**3GPP TSG RAN WG1 #112bis-e R1-2303653**

**e-Meeting, April 17th – April 26th, 2023**

**Agenda Item: 9.17.15**

**Source: Moderator (AT&T)**

**Title: Summary of UE features for BWP without restriction**

**Document for:** **Discussion/Decision**

# Introduction

This document presents the summary of email discussion/approval [112bis-e-R18-UE\_features-04] during RAN1 #112bis-e. According to the Chairman’s Notes:

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| [112bis-e-R18-UE\_features-04] Email discussion on UE features for BWP without restriction by April 26 – Ralf (AT&T)* Check points: April 21, April 26
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The following was discussed and/or agreed during RAN1 #112bis-e within the scope of [112bis-e-R18-UE\_features-04]. All proposals are based on the rapporteur input provided in [1].

# Summary of Contributions Submitted to RAN1 #112bis-e

The following is the moderator’s summary of contributions submitted to RAN1 #112bis-e in this agenda item.

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| Company | Summary |
| Ericsson [2] |

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| 53. BWP\_wor | 53-1 | BM/RLM/BFD performed on CD-SSB without MG  | Support of BM/RLM/BFD performed on CD-SSB without measurement gap | 6-1a | Yes |  | BM/RLM/BFD performed on CD-SSB outside active BWP is not supported | Per band | NA | NA | NA | B-1-1, B-1-2Candidate values: {‘with interrupt’ ,’without interrupt’} | Optional |
| 53. BWP\_wor | 53-2 | BM/RLM/BFD performed on NCD-SSB inside active BWP | Support of BM/RLM/BFD performed on NCD-SSB  | 6-1 | Yes |  | BM/RLM/BFD performed on NCD-SSB is not supported | Per band | NA | NA | NA | C | Optional |

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| vivo [3] | For Option B-1-1, an FG X-1 of “Support RLM/BM/BFD measurements based on SSB outside active BWP without interruptions” needs to be defined. Following components can be included for the FG X-1:* Componnets:
	1. BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for SCell
	2. UE performs RLM/BM/BFD measurements based on SSB without interruptions, where the SSB is outside active DL BWP but is in the bandwidth of the corresponding carrier(s) to be measured
	3. The UE is not expected to receive PDSCH, PDCCH, or CSI-RS outside an active DL BWP.

Given FG X-1 and FG X-3 are to replace legacy FG 6-1a, the component of legacy 6-1a should be included as one component for FG X-1 and FG X-3. In addition, component is also added for FG X-1 and FG X-3 to make clear that for Option B-1-1 and Option B-1-2, UE is allowed to only measure SSB outside the active DL BWP, but it does not mean UE needs to receive other DL signals/channels outside the active DL BWP. **Proposal 1: Introduce FGX-1 of “Support RLM/BM/BFD measurements based on SSB outside active BWP without interruptions” for Option B-1-1, with following comopnents:**1. **BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for SCell**
2. **UE performs RLM/BM/BFD measurements based on SSB without interruptions, where the SSB is outside active DL BWP but is in the bandwidth of the corresponding carrier(s) to be measured**
3. **The UE is not expected to receive PDSCH, PDCCH, or CSI-RS outside an active DL BWP.**

About Prerequisite feature groups for FG X-1, we do not FG 6-1a should be the prerequisite FG for Option B-1-1 and Option B-1-2, due to following reasons:This approved WI indicates that the specification support for FG 6-1a is not yet fully complete; andThe component of FG 6-1a is now added as one component for FG X-1 and X-3..**Proposal 2: FG6-1a should not be the prerequisite FG for the FGs introduced for Option B-1-1 and Option B-1-2.**About the Type, same as the Type defined for FG 6-1a “bwp-WithoutRestriction”, FG X-1 (Option B-1-1) should be defined per band and no need of FDD/TDD and FR1/FR2 differentiation. **Proposal 3: For the FGs introduced for Option B-1-1, Option C and Option B-1-2, the Type should be per band and no FDD/TDD and FR1/FR2 differentiation.** In addition, FG X-1 (Option B-1-1) should have a note of “FGX-1 is applicable to FG 6-1, 6-2, 6-3 or 6-4”, which is the same as that for FG6-1a.**Proposal 4: Add the note that the FGX-1 is applicable to FG 6-1, 6-2, 6-3 or 6-4.**For Option C, an FG X-2 of “Support RLM/BM/BFD measurements based on NCD-SSB within active BWP” needs to be defined. The component that UE performs RLM/BM/BFD measurements based on NCD-SSB, where the NCD-SSB is within the active DL BWP can be included for the FG X-2.**Proposal 5: Introduce FGX-2 of “Support RLM/BM/BFD measurements based on NCD-SSB within active BWP” for Option C, with following component:*** **UE performs RLM/BM/BFD measurements based on NCD-SSB, where the NCD-SSB is within the active DL BWP**

