proposal 15:** The location of the on-demand SSB should at least include the time instance A and time instance B, and the parameters to determine the time instance A and time instance B should be known to the UE.**Proposal 16:** Multiple on-demand SSB pattern with at least one of the parameters such as periodicity of the on-demand SSB, the SSB positions within an on-demand SSB burst, the duration or the value of N should be configured for UE. |
| [16] InterDigital | **Observation 3:** Signaling the timing for the reception of the first SSB of OD-SSB in the OD-SSB indication (e.g. MAC CE) provides more flexibility to gNB to decide on OD-SSB transmission and reuse the same OD-SSB for multiple Ues**Proposal 6:** The timing for the reception of the first SSB of OD-SSB burst (i.e. value of T) is signalled in the indication on OD-SSB**Proposal 7:** Configuration of more than one OD-SSB configurations is not supported |
| [18] LG Electronics | **Proposal #1:** For Case #1 (i.e., No always-on SSB on a cell), discuss how to signal SSB-related parameters and SMTC configuration, and how to inform the UE whether timing reference cell for the cell is provided or not.**Proposal #5:** The half frame index where on-demand SSB for an Scell is transmitted is known implicitly to UE by using the half frame index for always-on SSB in the Scell or in the other serving cell.* In the case of no always-on SSB in the Scell or reference Cell (for SSB-less Scell), the half frame index for on-demand SSB is configured via L3 RRC singling.

**Proposal #6:** Consider the number of on-demand SSB bursts transmission as one of contents for configuration of on-demand SSB.* Configuration of timer or window size can be also considered to terminate the on-demand SSB transmission.
 |
| [19] Samsung | **Proposal 9:** For parameters of on-demand SSB, adopt the following delivery methods correspondingly.

|  |  |
| --- | --- |
| Parameter of on-demand SSB | Delivery method  |
| Frequency of the on-demand SSB | New RRC parameter |
| Periodicity of the on-demand SSB | New RRC parameter |
| Physical cell ID of the on-demand SSB | Same as the RRC parameter for periodic SSB in the cell, if any; new RRC parameter, otherwise. |
| Subcarrier spacing of the on-demand SSB | Same as the RRC parameter for periodic SSB in the cell, if any; new RRC parameter, otherwise. |
| Transmission power of the on-demand SSB | Same as the RRC parameter for periodic SSB in the cell, if any; new RRC parameter, otherwise. |
| SSB positions in burst | Same as the RRC parameter for periodic SSB in the cell, if any; new RRC parameter, otherwise.Also in the DL indicator (RRC or MAC CE indicating the on-demand SSB transmission). |
| Half frame information of the on-demand SSB | DL indicator (RRC or MAC CE indicating the on-demand SSB transmission) or no explicit indication will be up to RAN2. |
| A number of bursts for the on-demand SSB (for Option 3) | DL indicator (RRC or MAC CE indicating the on-demand SSB transmission). |

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| [21] NEC | **Observation 4:** On-demand SSB should be available for reception immediately after UE receives the Scell configuration which includes Scell activation to reduce the Scell activation delay specified by RAN4.**Observation 5:** gNB can indicate the availability of on-demand SSB within the Scell configuration itself if on-demand SSB is already being transmitted in the cell for another UE.**Proposal 12:** Support indication of availability of on-demand SSB transmission using a parameter within the Scell configuration.**Proposal 13:** For Case#1, UE assumes that SSB transmissions are stopped immediately after Scell deactivation. There is no need to define explicit deactivation signalling for on-demand SSB.**Proposal 16:** For UE to determine the value of T2, the on-demand SSB configuration should indicate potential SSB burst occasions where SSB bursts can be transmitted.**Proposal 30:** For Case#1, on-demand SSB configuration can reuse the Scell SSB Ies (*absoluteFrequencySSB*, *ssb-periodicityServingCell*, *ssb-periodicityServingCell*, *ssbSubcarrierSpacing*, *ss-PBCH-BlockPower*) included within *ServingCellConfigCommon*.* Additional Ies can be introduced for remaining aspects specific to on demand SSB operation.

**Proposal 31:** For Case#2, if on-demand SSB is transmitted in the same frequency as always-on SSB, the on-demand SSB and always-on SSB can share some of the transmission parameters (*absoluteFrequencySSB*, *ssb-periodicityServingCell*, *ssb-periodicityServingCell*, *ssbSubcarrierSpacing*, *ss-PBCH-BlockPower*).* Additional Ies can be introduced for other remaining aspects specific to on-demand SSB operation.

**Proposal 32:** For Case#2, if on-demand SSB is not transmitted in the same frequency as always-on SSB, the on-demand SSB configuration can be provided using *NonCellDefiningSSB-r17** Additional Ies can be introduced for remaining aspects specific to on-demand SSB operation.

**Proposal 33:** No more than one on-demand SSB configuration should be configured for a Scell to the UE.**Proposal 34:** For a cell supporting on-demand SSB Scell operation, gNB indicates the following to the UE:* Whether a configured SSB is always-on or on-demand transmitted. FFS whether this indication is provided explicitly or implicitly using another parameter.
* Parameters for UE request for on-demand SSB.
* Parameters for time window for monitoring on-demand SSB by the UE.

**Proposal 35:** For Case#2, on-demand SSB can share some of the parameters with always-on SSB including SCS and SSB transmission power. Following transmission parameters are additionally configured for on-demand SSB (different than parameters for always-on SSB): * Time offset between the always-on SSB burst occasions and on-demand SSB burst occasions
* Periodicity of on-demand SSB
 |
| [22] Transsion | **Proposal 5** More than one on-demand SSB configurations can be configured for the cell to UE.**Proposal 6** On-demand SSB period following the legacy value.**Proposal 7** RRC can be legacy or newly introduced. |
| [24] ETRI | **Proposal 4:** For on-demand SSB operation, most of parameters except for location of on-demand SSB burst are already in existing RRC IE, *ServingCellConfigCommon* and can be reused.* For location of on-demand SSB burst, at least system frame number (SFN) and half frame index should be added.
* FFS: other parameters

**Proposal 8:** It is proposed to report additional information for proper configuration for on-demand SSB transmission.* Details of additional information can be discussed further.
 |
| [25] MediaTek | **Proposal 4:** As the RAN1 #117 agreement only states the start time instant (time instance A) of the on-demand SSB but not the stop time instant, the DL MAC-CE should include the following time domain properties of the to-be-transmitted on-demand SSB:* Number of SSB bursts
* Number of SSB burst clusters (one cluster includes multiple SSB burst)

**Proposal 5:** 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. |
| [27] Apple | **Proposal 7:** The multiple T values are configured by OD-SSB configuration and a value of T to be assumed by UE is indicated by MAC-CE based OD-SSB indication.**Proposal 10:** UE assumes that OD-SSB bursts(s) is periodically transmitted from time instance A until gNB turns off the OD-SSB. |
| [28] Mavenir | **Proposal 3:** in MAC-CE indicating on-demand SSB transmission, a field T can be included which value equal to the time elapse between the slot boundary where the first on-demand SSB actually is transmitted and the slot boundary where UE receives the MAC-CE signalling. |
| [29] NTT DOCOMO | **Proposal 2:*** Support more than one configuration of on-demand SSB.
* RAN1 to discuss necessary RRC parameters and other details after decision on supported time domain behaviors and applicable use-case of on-demand SSB
 |
| [31] Qualcomm | **Proposal 9:** For SSB transmission case #1, further discuss the following options for the time instance B:* Option 1: The time instance B is the time UE receives the Scell deactivation command or the time UE sends HARQ-ACK in response to the reception of Scell deactivation command.
* Option 2: The time instance B is the time UE receives the signaling indicating unavailability of on-demand SSB transmission.

**Proposal 10:** For SSB transmission case #2, the time instance B is the time UE successfully completes Scell activation (e.g., transmitting the CSI report after UE receives the Scell activation command). |
| [32] Ericsson | **Proposal 4** Support indication of on-demand SSB periodicity via MAC CE.**Proposal 5** 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.**Proposal 6** Support more than one on-demand SSB configuration per Scell. |
| [33] CEWiT | **Proposal 7:** Support indication of time duration T from the gNB to UE for determination of actual start time of transmitting on-demand SSB burst. |

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| **Agreement (RAN1#117)*** For a cell supporting on-demand SSB Scell operation, at least the following for on-demand SSB via higher layer RRC signaling is supported.
	+ Frequency of the on-demand SSB
	+ SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*
	+ Periodicity of the on-demand SSB
	+ FFS: Whether more than one on-demand SSB configurations can be configured for the cell to UE
	+ FFS: Whether the RRC is newly introduced or existing RRC is reused

**Agreement (RAN1#117)*** For a cell supporting on-demand SSB Scell operation, at least the followings for on-demand SSB are known to UE.
	+ Sub-carrier spacing of the on-demand SSB
	+ Physical Cell ID of the on-demand SSB
	+ Location of on-demand SSB burst
	+ Downlink transmit power of on-demand SSB
	+ FFS: Other parameters
	+ FFS: Whether each of above parameters is configured/indicated explicitly or not
 |