About the Prerequisite feature groups for FG X-2, it seems the current feature that active BWP includes NCD-SSB contradicts the legacy FG6-1a since in FG 6-1a, the “SSB” includes both CD- and NCD-SSB. Hence the FG 6-1a should not be the Prerequisite feature group for FG X-2.**Proposal 6: FG6-1a should not be the prerequisite FG for the FG introduced for Option C.**Besides the note that FGX-2 is applicable to FG 6-1, 6-2, 6-3 or 6-4”, it should be clear that FGX-2 is only applicable to non-RedCap UEs.**Proposal 7: Following should be included in the “Note” colomn for FGX-2 (Option C).*** **X-2 is applicable to 6-1, 6-2, 6-3, or 6-4.**
* **X-2 is only applicable to non-RedCap UEs.**

For Option B-1-2, an FG X-3 of “Support RLM/BM/BFD measurements based on SSB outside active BWP with interruptions” needs to be defined. Following components can be included for the FG X-3:* Components:
1. BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for SCell
2. The UE is allowed to perform RLM/BM/BFD measurements based on SSB outside the active BWP with interruptions only if there is no CSI-RS, no NCD SSB and no CD SSB configured for RLM/BM/BFD in the active DL BWP of the corresponding carrier(s) to be measured.
3. The UE is not expected to receive PDSCH, PDCCH, or CSI-RS outside an active DL BWP.

**Proposal 8: Introduce FGX-3 of “Support RLM/BM/BFD measurements based on SSB outside active BWP with interruptions” for Option B-1-2, with following comopnents:**1. **BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for SCell**
2. **The UE is allowed to perform RLM/BM/BFD measurements based on SSB outside the active BWP with interruptions only if there is no CSI-RS, no NCD SSB and no CD SSB configured for RLM/BM/BFD in the active DL BWP of the corresponding carrier(s) to be measured.**
3. **The UE is not expected to receive PDSCH, PDCCH, or CSI-RS outside an active DL BWP.**

About Prerequisite feature groups for FG X-3, based on WID that * The UE shall be allowed to use B-1-2 only if there is no CSI-RS, no NCD SSB and no CD SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s) to be measured; and
* UE shall support option (C) NCD-SSB (subject to IoDT availability).

Hence, FG 1-7, 2-24, 2-31, X-2 should be the prerequisite FGs for Option B-1-2. **Proposal 9: FG 1-7, 2-24, 2-31, X-2 should be the prerequisite FGs for FG X-3 (Option B-1-2).** Besides the note that FGX-3 is applicable to FG 6-1, 6-2, 6-3 or 6-4”, following notes should added for FG X-3.* This feature only applies if there is no CSI-RS, no NCD- SSB, and no CD-SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s) to be measured
* The interruption time and corresponding UE behevaior is left to RAN4 to decide

**Proposal 10: Following should be included in the “Note” colomn for FGX-3 (Option B-1-2).*** **X-3 is applicable to 6-1, 6-2, 6-3, or 6-4.**
* **This feature only applies if there is no CSI-RS, no NCD- SSB, and no CD-SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s) to be measured**
* **The interruption time and corresponding UE behevaior is left to RAN4 to decide**

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| X. NR\_BWP\_wor | X-1 | Support RLM/BM/BFD measurements based on SSB outside active BWP without interruptions  | 1. BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for SCell
2. UE performs RLM/BM/BFD measurements based on SSB without interruptions, where the SSB is outside active DL BWP but is in the bandwidth of the corresponding carrier(s) to be measured

The UE is not expected to receive PDSCH, PDCCH, or CSI-RS outside an active DL BWP. |  | Yes | n/a | UE cannot support RLM/BM/BFD measurements based on SSB outside active BWP without interruptions  | Per Band | No | No | n/a | X-1 is applicable to 6-1, 6-2, 6-3, or 6-4. | Optional with capability signalling |
| X. NR\_BWP\_wor | X-2 | Support RLM/BM/BFD measurements based on NCD-SSB within active BWP  | UE performs RLM/BM/BFD measurements based on NCD-SSB, where the NCD-SSB is within the active DL BWP  |  | Yes | n/a | UE cannot support RLM/BM/BFD measurements based on NCD-SSB within active BWP  | Per Band | No | No | n/a | * X-2 is applicable to 6-1, 6-2, 6-3, or 6-4.