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

* Details on higher layer parameter signaling
	+ Frequency of the on-demand SSB
		- Explicit RRC signaling: Huawei, Google, vivo, Samsung
	+ SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*
		- Explicit RRC signaling: Google, vivo, Samsung (also in on-demand SSB indication signaling)
		- Same as always-on SSB: Samsung
		- MAC CE: vivo
		- Huawei: New pattern?
	+ Periodicity of the on-demand SSB
		- Explicit RRC signaling: Google, Samsung, NEC
		- MAC CE: vivo
		- Huawei: New value
	+ Sub-carrier spacing of the on-demand SSB
		- Explicit RRC signaling: Huawei, Spreadtrum, vivo, Samsung
		- Same as always-on SSB: CMCC, Samsung
	+ Physical Cell ID of the on-demand SSB
		- Explicit RRC signaling: Huawei, Spreadtrum, Samsung
		- Same as always-on SSB: Samsung
		- MAC CE: vivo
	+ Location of on-demand SSB burst (or half-frame index of the on-demand SSB)
		- Implicitly known: LG Electronics
		- Explicit signaling: vivo, LG Electronics, Samsung (Up to RAN2?)
	+ Downlink transmit power of on-demand SSB
		- Explicit RRC signaling: Huawei, CMCC, vivo, Samsung
		- Same as always-on SSB: Samsung
	+ Others
		- # of SSB bursts: CMCC, ZTE, LG Electronics, Samsung (in on-demand SSB indication signaling), MediaTek
		- Transmission duration/window: ZTE, NEC, CMCC
		- On/Off status of on-demand SSB: CATT, NEC, Google (in on-demand SSB indication signaling)
		- Time gap: CMCC
		- Offset between always-on SSB and on-demand SSB: NEC
		- SMTC and timing reference cell: LG Electronics
* Multiple on-demand SSB configurations
	+ Supported by Futurewei, Huawei, Nokia, CATT, ZTE, LG Electronics, Ericsson
		- Also, indication of configuration index is supported by Futurewei, Huawei, Nokia, CATT, ZTE, LG Electronics
	+ Single configuration is enough: InterDigital, NEC
* Deactivation of on-demand SSB via MAC-CE (or DCI)
	+ Supported by Huawei, China Telecom, Apple, Qualcomm (only for Case #1)
	+ NO for Case #1: NEC (for Case #1, Scell deactivation means on-demand SSB deactivation)
	+ NO for Case #2: Qualcomm (for Case #2, Scell activation completion means on-demand SSB deactivation)
* In MAC-CE for on-demand SSB indication
	+ Scell index: Google
	+ The value of T (for determining time instance A): Google, OPPO, InterDigital, Samsung?, Apple, Mavenir, CEWiT

Before deciding which parameter(s) can be explicitly/implicitly determined, it seems more important to discuss overall framework for on-demand SSB configuration/indication.

### Proposal #4-1 (Contents):

* For a cell supporting on-demand SSB Scell operation,
	+ More than one on-demand SSB configurations can be configured for the cell to UE, e.g., OD-SSB config #0, OD-SSB config #1, and so on.
	+ If multiple on-demand SSB configurations for the cell are provided to UE,
		- RRC signaling for on-demand SSB transmission indication configures an index for one of multiple pre-configured OD-SSB configs.
		- MAC CE signaling for on-demand SSB transmission indication indicates an index for one of multiple pre-configured OD-SSB configs.
	+ **If on-demand SSB transmission is indicated by MAC CE,** two sets for information on on-demand SSB are defined as follows.
		- Info-Set 1: Information for on-demand SSB that can be included in OD-SSB config, e.g.,
			* Frequency of the on-demand SSB
			* SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*
			* Periodicity of the on-demand SSB
			* Sub-carrier spacing of the on-demand SSB
			* Physical Cell ID of the on-demand SSB
			* Location of on-demand SSB burst
			* Downlink transmit power of on-demand SSB
			* The number of SSB bursts
			* The value of T (for determining time instance A)
			* FFS: If above parameters are not included in OD-SSB config.
		- Info-Set 2: Information for on-demand SSB that can be carried by MAC CE signaling for on-demand SSB transmission indication, e.g.,
			* Index of OD-SSB config
			* Scell index
			* SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*
			* Periodicity of the on-demand SSB
			* The number of SSB bursts
			* The value of T (for determining time instance A)
			* Deactivation of on-demand SSB

Companies are encouraged to provide views on Proposal #4-1 and which information for on-demand SSB can be classified to either of Info-Set 1 or Info-Set 2.

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| --- | --- |
| Company | Views |
| Google | We think FFS should be added for the following information:* + - * Sub-carrier spacing of the on-demand SSB
			* Location of on-demand SSB burst
			* Downlink transmit power of on-demand SSB
			* The number of SSB bursts

If there is always-on SSB, the SCS and Tx power for the on-demand SSB should be the same as the always-on SSB. We are not sure what the “location of on-demand SSB burst” means. The intention of the number of SSB bursts is also unclear.For the info-set2, if multiple OD-SSB configurations are allowed, then for MAC CE, it seems we only need the index of OD-SSB config.  |
| DCM | The necessary contents of MAC CE for flexibility would depend on the possible number of OD-SSB config which can be RRC-configured simultaneously, but We feel that at least “ssb position in burst” and “periodicity” should not be included in MAC CE (just indicating index of OD-SSB config from multiple OD-SSB configs is enough)The unnecessary flexibility of MAC CE indication might increase UE processing time related to T in order to determine OD-SSB occasion. |
| ZTE, Sanechips | In general, we support this proposal. I have one clarification question on the meaning of parameter ‘The number of SSB bursts’, is it same as the meaning of option 3 in section 5 as follows ? * 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.

If yes, we prefer to keep this parameter.  |
| CMCC | We think “periodicity” and “the number of SSB bursts” should not change frequently and be configured semi-statically in info-set1 instead of in MACCE. |
| LGE | The number of SSB bursts and Deactivation of on-demand SSB can be indicated by MAC CE.Frequency, SSB positions, periodicity, SCS, and Downlink transmit power should be Configured in RRC.Location of on-demand SSB burst(i.e., half frame index) can be implicitly known to Ues without indicating the parameter directly to reduce signaling overhead. |
| Sharp | Does “location of on-demand SSB burst” refer to “frequency location of on-demand SSB burst”?For MAC CE-based OD-SSB triggering, we share the view with Google and DCM that the parameters that needs flexibility can be configured in the different OD-SSB configurations, and the NW can use MAC CE to indicate one of them. However, for RRC-based OD-SSB triggering, we think the design may be more straightforward, and we can have another proposal for it.In brief, we suggest splitting the proposal into two, each corresponding to RRC-based and MAC CE-based OD-SSB triggering. |
| Spreadtrum | Multiple SSB burst configurations are too complicated. On-demand SSB just has one configuration. |
| OPPO | Regarding multiple OD-SSB configurations, we do not see the benefit of supporting multiple OD-SSB configs for one cell, especially when the cell is operating in energy saving mode. One OD-SSB config per cell is enough.In our view, for MAC CE based OD-SSB trigger information, Info-Set 1 can include:* Frequency of the on-demand SSB
* SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*
* Periodicity of the on-demand SSB
* Sub-carrier spacing of the on-demand SSB
* Physical Cell ID of the on-demand SSB
* Downlink transmit power of on-demand SSB

and Info-Set 2 can include:* The number of SSB bursts
* The value of T (for determining time instance A)
* Activation of on-demand SSB
* Deactivation of on-demand SSB

The location of OD-SSB burst is not needed because it can be determined according to time instance A and SSB positions indication.  |
| Moderator | Given that multiple OD-SSB configurations were controversial during online session, it would be better to focus on Info-Set 1 and Info-Set 2 which seem to be necessary even for the case where only a single OD-SSB config is provided. |
| Xiaomi | We understand network vendors want some flexibility on the on-demand SSB for different scenarios. However, the motivation is not clear to us. SSB is basically transmitted in a particular pattern not changed frequently. The only way to change SSB transmission pattern is SIB1. We think same principle should be maintained.On the other hand, if majority companies think such kind of flexibility is needed, we can live with the direction. If so, we think a high-level proposal is sufficient to avoid too many and too divergent discussion on the details. To be specific, all the examples for info-set1 and info-set2 can be removed and left to further discussion.  |

# TX behavior of on-demand SSB burst

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| --- | --- |
| Company | Views |
| [1] Futurewei | **Proposal 1:** The time offset T may include additional slots offset after the slot where UE transmits HARQ-ACK corresponding to a signaling from gNB to trigger on-demand SSB.**Proposal 9:** For on-demand SSB transmission, UE expects that on-demand SSB burst(s) is transmitted N (≥0) times after the MAC CE or DCI indication, followed by periodic SSB transmission. |
| [2] Huawei | **Proposal 8:** From UE perspective, reference start time T\_0 is the ending slot of on-demand SSB indication MAC CE.**Proposal 9:** Time instance A is the slot boundary of the first SSB time domain position of actually transmitted on-demand SSB burst.**Proposal 10:** The value of T (the difference between $T\_{0}$ and the slot which starts with time instance A) is not less than $m+3N\_{slot}^{subframe,μ}$.**Proposal 11:** The value of T can be configured via RRC reconfiguration. |
| [4] Spreadtrum | **Proposal 10:** For mechanism of on-demand SSB transmission, Option 1 and Option 1A should be excluded.**Observation 7:** For Scenario #2, Option 2 can be supported.**Observation 8:** For Scenario #2A, Option 2 can be supported.**Proposal 11:** For mechanism of on-demand SSB transmission, at least Option 2 (i.e. UE expects that on-demand SSB burst(s) is transmitted from time instance A to time instance B and not transmitted after time instance B) is supported in R19.**Proposal 12:** For agreement of the time instance A, square bracket around [the slot boundary of] can be removed, [of actually transmitted on-demand SSB burst] can be removed, and [slots or symbols] can be replaced by slots without square bracket. |
| [6] 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 5:** For SSB burst(s) indicated by on-demand SSB SCell operation via MAC CE, the time offset T between MAC CE and time instance A includes K1 and a time gap configured by gNB.**Proposal 8:** 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. |
| [7] Intel | **Proposal 5:** For SSB burst(s) indicated by on-demand SSB SCell operation via RRC, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.* Time instance A is the first SSB time domain position which is T slots after the slot where the UE transmitted the RRCReconfigurationComplete message to the gNB while receiving no UL grant for at least B slots after the last transmission of this message.

**Proposal 6:** For MAC-CE based OD-SSB indication timeline:* Time instance A is defined in terms of slots with the delay T also defined in terms of slots
* The value of the time T is predefined
* The slot where the UE receives the OD-SSB indication via MAC CE is defined as the slot where a UE receives and physical layer transmission that does not result in a CRC error and is later correctly identified as OD-SSB related MAC CE signalling by the MAC layer.
 |
| [8] Nokia | **Observation-5:** For the RRC-based signaling, in practice it is not accurately known in advance the exact time slot when the RRC message can be scheduled and received by a UE. Thus, the UE cannot assume the time slot of RRC signaling reception as time reference for the first SSB time domain position.**Observation-6:** UE may not have the time synchronization with SCell in certain scenarios e.g Scenario#2 or Scenario#2A and the time when UE may start monitoring for on-demand SSB needs to be referenced with respect to PCell SFN.**Proposal-10:** For RRC-based signaling to activate the on-demand SSB transmission, the time reference for the first SSB time domain position can be based on the SFN timing in PCell.**Observation-7:** Similar timing for MAC CE/RRC based SCell (de-)activation can be considered for the timing of MAC CE/RRC based on-demand SSB transmission.**Proposal-11:** For the MAC CE based signaling, the UE may start monitoring for on-demand SSB no earlier than slot n+k where n is the slot when MAC-CE command received at the UE and k is the occasion for HARQ transmission.**Proposal-12:** The minimum value of T shall be larger than the UE processing delay of RRC/MAC-CE signaling.**Proposal-13:** RAN1 to discuss the following options on how to stop UE monitoring of OD-SSB:* Option-A: Stopping of UE monitoring of OD-SSB based on NW configuration.
* Option-B: Stopping of UE monitoring of OD-SSB explicitly via MAC CE signaling.
* Option-C: Stopping of UE monitoring of OD-SSB implicitly based on conditions, e.g. after NW receiving or UE sending measurement reporting.

**Observation-8:** Option 4 is intended for Case-2 with always-ON periodic SSB transmission in SCell, where the NW triggers on-demand denser SSB transmission with shorter SSB periodicity from time instance A, i.e. when NW sends SCell activation command, and later NW starts sending SSB with longer periodicity after time instance B, i.e. when NW has received UE measurement report.**Proposal-14:** Option 4 can be jointly considered with the agreement from AI 9.5.3 about adaptation of SSB burst periodicity in time-domain. |
| [10] vivo | **Proposal 7:** A unified design of on-demand SSB transmission in Scenario #2, Scenario 2A and Scenario #3A is preferred.**Proposal 8:** 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 9:** The value of T is predefined which corresponds to the minimum processing time required for UE’s MAC CE processing.**Proposal 10:** The slot starting from the time instance A should include the first SSB of a complete actually transmitted on-demand SSB burst.**Proposal 11:** Introduce the time where UE receives the signalling from gNB as the start to determine time instance A.**Proposal 12:** Time instance A is the slot boundary of the first SSB time domain position of complete actually transmitted on-demand SSB burst which is T slots after the slot in the cell with signalling transmission where UE receives signalling from gNB to indicate on-demand SSB transmission.**Proposal 13:** The value of T is determined with the numerology of the cell with signalling transmission. |
| [11] OPPO | **Proposal 9:** Do not associate the starting position of T to the slot or symbol where UE transmits HARQ-ACK corresponding to the on-demand SSB indication.**Proposal 11:** Change the definition of Time instance A as follow:* Time instance A is the half-frame boundary of the first SSB time domain position of actually transmitted on-demand SSB burst which is T half-frame after the half-frame boundary where UE receives a signalling from gNB to indicate on-demand SSB transmission.
 |
| [12] Xiaomi | **Proposal 3:** Time instance A and value of T can be defined as follows.* If on-demand SSB is triggered by UL WUS, time instance A could be defined as the symbol of the first SSB time domain position of actually transmitted OD-SSB burst.
* If on-demand SSB is triggered by gNB, instance A could be defined as the slot of the first SSB time domain position of actually transmitted on-demand SSB burst
	+ If triggering message is carried by RRC signalling, instance A is the first slot after slot n, slot n is the last downlink slot overlaps with uplink slot on which UE transmit ACK for the RRC signaling. T at least includes the RRC processing delay.
	+ If triggering message is carried by MAC CE, T is $m+3 N\_{slot}^{subframe,μ}+1$ where m is determined by the HARQ-ACK timing for PUCCH transmission with HARQ-ACK information for the PDSCH reception and $3 N\_{slot}^{subframe,μ}$ is a number of slots per subframe for the SCS configuration μ of the PUCCH transmission.
	+ If triggering message is carried by DCI, instance A is the first slot that is not earlier than T after slot n wherein UE receives the DCI. T at least includes processing time for the PDCCH which may be up to UE capability.
 |
| [13] CATT | **Proposal 7:** 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 8:** For SSB burst(s) indicated by on-demand SSB SCell operation via MAC CE, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.* Alt 3-1: Time instance A is the slot boundary of the first SSB time domain position of actually transmitted on-demand SSB burst which is T slots after the slot where UE receives a signalling from gNB to indicate on-demand SSB transmission
	+ The SSB time domain positions of on-demand SSB burst are configured by gNB.

**Proposal 9:** The value of T should be different for intra-frequency SCell and inter-frequency SCell.**Proposal 10:** For SSB burst transmission, the time instance B could be associated with predefined SSB termination events. |
| [14] ZTE | **Proposal 9:** For SSB burst(s) indicated by on-demand SSB SCell operation, the option 1 should be excluded.**Proposal 10:** Modifying the Alt 3-1 as follows: Time instance A is ~~[~~the slot boundary of~~]~~ the first SSB time domain position ~~[~~of ~~actually transmitted~~ on-demand SSB burst~~]~~ which is T ~~[~~slots ~~or symbols]~~ after the ~~[~~slot ~~or symbol]~~ where UE receives a signalling from gNB to indicate on-demand SSB transmission.**Proposal 11:** For SSB burst(s) indicated by on-demand SSB SCell operation via RRC based signaling, the instance A should follow the legacy protocol in principle.**Proposal 12:** For DCI based signaling (if supported), time instance A can be the slot boundary of the first SSB time domain position of on-demand SSB burst which is T’ slots after the slot where UE receives a DCI signalling from gNB to indicate on-demand SSB transmission.**Proposal 13:** For SSB burst(s) indicated by on-demand SSB SCell operation via MAC CE, multiple components should be included in T.**Proposal 14:** Time instance B can be determined by a transmission duration after time instance A or N times SSB transmission after time instance A. |
| [16] InterDigital | **Proposal 4:** Support one of the following options:* Option 1: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A.
* Option 1A: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A until gNB turns OFF the on demand SSB.
* Option 3: UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted. FFS: A, N values.

**Proposal 5:** Confirm the following: For SSB burst(s) indicated by on-demand SSB SCell operation via MAC CE, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.* Time instance A is ~~[the slot boundary of]~~ the first SSB time domain position ~~[~~of actually transmitted on-demand SSB burst~~]~~ which is T ~~[~~slots ~~or symbols]~~ after the ~~[~~slot ~~or symbol]~~ where UE receives a signalling from gNB to indicate on-demand SSB transmission
 |
| [17] 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 on-demand SSB can be stopped at certain time instance, when or after the SCell state is deactivated.**Proposal 5.** For 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.
* Option 3. On-demand SSB is transmitted N times after time instance A and then not transmitted after N transmission times have been completed.
* The values of time instance A and B can be provided by on-demand SSB configuration or triggering signaling.
* FFS how to define the value of N.

**Proposal 6.** The transmission of an on-demand SSB burst should follow the legacy constraint of being confined within a half-frame window.**Proposal 7.** Time instance A is the half frame / slot boundary of the first SSB time domain position on the on-demand SSB SCell which is T slots after the SCell slot *nd*.* For the case that on-demand SSB transmission is indicated by MAC-CE, SCell slot *nd* is the last SCell slot coinciding with the reference slot n+k.
	+ The reference slot n+k follows the same definition as in clause 4.3 of TS 38.213.
* For the case that on-demand SSB transmission is indicated by DCI (if supported), SCell slot *nd* is the last SCell slot coinciding with the DL slot on another cell where the DCI is received.

**Proposal 8.** For the case that on-demand SSB transmission is indicated by RRC, time instance A is the half frame / slot boundary of the first configured SSB time domain position after the SCell slot *nd*.* SCell slot *nd* is the last SCell slot coinciding with the UL slot containing RRCReconfigurationComplete message.
 |
| [18] LG Electronics | **Proposal #8:** When PDSCH including MAC-CE for On-demand SSB transmission indication is received at slot n and corresponding HARQ-ACK is transmitted at slot n + K1, UE can expect on-demand SSB is periodically transmitted from time instance A which is the first SSB burst position from the slot that is after slot n + K1+$3∙N\_{slot}^{subframe,μ}$.**Proposal #9:** When PDSCH including RRC for On-demand SSB transmission indication is received at slot n, UE can expect on-demand SSB is periodically transmitted from time instance A which is the first SSB burst position from the slot that is after slot n + X$∙N\_{slot}^{subframe,μ}$.* FFS: The value of X by taking 16 as the starting point
 |
| [19] Samsung | **Proposal 6:** The transmission of on-demand SSB is using a half frame as a transmission unit.**Proposal 7:** For the transmission pattern of on-demand SSB: * For Case 1, support Option 1;
* For Case 2, prioritize Option 2 and Option 3 and further discuss their details.

**Proposal 8:** Time instance A shall be defined as T2 after the DL trigger, wherein T2 corresponds to the difference between the DL trigger and the first actually transmitted SSB in the burst, and T2 is no less than the minimum processing delay of the DL trigger. * If the offset is indicated in the DL trigger, the offset can be indicated as T1, wherein T1 corresponds to the number of half frames between the DL trigger and the half frame including the first actually transmitted SSB in the burst.
 |
| [20] Lenovo | **Proposal 6:** 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 7:** For MAC CE based on-demand SSB transmission indication, time instance A is the slot boundary of the first SSB time domain position of actually transmitted on-demand SSB burst which is T slots after the slot where UE receives the MAC CE. T is determined based on a similar timing for legacy MAC CE based SCell activation. |
| [21] NEC | **Proposal 2:** RAN1 should strive to keep the SCell activation timeline as it is. In case any update is deemed necessary, impact on the existing timeline should be minimized.**Proposal 14:** For Case#2, UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted.**Proposal 15:** The value of T can compose of two components - T1 and T2:* T1 is the delay due to UE processing of on-demand SSB indication and/or configurable by gNB
* T2 is the time difference between the end of T1 and start of the first SSB time domain position of the transmitted SSB burst determined by UE

**Observation 6:** For Case#1, on-demand SSB transmission can be initiated by the gNB before it sends indication to the UE and hence configured/indicated value of T may not be required. However, for Case#2, indication of starting time instance of on-demand SSB allows proper sync between UE and gNB in terms of actual transmission occasions of on-demand SSB.**Proposal 17:** Support indication of value of T1 from gNB to UE for indicating the start of on-demand SSB at least for Case#2.**Proposal 18:** Support the case where SCell with on-demand SSB transmission and PCell with on-demand SSB indication have different numerology.**Observation 7:** NR currently supports indication of smtc within *SCellConfig* during SCell addition which allows UE to optimise the SSB search. The smtc time reference is with respect to the PCell and contains the same periodicity value as *ssbperiodicityServingCell* indicated in *sCellConfigCommon*.**Proposal 19:** For SSB burst(s) indicated by on-demand SSB SCell operation via MAC CE where SCell with on-demand SSB transmission and cell with on-demand SSB indication have different numerology, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.* Time instance A is the slot boundary of the first SSB time domain position of actually transmitted on-demand SSB burst which is T(μ) slots after the slot where UE receives a signalling from gNB to indicate on-demand SSB transmission,
	+ μ is the SCS configuration of the cell from which UE receives the indication
 |
| [22] Transsion | **Proposal 8** T should be at least related to the HARQ feedback time of the MAC CE and T should be indicated/configured by the gNB .**Proposal 9** Similar to MAC CE, the application time T for RRC signaling should also be discussed.**Proposal 10** It is recommended that on-demand SSB burst(s) transmitted N times after time instance A can be supported. |
| [24] ETRI | **Proposal 5:** For SSB burst(s) indicated by on-demand SSB SCell operation via MAC CE, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.* Alt 3-1: Time instance A is ~~[~~the slot boundary of~~]~~ the first SSB time domain position ~~[~~of actually transmitted on-demand SSB burst~~]~~ which is T ~~[~~slots ~~or symbols]~~ after the ~~[~~slot ~~or symbol]~~ where UE receives a signalling from gNB to indicate on-demand SSB transmission
	+ The SSB time domain positions of on-demand SSB burst are configured by gNB.
* The value of T is defined as the existing timeline required for UE’s MAC CE procseeing for SCell activation.
* This can be applied regardless of numerology for SCell with on-demand SSB transmission and numerology for cell with indication signaling transmission.

**Proposal 6:** 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 1:** The CSI reporting for the SCell can be used as the confirmation for the completion of SCell activation.**Proposal 7:** 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. |
| [26] Panasonic | **Proposal 9:** 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. |
| [27] Apple | **Proposal 8:** On the candidate values of T, the minimum value of T should be decided by RAN4 while considering agreement (*Note: The value of T is not less than existing timeline required for UE’s MAC CE processing for SCell activation*).**Proposal 9:** The unit of T value is based on slot. |
| [29] NTT DOCOMO | **Proposal 9:** For timeline of MAC CE indication of on-demand SSB at least for SCell activation,* Support the timing of transmission of HARQ ACK as a timing reference, following the legacy time-line.
* Support T as a specific value (not configurable)
* Support time unit as slot level
 |
| [31] Qualcomm | **Proposal 5:** Support the Option 2 with **modification** * Modified Option 2: UE expects that on-demand SSB burst(s) is **periodically** transmitted from time instance A to time instance B and not transmitted after time instance B.

**Proposal 6:** For on-demand SSB transmission indication via MAC-CE, update the agreement on determination of time instance A as follows:* Time instance A is ~~[the slot boundary of]~~ the first symbol of the first actually transmitted SSB ~~time domain position [of actually transmitted~~ of on-demand SSB burst~~]~~ which is T ~~[slots or~~ symbols~~]~~ after the ~~[~~slot ~~or symbol]~~ where UE receives a signalling from gNB to indicate on-demand SSB transmission

**Proposal 7:** Discuss the following alternatives for determining the value of T in the number of symbols: * Alt. 1: $T= 14T\_{0}+ ∆\_{MAC-CE}$
* Alt. 2: $T= 14(m+T\_{0})+ ∆\_{MAC-CE}$ where $n+m $is a slot indicated for PUCCH transmission with HARQ-QCK information for the PDSCH reception at slot n containing signaling to indicate on-demand SSB transmission.
* $T\_{0}=3N\_{slot}^{subframe,μ}$, $N\_{slot}^{subframe,μ}$ is the number of slots per subframe for the SCS configuration $μ$
* $∆\_{MAC-CE} $is in the number of symbols and configurable as part of on-demand SSB configuration.
* The SCS for determining the value of T is the SCS of the active DL BWP that UE receives the OD-SSB transmission indication signaling.

**Proposal 8:** For SSB burst(s) indicated by on-demand SSB SCell operation via RRC, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is the first symbol of the first actually transmitted SSB of on-demand SSB burst which is T symbols after the slot where* Alt. 1: UE receives a signalling from gNB (in PDSCH) to indicate on-demand SSB transmission
* Alt. 2: UE receives PDCCH with UL grant
* FFS: details of T

**Proposal 9:** For SSB transmission case #1, further discuss the following options for the time instance B:* Option 1: The time instance B is the time UE receives the Scell deactivation command or the time UE sends HARQ-ACK in response to the reception of Scell deactivation command.
* Option 2: The time instance B is the time UE receives the signaling indicating unavailability of on-demand SSB transmission.

**Proposal 10:** For SSB transmission case #2, the time instance B is the time UE successfully completes Scell activation (e.g., transmitting the CSI report after UE receives the Scell activation command). |
| [32] Ericsson | **Proposal 2** Support mechanisms to start on-demand SSB transmissions on an SCell and to stop an ongoing on-demand SSB transmission.**Proposal 3** Support mechanism to switch on-demand SSB periodicity.**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] CEWiT | **Proposal 4:** Support following alternatives for a gNB transmitting the on demand SSB multiple times after receiving the UL WUS.* Alt 1: for a duration of time.
* Alt 2: for a number(N) of times
* Alt 3: Until a deactivation command is received by the gNB.

**Proposal 5:** Support study on gNB behavior in case of no UE camps on the SCell within the fixed duration. |

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| **Agreement (RAN1#116)*** For SSB burst(s) triggered by on-demand SSB SCell operation, study at least the following options.
	+ Option 1: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A.
	+ Option 1A: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A until gNB turns OFF the on demand SSB
	+ Option 2: UE expects that on-demand SSB burst(s) is transmitted from time instance A to time instance B and not transmitted after time instance B.
	+ Option 3: UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted.
	+ Option 4: UE expects that on-demand SSB burst(s) is transmitted with a periodicity from time instance A to time instance B and with the other periodicity after time instance B.
	+ FFS: The combination of above options
	+ FFS: How to define time instance A/B and the value of N per option
	+ FFS: Each option is applicable to which Cases or Scenarios (as per the previous agreement)

**Agreement (RAN1#117)**For SSB burst(s) indicated by on-demand SSB SCell operation via MAC CE, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.* Alt 3-1: Time instance A is [the slot boundary of] the first SSB time domain position [of actually transmitted on-demand SSB burst] which is T [slots or symbols] after the [slot or symbol] where UE receives a signalling from gNB to indicate on-demand SSB transmission
	+ The SSB time domain positions of on-demand SSB burst are configured by gNB.
* FFS: Details of the value of T (≥ 0) including possibility of T comprising of multiple components
* Note: The value of T is not less than existing timeline required for UE’s MAC CE processing for SCell activation
* FFS: Whether the value of T is predefined or indicated/configured by gNB
* FFS: Details of “the [slot or symbol] where UE receives a signalling from gNB” or “the [slot or symbol] where UE transmits HARQ-ACK corresponding to a signalling from gNB to trigger on-demand SSB”

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

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

* Option 1
	+ Supported by InterDigital, Samsung (for Case #1)
	+ Objected by Spreadtrum, ZTE, ETRI
* Option 1A
	+ Supported by CMCC (for Scenario #2A), CATT, InterDigital, Fujitsu
	+ Objected by Spreadtrum,
* Option 2
	+ Supported by Spreadtrum, CMCC (for Scenario #2), CATT, Fujitsu, Samsung (for Case #2), Lenovo, Qualcomm (with modification)
* Option 3
	+ Supported by CMCC (for Scenario #2), vivo, CATT, InterDigital, Fujitsu, Samsung (for Case #2), Lenovo, NEC (for Case #2), Transsion
* Option 4
	+ Supported by CMCC (for Scenario #2A)

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

* Time instance A
	+ The slot boundary of the first SSB time domain position of actually transmitted on-demand SSB burst
		- Supported by Huawei, vivo, Samsung?, Lenovo, NEC, ETRI
	+ Numerology issue
		- Nokia: Reference to PCell SFN
		- vivo, NEC: Follow the numerology of the cell with signalling transmission
	+ vivo: The slot starting from the time instance A should include the first SSB of a complete actually transmitted on-demand SSB burst.
* T = Not less than $m+3N\_{slot}^{subframe,μ}$ where m is slot offset between the slot containing MAC CE and the slot containing the corresponding HARQ-ACK
	+ Huawei, LG Electronics, Qualcomm
	+ Xiaomi, Fujitsu, Lenovo 🡪 +1 slot added
	+ OPPO: NOT associated with HARQ-ACK timing
* T can be configurable
	+ Supported by Huawei, CMCC, NEC, Transsion, Apple, CATT?
	+ Negative: NTT DOCOMO
* Time unit for T
	+ Slot-level: Intel, vivo, CATT, ZTE, Apple, NTT DOCOMO
	+ Symbol-level: Qualcomm
	+ Half-frame-level: Fujitsu, OPPO
* T for RRC based signaling
	+ Depending on *RRCReconfigurationComplete* message TX
		- Supported by Intel, Fujitsu, Qualcomm
	+ Depending on PDSCH reception timing
		- Supported by LG Electronics, Qualcomm
	+ Depending on reception of UL grant
		- Supported by Qualcomm (NOTE: The latency from UL grant to RRC UL response is up to UE implementation)

First of all, it is observed that companies have different understanding on the definition of T. For the convenience, let’s assume that UE receives MAC CE (for on-demand SSB transmission indication) at **slot n**.

* **Understanding #1 for T:** Time instance A is located after T, so the distance between slot n and time instance A can be greater than T.



* **Understanding #2 for T**: T equals to the distance between slot n and time instance A.



From the moderator’s view, **Understanding #1 should be taken** since it provides more flexibility for OD-SSB TX indication timing at gNB side and this was the baseline assumption in the discussion during the last meeting. Therefore, **Time instance A is located after T from slot n.**

### Companies are encouraged to provide views if your understanding is different from me.

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| Company | Views |
| Tejas | Support |
|  |  |

Next issue is how to define time instance A if some of SSB indexes are configured as *not-transmitted* (i.e., bitmap of *ssb-PositionsInBurst* for OD-SSB is NOT all ones).

* Alt 1: Time instance A is defined as the slot/symbol boundary of the first SSB time domain position, regardless of how SSB positions within an on-demand SSB burst are configured to the UE.



* Alt 2: Time instance A is defined as the slot/symbol boundary of the first SSB time domain position of **actually transmitted** on-demand SSB burst.



### Companies are encouraged to provide views between Alt 1 and Alt 2.

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| Company | Views |
| DCM | We support Al1. PCell where OD-SSB indication will be sent and SCell might have small time different (e.g., a few symbols in some cases), so UE behavior of Alt2 would result in UE missing some SSB index(es). |
| LGE | Prefer Alt 1, Time instance A is defined as the slot boundary. |
| Spreadtrum | Alt 1 |
| OPPO | Alt 1 |
| Tejas | We support Alt-1 |

One additional issue is how to define time instance A **if T is located in the middle of the on-demand SSB burst**.

* Alt A: Time instance A is the slot/symbol boundary of the next on-demand SSB burst.



* Alt B: Time instance A is the slot/symbol boundary of the first SSB time domain position within the current on-demand SSB burst, located after T.



### iCompanies are encouraged to provide views between Alt A and Alt B.

|  |  |
| --- | --- |
| Company | Views |
| DCM | We prefer Alt B. |
| LGE | Prefer Alt A, Time instance A is the slot boundary of the next on-demand SSB burst. |
| Spreadtrum | Alt B |
| OPPO | Alt A |
| Tejas  | We support Alt-A |

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

### Proposal #5-1 (Time instance A):

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

* For SSB burst(s) indicated by on-demand SSB SCell operation via MAC CE, UE expects that on-demand SSB burst(s) is transmitted from time instance A which is determined as follows.
	+ Alt 3-1: Time instance A is ~~[~~the slot boundary of~~]~~ the first SSB time domain position ~~[~~of [actually transmitted] on-demand SSB burst~~]~~ which is located after T ~~[~~slots ~~or symbols] after~~ from the ~~[~~slot ~~or symbol]~~ where UE receives a signalling from gNB to indicate on-demand SSB transmission
		- The SSB time domain positions of on-demand SSB burst are configured by gNB.
	+ ~~FFS: Details of the value of T (≥ 0) including possibility of T comprising of multiple components~~
	+ T is not less than $m+3N\_{slot}^{subframe,μ}$ where slot *n*+*m* is a slot indicated for PUCCH transmission with HARQ-QCK information for the PDSCH reception at slot *n* containing MAC CE signaling to indicate on-demand SSB transmission.
	+ ~~Note: The value of T is not less than existing timeline required for UE’s MAC CE processing for SCell activation~~
	+ FFS: Whether the value of T is predefined or indicated/configured by gNB
	+ ~~FFS: Details of “the [slot or symbol] where UE receives a signalling from gNB” or “the [slot or symbol] where UE transmits HARQ-ACK corresponding to a signalling from gNB to trigger on-demand SSB”~~
* Above applies at least for the case where SCell with on demand SSB transmission and cell with signalling transmission have the same numerology.

Companies are encouraged to provide views on Proposal #5-1 and please note that based on discussion, above Proposal #5-1 can be updated accordingly.

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| Company | Views |
| Google | OK |
| ZTE, Sanechips | We support this proposal. |
| CMCC | Support. |
| LGE | OK, but, with “Actually transmitted”, staring point of SSB burst on SSB positions within an on-demand SSB can be variable and different. So, “Actually transmitted” is preferred to remove  |
| Spreadtrum | Fine for removing “actually transmitted”. We usually use it for ssb-PositionsInBurst. |
| Xiaomi | Support. |
| Tejas | Support |

# L1/L3 measurement based on on-demand SSB

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| Company | Views |
| [1] Futurewei | **Proposal 10:** For on-demand SSB based L1 and/or L3 measurement, reuse existing L1 and L3 measurement and reporting mechanisms designed for always-on SSB. |
| [2] Huawei | **Proposal 12:** RAN1 to support L3-based measurement for on-demand SSB and further discuss, possibly with other working groups, the needed modification on existing L3 measurement procedure/requirement. |
| [5] Google | **Proposal 8:** Support to configure the on-demand SSB for RLM/BFD/CBD.**Proposal 9:** For L1-RSRP/L1-SINR report based on on-demand SSB, support the UE to report the SSBRI based on the activated SSBs. |
| [6] CMCC | **Proposal 15:** For L1 measurement based on on-demand SSB, aperiodic L1 measurement report is supported. |
| [7] Intel | **Proposal 8:** For L1 measurements based on OD-SSB update the reporting mechanism to include the case that these only need to be transmitted by the UE when the OD-SSBs are present.**Proposal 9:** On-demand SSB should enable or aid (at least) RRM measurement for Scells after Scell configuration. |
| [10] vivo | **Proposal 5:** Support aperiodic L1 measurement report based on on-demand SSB.**Proposal 6:** When trigger L1 measurement and L1 measurement report, it should be indicated explicitly that either always-on SSBs or OD-SSBs are to-be-measured, especially if they have the same SSB frequency but different SSB power. |
| [11] OPPO | **Proposal 2:** Perform L1 and/or L3 measurement based on on-demand SSB after SCell activation command is received, no matter the on-demand SSB indication is received in Scenario #2 or Scenario #2A. |
| [13] CATT | **Proposal 11:** 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 12:** Aperiodic report based on existing CSI framework should be supported for on-demand SSB.**Proposal 13:** Consider two candidate solutions to add on-demand SSB resource configuration to existing CSI resource configuration.* Alt-1: The existing IE CSI-ResourceConfig should include the on-demand SSB resource configuration information.
* Alt-2: A new dedicated resource configuration IE for on-demand SSB resource configuration should be introduced, e.g. CSI-ResourceConfig-NES.

**Proposal 14:** Consider two candidate solutions to add on-demand SSB reporting configuration to existing CSI reporting configuration.* Alt-1: The existing IE CSI-ReportConfig should include the on-demand SSB reporting configuration information.
* Alt-2: A new dedicated reporting configuration IE for on-demand SSB reporting configuration should be introduced, e.g. CSI-ReportConfig-NES.

**Proposal 15:** Consider two candidate solutions to activate and deactivate semi-persistent L1 measurement reporting on PUCCH for on-demand SSB.* Alt-1: The existing SP CSI reporting on PUCCH Activation/Deactivation MAC CE should include the activation and deactivation of SP CSI reporting on PUCCH for on-demand SSB, e.g., one of the reserved bits can be used to indicate whether the MAC CE applies to SP CSI reporting on PUCCH Activation/Deactivation for on-demand SSB or not.
* Alt-2: A new dedicated MAC CE should be introduced for activation and deactivation of semi-persistent L1 measurement reporting on PUCCH for on-demand SSB.

**Proposal 16:** Consider two candidate solutions to trigger semi-persistent L1 measurement reporting on PUSCH for on-demand SSB.* Alt-1: The existing DCI field CSI request is reused to trigger semi-persistent L1 measurement reporting on PUSCH for on-demand SSB, and the existing DCI field Transform precoding indicator is used to indicate the DCI is used to trigger semi-persistent L1 measurement reporting on PUSCH for on-demand SSB, or for legacy MIMO/LTM.
* Alt-2: A new dedicated RNTI (e.g., NES-RNTI) for DCI format 0\_1 and 0\_2 should be introduced for triggering of semi-persistent L1 measurement reporting on PUSCH for on-demand SSB.

**Proposal 17:** Consider two candidate solutions to support the semi-persistent L1 measurement reporting on PUSCH for multiple on-demand SSBs from multiple SCells.* Alt-1: The existing IE *CSI-SemiPersistentOnPUSCH-TriggerState* should include multiple *CSI-ReportConfigIds*. Each *CSI-ReportConfigId* is associated with one on-demand SSB resource configuration information.
* Alt-2: A new dedicated trigger state IE for on-demand SSB should be introduced, e.g. *CSI-SemiPersistentOnPUSCH-TriggerState-NES*.
 |
| [14] ZTE | **Proposal 17:** For L1 measurement, the enhancements of the SSB resources and/or the on-demand SSB resources for CSI report configuration should be considered. |
| [17] Fujitsu | **Proposal 9.** For the LTM related L1 measured performed on OD-SSB, the necessity and benefit need further clarification.**Proposal 10.** On-demand SSB and always-on SSB can be configured in the same BWP.**Proposal 11.** Enhancements on configurations of CSI measurement, RLM or BFD are necessary to specify the corresponding L1 measurement is performed based on which SSB.* Specify the "*ssb-Index*" configured in the *csi-SSB-ResourceSet*, *RadioLinkMonitoringRS*, and *BeamLinkMonitoringRS* refers to always-on SSB and/or on-demand SSB.
 |
| [18] LG Electronics | **Proposal #10:** Discuss how to configure on-demand SSB as the measurement resource for CSI report configuration for L1 measurement.**Proposal #11:** Discuss the relationship between the frequency position of on-demand SSB and the frequency range of the first active BWP given by the higher layer parameter *firstActiveDownlinkBWP-Id*.**Proposal #12:** Discuss UE behaviour to perform the measurement/report based on on-demand SSB after the on-demand SSB is deactivated. |
| [21] NEC | **Proposal 24:** Support periodic and semi-persistent CSI reporting based on on-demand SSB for Case#1.* The on-demand SSB indication shall be provided to the UE before the first CSI report transmission occasion.

**Proposal 25:** Support aperiodic CSI reporting based on on-demand SSB for Case#2.**Proposal 26:** For aperiodic CSI reporting based on on-demand SSB consider one of the following options:* Option-1: Support group-common based DCI indication
* Option-2: Support indication of on-demand SSB within the CSI report trigger indication
 |
| [26] Panasonic | **Proposal 3:** L3 measurement based on on-demand SSB should be supported at least for Scenario #2. To facilitate the SCell deactivation and on-demand SSB ON/OFF, other scenarios can also be supported.**Proposal 4:** L1 measurement when on-demand SSB is ON should be supported at least for Scenario 2A, 3A and 3B i.e., after the SCell is activated. On Scenario 2, further clarification is needed on whether to support on-demand SSB based L1 measurement.**Proposal 5:** For RRC triggered/indicated on-demand SSB, the periodic, semi-persistent and aperiodic CSI report should be supported.**Proposal 6:** For MAC CE triggered/indicated on-demand SSB, only semi-persistent and aperiodic CSI report should be supported.**Proposal 7:** For group common DCI triggered/indicated on-demand SSB, only semi-persistent and aperiodic CSI report should be supported. |
| [27] Apple | **Proposal 12:** The RRC configuration for OD-SSB SCell operation to include one set of BFD parameters for OD-SSB per the SCell. Once UE receives RRC or MAC-CE based OD-SSB indication, UE shall use BFD parameters for OD-SSB. |
| [29] NTT DOCOMO | **Observation 2:** In order for NW to know which configured SCell and beam is best to be activated with minimizing NW TX, L1 meas. based on OD-SSB is beneficial.**Proposal 10:*** Support L1 meas. based on OD-SSB at least in scenario#2/case#1.
* L1 meas. based on OD-SSB in other scenarios and case#2 can be supported by reusing a spec. support for scenario#2/case#1.

**Proposal 11:*** Support aperiodic L1 measurement report using on-demand SSB.
* Note: the restriction on time domain behavior of OD-SSB and L1 reporting should follow the legacy CSI framework.
	+ E.g., Periodic L1 meas. report should be associated with periodic on-demand SSB only where we as-sume that periodic on-demand SSB is turned on/off via RRC signaling only.

**Proposal 12:** For triggering/activation mechanism, support reuse of the existing behavior, i.e., * periodic reporting triggered by RRC
* Semi-Persistent reporting on PUCCH triggered by MAC CE, on PUCH triggered by DCI
* Aperiodic reporting on PUSCH triggered by DCI, additionally activated by MAC CE

**Proposal 13:** Support L3 meas. based on on-demand SSB at least in scenario#2/case#1. |
| [30] Sharp | **Proposal 2** Support L3 measurement based on on-demand SSB for SCell operation in Scenario 3B and Case #1.**Observation 1** The UE cannot receive OD-SSB if the OD-SSB is outside the UE’s active DL BWP in scenario 3B, i.e., SCell activation has been completed.**Proposal 3** RAN1 to study how to support OD-SSB-based L1-RSRP measurement in scenario 3B, taking BWP aspects into account.**Proposal 4** RAN1 to study the following options for OD-SSB-based L1-RSRP measurement in scenario 3B in the cases where the triggered OD-SSB is outside the active DL BWP:* Solution #1: Ignoring the triggered OD-SSB
* Solution #2: Using measurement gap to perform OD-SSB-based L1-RSRP measurement
* Solution #3: Supporting BWP change due to OD-SSB triggering
* Solution #4: Supporting BWP-specific OD-SSB configuration
 |
| [31] Qualcomm | **Proposal 11:** For L1 measurement based on on-demand SSB, aperiodic L1 measurement reports based on existing CSI framework are supported.**Observation 2:** It should be sufficient to use always-on SSB for L3 measurement in SSB transmission case 2**Proposal 12:** For SSB transmission case 1, support L3 measurement based on on-demand SSB.* Impact of OD-SSB based L3 measurement on the existing RRM requirements needs to be investigated by RAN4 since periodic SSB transmission is only available within a finite time window.
 |
| [32] 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. |

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| **Agreement (RAN1#117)*** At least support L1 measurement based on on-demand SSB
	+ For L1 measurement based on on-demand SSB, periodic, semi-persistent, [and aperiodic] L1 measurement reports based on existing CSI framework are supported.
		- FFS on potential enhancements of CSI report configuration and/or triggering/activation mechanisms for L1 measurement based on on-demand SSB
 |

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

* L1 measurement reporting type
	+ Aperiodic L1 measurement reporting
		- Supported by CMCC, vivo, CATT, NEC (for Case #2), Panasonic, NTT DOCOMO, Qualcomm
	+ Panasonic and NTT DOCOMO stated that periodic reporting is supported only for RRC based signaling
* Whether to configure the on-demand SSB for BFD/CBD
	+ Supported by Google, Fujitsu, Apple
* How configure/indicate on-demand SSB as a measurement resource for L1 measurement reporting
	+ vivo, CATT, ZTE, LG Electronics
* CATT suggested further details on CSI reporting mechanism
	+ How to activate and deactivate semi-persistent L1 measurement reporting on PUCCH for on-demand SSB
	+ How to trigger semi-persistent L1 measurement reporting on PUSCH for on-demand SSB
	+ How to support the semi-persistent L1 measurement reporting on PUSCH for multiple on-demand SSBs from multiple SCells
* How to handle CSI reporting if the corresponding on-demand SSB is absent
	+ Intel, LG Electronics
* Fujitsu, LG Electronics, and Sharp (for Scenario #3B) suggested to clarify the relationship between BWP of always-on SSB and BWP of on-demand SSB
* Google suggested to support SSBRI based on on-demand SSB

### Proposal #6-1 (AP L1 reporting):

* Update the previous RAN1 agreement as follows.
	+ At least support L1 measurement based on on-demand SSB
		- For L1 measurement based on on-demand SSB, periodic, semi-persistent, ~~[~~and aperiodic~~]~~ L1 measurement reports based on existing CSI framework are supported.
			* FFS on potential enhancements of CSI report configuration and/or triggering/activation mechanisms for L1 measurement based on on-demand SSB

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

|  |  |
| --- | --- |
| Company | Views |
| Google | Support |
| DCM | Support. No reason to preclude Aperiodic L1 reporting based on OD-SSB. |
| ZTE, Sanechips | Support |
| CMCC | Support |
| LGE | We prefer that Square bracket is removed. Additionally, when SCell is configured and SCell is activated, on-demand SSB should be located within FirstActiveDownlinkBWP. If on-demand SSB is located out of FirstActiveDownlinkBWP, there is no reason to trigger on-demand SSB for measurement and fast synchronization with measurement Gap. |
| Sharp | Support |
| Moderator | During online session, the following agreement was made. So, this issue can be closed.**Agreement*** Update the previous RAN1 agreement as follows.
	+ At least support L1 measurement based on on-demand SSB
		- For L1 measurement based on on-demand SSB, periodic, semi-persistent, ~~[~~and aperiodic~~]~~ L1 measurement reports based on existing CSI framework are supported.
			* FFS on potential enhancements of CSI report configuration and/or triggering/activation mechanisms for L1 measurement based on on-demand SSB
			* The support of LTM is a separate discussion point
 |

### Q#6-1) Do you agree that on-demand SSB can be configured for BFD-RS?

|  |  |
| --- | --- |
| Company | Views |
| Google | This may need more study, but we think OD-SSB can be configured as CBD-RS. Probably we can start with CBD-RS. |
| DCM | Further study is needed. This is related to the potential issue of L3 or periodic L1 measurement on OD-SSB which can be occasionally turned off.  |
| CMCC | Open to discuss. At least for legacy UEs, SSB cannot be used as BFD RS on SCell. |
| LGE | It can be discussed |
| Sharp | Further study is needed. |
| Xiaomi | We are open to further discussion. Some enhancement may be needed as currently UE assumes SSB is always transmitted based on fixed SSB burst pattern. |

### Q#6-2) The following figure is captured from [14] ZTE. Do you agree that CSI-SSB resource set for on-demand SSB can be separately configured from CSI-SSB resource set for always-on SSB?



Figure 2 Configuration of SSB/on-demand SSB resources

|  |  |
| --- | --- |
| Company | Views |
| Google | No. We failed to see the necessity. |
| DCM | We are fine with the direction.But it seems a first step to discuss whether a UE should manage/measure always-on SSB and on-demand SSB separately or jointly to derive one CSI (especially for case#2).  |
| ZTE, Sanechips | L1 meeasurement based on on-demand SSB anyway introduces new features, including some changes on configuration of CSI-SSB resource set, otherwise the default way is that UE relies on legacy always-on SSB for L1 measurement. |
| CMCC | No. The intention is to indicate whether always-on SSB or on-demand SSB resources is utilized for L1 measurement. For R19 UEs, when there are multiple SSB configurations, SSB index in CSI-SSB resource set can be associated with activated SSB configuration. |
| LGE | OK |

# UE-triggered on-demand SSB operation

|  |  |
| --- | --- |
| Company | Views |
| [4] Spreadtrum | **Observation 3:** UL WUS to SCell may be feasible, if UL WUS is a PRACH (preamble).**Observation 4:** UL WUS to SCell may not be necessary.**Observation 5:** UL WUS to PCell is feasible.**Observation 6:** Whether UL WUS to PCell is necessary should be further studied.**Proposal 9:** If triggering method of UL WUS is supported, UE should transmit UL WUS to PCell. |
| [5] 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
 |
| [6] CMCC | **Observation 2:** Compared with “SR/BSR + gNB indication”, the scheme “UL WUS + gNB confirmation” can save UL grant and BSR transmission and reduce total latency of SCell activation procedure.**Proposal 3:** For on-demand SSB SCell operation in Scenario #2, UL WUS can be used to request on-demand SSB and subsequent gNB confirmation indicates on-demand SSB on NES SCell. |
| [11] OPPO | **Proposal 8:** Support on-demand SSB SCell operation triggered by UE. |
| [12] 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.**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. |
| [13] CATT | **Proposal 20:** 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 21:** 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 22:** 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 23:** 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).
 |
| [15] Sony | **Proposal 1:** RAN1 should support on-demand SSB Scell operation triggered by UE. |
| [16] InterDigital | **Observation 5:** Transmitting OD-SSB in the time occasions expected by the UE (e.g. for making timely measurements and reporting) can reduce the SCell activation delay**Proposal 9:** Support UL WUS for requesting on-demand SSB transmission at SCell**Proposal 10:** Support using PRACH preamble on the PCell as UL WUS for requesting OD-SSB on the SCell |
| [17] Fujitsu | **Proposal 4.** For UE uplink wake-up-signal, further clarification on useful use case(s) is needed.  |
| [18] LG Electronics | **Proposal #13:** 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 #14:** 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 #15:** Discuss how to handle the case where UE does not receive gNB’s response corresponding to UE’s uplink wake-up-signal or UE does not detect the SSB on an SCell after UE transmits uplink wake-up-signal. |
| [19] Samsung | **Proposal 5:** Support UE triggered on-demand SSB based on an UL WUS. |
| [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). |
| [21] NEC | **Proposal 20:** Specify UE-triggered on-demand SSB request for SCell operation.**Proposal 21:** UE request for on-demand SSB on SCell may be sent via configured PUCCH resources.* FFS whether PUCCH resources are configured only in PCell or can SCell resources be used
 |
| [27] Apple | **Proposal 11:** 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.
 |
| [29] 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 3:*** 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.
 |
| [31] 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 13:** Wake-up signal from the UE to trigger on-demand SSB transmission is not supported. |
| [33] 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 UE* Alt.1. an UL signal configured by PCell
* Alt.2. a predefined sequence.

**Proposal 3:** Following alternatives can be considered to provide resources of the trigger.* Alt.1. Configured by PCell
* Alt.2. Predefined in specification.
 |

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

* Positive view: Google, CMCC, OPPO, Xiaomi, CATT, Sony, InterDigital, LG Electronics, Samsung, Lenovo, NEC, 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.

* 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.
* InterDigital
	+ Such conditions can include those related to UL data arrival, measurements of pathloss RS, DL synchronization with Scell and timing alignment with Scell.
* 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.
* 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.

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

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

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

|  |  |
| --- | --- |
| Company | Views |
| Google | Support |
| DCM | The identified cases are more like UE-initiated new procedures. This is beyond this on-demand SSB topic. |
| CMCC | UE sends request for OD-SSB, the transmission of OD-SSB is still indicated by gNB’s confirmation. |
| LGE | Support the proposal |
| Sharp | Do not support. This agenda item is under NES, but the proposed events is not directly related to NES. |
| xiaomi | Support. |

# Further details on on-demand SSB operation

|  |  |
| --- | --- |
| Company | Views |
| [1] Futurewei | **Proposal 6:** 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.
 |
| [5] 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*. |
| [7] Intel | **Proposal 10:** Prevent access for UEs not supporting Rel-19 NES features via legacy baring feature. Rel-19 NES features are supported via a non-barring indication like for Rel-18 NES. |
| [9] China Telecom | **Observation 6:** To avoid the energy wasting, only one SSB should be transmitted if there is overlap between the on-demand SSB and always-on SSB**Observation 7:** To reduce the complexity for handling the case where conflict of on-demand SSB and always-on SSB exists, gNB should try to transmit the on-demand SSB and one of the legacy always-on SSB at the same time. |
| [10] vivo | **Proposal 20:** To support on-demand SSB operation, further discuss the collision between on-demand SSB transmission and other transmissions. |
| [12] Xiaomi | **Observation 2:** No matter which mechanism is adopted for SSB triggering, UE may not be able to recognize SSB transmission status.**Proposal 10:** 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 11:** Further study whether/how to optimize SCell release procedure with taking SSB ON/OFF into consideration. |
| [13] CATT | **Proposal 18:** From UE’s perspective, multiple configuration of on-demand SSBs activated at the same time for a cell should not be allowed.**Proposal 19:** When multiple MAC-CE based signallings indicating on-demand SSB transmission are received successively, time instance A is decided only by the first MAC-CE signalling. |
| [18] LG Electronics | **Proposal #16:** 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 #17:** 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. |
| [19] 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. * Time domain and frequency domain resources for on-demand SSB shall not overlap with time domain and frequency domain resources for the periodic SSB, if any.

**Proposal 3:** SSB structure and SSB mapping pattern in a half frame for the on-demand SSB maintain the same as legacy. |
| [21] NEC | **Proposal 22:** For Case#2, when on-demand SSB and always-on SSB overlap in time domain, consider always-on SSB is given higher priority than on-demand SCell SSB request. **Proposal 23:** For Case#1 and Case#2, within a time window, combine multiple on-demand SSB transmissions due to multiple on-demand SSB requests into one in order to maximize network energy saving.**Proposal 28:** 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 29:** RAN1 to discuss UE behaviour on PDSCH rate matching around on-demand SSB. |
| [22] Transsion | **Proposal 11** It is recommended that the feasibility of joint use of on-demand SSB transmission and cell DTX can be studied. |
| [25] 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. |
| [26] Panasonic | **Proposal 8:** For time/frequency synchronization and TCI state using on-demand SSB as reference resource, only Scenario #3B is supported.**Proposal 11:** When always-on SSB and on-demand SSB are both transmitted within the same SCell or in different cells, the relation and the QCL should be further discussed and clarified. |
| [29] NTT DOCOMO | **Observation 3:** On-demand SSB is beneficial during SCell activation procedure to avoid both long activation delay and high NW energy consumption.**Proposal 14:** Support SCell activation based on only on-demand for case#1 and both on-demand SSB and always-on SSB for case#2. |
| [33] CEWiT | **Proposal 6:** Support handling of the case where UE cannot receive SSB after after on-demand SSB operation.**Proposal 8:** Support study on impacts of on-demand SSB on RACH occasions for RRC connection establishment. |

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

* Relation between always-on SSB and on-demand SSB
	+ Futurewei
* Whether/how to handle rate-matching issue
	+ Google, NEC
* Whether/how to allow overlapping of always-on SSB and on-demand SSB
	+ China Telecom, Samsung, NEC
* Whether/how to handle collision issue between SSB and other signals/channels
	+ vivo, LG Electronics
* Whether/how to optimize SCell release procedure with taking SSB ON/OFF into consideration
	+ Xiaomi
* Whether/how to allow overlapping of multiple on-demand SSBs
	+ CATT, NEC
* Whether/how to use on-demand SSB for time/frequency synchronization and TCI state/QCL
	+ LG Electronics, Panasonic
* Whether/how to handle the case where UE cannot receive SSB after on-demand SSB operation
	+ LG Electronics, NEC, CEWiT
* Joint operation of cell DTX and on-demand SSB
	+ LG Electronics, Transsion
* Whether to change the structure of SSB triggered by on-demand SSB operation
	+ NO: Samsung

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

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

# Reference

1. R1-2405811 Discussion of on-demand SSB Scell operation FUTUREWEI
2. R1-2405856 On-demand SSB SCell operation for eNES Huawei, HiSilicon
3. R1-2405894 On-demand SSB SCell operation Tejas Networks Limited
4. R1-2405916 Discussion on on-demand SSB SCell operation Spreadtrum Communications
5. R1-2405957 On-demand SSB SCell Operation Google
6. R1-2405993 Discussion on on-demand SSB SCell operation CMCC
7. R1-2406021 Design of on-demand SSB SCell operation Intel Corporation
8. R1-2406049 On-demand SSB SCell Operation Nokia, Nokia Shanghai Bell
9. R1-2406095 Discussion on on-demand SSB operation for SCell China Telecom
10. R1-2406190 Discussions on on-demand SSB Scell operation vivo
11. R1-2406226 Discussion on the enhancement to support on demand SSB SCell operation OPPO
12. R1-2406292 Discussion on on-demand SSB SCell operation Xiaomi
13. R1-2406376 Discussion on on-demand SSB SCell operation CATT
14. R1-2406409 Discussion on on-demond SSB for NES ZTE Corporation, Sanechips
15. R1-2406477 On-demand SSB SCell operation Sony
16. R1-2406507 Discussion on on-demand SSB SCell operation InterDigital, Inc.
17. R1-2406515 Discussion on on-demand SSB SCell operation Fujitsu
18. R1-2406608 On-demand SSB SCell operation LG Electronics
19. R1-2406658 On-demand SSB SCell operation Samsung
20. R1-2406689 On-demand SSB SCell operation Lenovo
21. R1-2406694 Discussion on on-demand SSB for SCell operation NEC
22. R1-2406704 Discussion on On-Demand SSB SCell operation Transsion Holdings
23. R1-2406708 DCI based signaling for on-demand SSB ASUSTeK
24. R1-2406732 Discussion on On-demand SSB SCell operation ETRI
25. R1-2406758 On-demand SSB SCell operation MediaTek Inc.
26. R1-2406783 Discussion on on-demand SSB SCell operation Panasonic
27. R1-2406847 On-demand SSB SCell Operation Apple
28. R1-2406902 Discussion of On-demand SSB SCell operation Mavenir
29. R1-2406938 Discussion on on-demand SSB SCell operation NTT DOCOMO, INC.
30. R1-2406971 Discussion on details of on-demand SSB operation on Scell Sharp
31. R1-2407037 On-demand SSB operation for Scell Qualcomm Incorporated
32. R1-2407056 On-demand SSB SCell operation Ericsson
33. R1-2407080 Discussion on on-demand SSB Scell operation CEWiT

# Appendix: Previous agreements

## RAN1#116

**Agreement**

Regarding the UE assumption on SSB transmission on a cell supporting on-demand SSB SCell operation, the following cases are identified for further study:

* Case #1: No always-on SSB on the cell
* Case #2: Always-on SSB is periodically transmitted on the cell
* FFS: Whether always-on SSB and on-demand SSB are not cell-defining SSB if transmitted.

FFS: Which scenario the above applies for

**Agreement**

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

**Agreement**

For the following identified scenarios for on-demand SSB SCell operation, focus future RAN1 discussion to down-select (both may be selected) between the two scenarios.

* Scenario #2: SCell is configured to a UE but before the UE receives SCell activation command (e.g., as defined in TS 38.321)
* Scenario #3: After UE receives SCell activation command (e.g., as defined in TS 38.321)
	+ This does not preclude SCell for which activation is completed
	+ FFS: The case where SCell activation is completed

FFS: Application timing between NW triggering message and on demand SSB transmission

**Agreement**

Support on-demand SSB SCell operation triggered by gNB.

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

**Agreement**

* For SSB burst(s) triggered by on-demand SSB SCell operation, study at least the following options.
	+ Option 1: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A.
	+ Option 1A: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A until gNB turns OFF the on demand SSB
	+ Option 2: UE expects that on-demand SSB burst(s) is transmitted from time instance A to time instance B and not transmitted after time instance B.
	+ Option 3: UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted.
	+ Option 4: UE expects that on-demand SSB burst(s) is transmitted with a periodicity from time instance A to time instance B and with the other periodicity after time instance B.
	+ FFS: The combination of above options
	+ FFS: How to define time instance A/B and the value of N per option
	+ FFS: Each option is applicable to which Cases or Scenarios (as per the previous agreement)

## RAN1#116bis

**Agreement**

For the identified scenarios and cases (as per RAN1#116 agreement), on-demand SSB can be triggered by gNB at least for the following scenarios/cases:

* Scenario #2 and Case #1
* Scenario #2 and Case #2
* Scenario #2A and Case #1
* Scenario #2A and Case #2
* FFS: Scenario #3A and Case #1
* FFS: Scenario #3A and Case #2
* FFS: Scenario #3B and Case #1
* FFS: Scenario #3B and Case #2
* For Case #1, once on-demand SSB is triggered, its transmission is in a periodic manner.
	+ Note: This does not imply periodic on-demand SSB is transmitted indefinitely after triggered.
* Notes:
	+ Scenario #2A refers to
		- “When UE receives SCell activation command (e.g., as defined in TS 38.321)”
	+ Scenario #3A refers to
		- “After UE receives SCell activation command (e.g., as defined in TS 38.321) until SCell activation is completed”
	+ Scenario #3B refers to
		- “When SCell activation is completed and SCell is activated” or
		- “After SCell activation is completed and SCell is activated”
	+ For discussion purpose under AI 9.5.1, always-on SSB is SSB supported in Rel-18 specifications.
	+ Timing for on-demand SSB transmission (e.g. when the triggered SSB starts and ends) will be separately discussed.

**Agreement**

* For a cell supporting on-demand SSB SCell operation,
	+ Note: It is up to gNB implementation whether always-on SSB (if transmitted) on the cell is cell-defining SSB or not.
	+ For on-demand SSB on the cell, downselect between the following alternatives
		- Alt-1: It is up to gNB implementation whether on-demand SSB is cell-defining SSB or not.
		- Alt-2: On-demand SSB is limited to non-cell-defining SSB.
			* FFS: Further limitations to on-demand SSB

**Agreement**

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

**Agreement**

The following agreement from RAN1#116 is modified (in red)

* For SSB burst(s) ~~triggered~~indicated by on-demand SSB SCell operation, study at least the following options.
	+ Option 1: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A.
	+ Option 1A: UE expects that on-demand SSB burst(s) is periodically transmitted from time instance A until gNB turns OFF the on demand SSB
	+ Option 2: UE expects that on-demand SSB burst(s) is transmitted from time instance A to time instance B and not transmitted after time instance B.
	+ Option 3: UE expects that on-demand SSB burst(s) is transmitted N times after time instance A and not transmitted after N on-demand SSB bursts are transmitted.
	+ Option 4: UE expects that on-demand SSB burst(s) is transmitted with a periodicity from time instance A to time instance B and with the other periodicity after time instance B.
	+ FFS: The combination of above options
	+ FFS: How to define time instance A/B and the value of N per option
	+ FFS: Each option is applicable to which Cases or Scenarios (as per the previous agreement)

**Agreement**

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

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

## RAN1#117

**Agreement**

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

**Agreement**

* For a cell supporting on-demand SSB SCell operation, at least the following for on-demand SSB via higher layer RRC signaling is supported.
	+ Frequency of the on-demand SSB
	+ SSB positions within an on-demand SSB burst by using signaling similar to *ssb-PositionsInBurst*
	+ Periodicity of the on-demand SSB
	+ FFS: Whether more than one on-demand SSB configurations can be configured for the cell to UE
	+ FFS: Whether the RRC is newly introduced or existing RRC is reused

**Agreement**

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

**Agreement**

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

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

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

**Agreement**

* For a cell supporting on-demand SSB SCell operation, at least the followings for on-demand SSB are known to UE.
	+ Sub-carrier spacing of the on-demand SSB
	+ Physical Cell ID of the on-demand SSB
	+ Location of on-demand SSB burst
	+ Downlink transmit power of on-demand SSB
	+ FFS: Other parameters
	+ FFS: Whether each of above parameters is configured/indicated explicitly or not