X-2 is only applicable to non-RedCap UEs. | Optional with capability signalling |
| X. NR\_BWP\_wor | X-3 | Support RLM/BM/BFD measurements based on SSB outside active BWP with interruptions  | 1. BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for SCell
2. The UE is allowed to perform RLM/BM/BFD measurements based on SSB outside the active BWP with interruptions only if there is no CSI-RS, no NCD SSB and no CD SSB configured for RLM/BM/BFD in the active DL BWP of the corresponding carrier(s) to be measured.

 The UE is not expected to receive PDSCH, PDCCH, or CSI-RS outside an active DL BWP. | 1-7, 2-24, 2-31, X-2 | Yes | n/a | UE cannot support RLM/BM/BFD measurements based on SSB outside active BWP with interruptions  | Per Band | No | No | n/a | * X-3 is applicable to 6-1, 6-2, 6-3, or 6-4.
* This feature only applies if there is no CSI-RS, no NCD- SSB, and no CD-SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s) to be measured

The interruption time and corresponding UE behevaior is left to RAN4 to decide | Optional with capability signalling |

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| ZTE [4] | The above WID is trying to address the issue of UE capability “bwp-WithoutRestriction”, where UE is allowed to be configured with BWP without including SSB for PCell/PSCell/SCell. However, it is not clear whether the “SSB” refers to CD-SSB or NCD-SSB. This uncertainty will impact the further discussion about new UE capabilities for this WID, thus it is worth clarifying it first.

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| ***bwp-WithoutRestriction***Indicates support of BWP operation without bandwidth restriction. The Bandwidth restriction in terms of DL BWP for PCell and PSCell means that the bandwidth of a UE-specific RRC configured DL BWP may not include the bandwidth of CORESET #0 (if configured) and SSB. For SCell(s), it means that the bandwidth of DL BWP may not include SSB. | Band | No | N/A | N/A |

Based on our understanding, * For non-RedCap UE, the “SSB” in UE capability “bwp-WithoutRestriction” refers to CD-SSB only since the UE capability “bwp-WithoutRestriction” has been in place since Rel-15.
* However, Redcap UE already supports BWP without CD-SSB but with NCD-SSB. Thus, for RedCap UE, the “SSB” in UE capability “bwp-WithoutRestriction” refers to both CD-SSB and NCD-SSB. Then in this case, RedCap UE has two level of indication as following:
* Indicating support of supportOfRedCap-r17 but not support bwp-WithoutRestriction: CD-SSB/NCD-SSB has to be configured within the active BWP.
* Indicating support of both supportOfRedCap-r17 and bwp-WithoutRestriction: UE supports active BWP without CD-SSB/NCD-SSB. UE may need to perform BM/RLM/BFD based on CSI-RS for example.

Thus, we have the following proposal.***Proposal 1****: Regarding UE capability “bwp-WithoutRestriction”** *For Redcap UE, clarifying that “SSB” in UE capability “bwp-WithoutRestriction” refers to both CD-SSB and NCD-SSB.*
* *For non- Redcap UE, clarifying that “SSB” in UE capability “bwp-WithoutRestriction” refers to CD-SSB but not NCD-SSB.*

**Analysis of new UE capabilities****Option A: Perform BM/RLM/BFD based on CSI-RS within active BWP**Based on the previous working group discussion, it seems that companies have common understanding that the spec for Option A is completed from function perspective. It may or may not need any clarifications of the existing requirements. But in any case, new UE feature for option A is not needed from our perspective. ***Observation 1****: From RAN1 perspective, no new UE feature for option A is needed.*

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| ***maxNumberCSI-RS-BFD***Indicates maximal number of CSI-RS resources across all CCs, and across MCG and SCG in case of NR-DC, for UE to monitor PDCCH quality. In this release, the maximum value that can be signalled is 16. If the UE includes the field in an FR1 band, it shall set the same value in all FR1 bands. If the UE includes the field in an FR2 band, it shall set the same value in all FR2 bands. The UE supports a total number of resources equal to the maximum of the FR1 and FR2 value, but no more than the FR1 value across all FR1 serving cells and no more than the FR2 value across all FR2 serving cells. It is mandatory with capability signalling for FR2 and optional for FR1. | Band | CY | N/A | N/A |
| ***csi-RS-RLM***Indicates whether the UE can perform radio link monitoring procedure based on measurement of CSI-RS as specified in TS 38.213 [11] and TS 38.133 [5]. This parameter needs FR1 and FR2 differentiation. If the UE supports this feature, the UE needs to report *maxNumberResource-CSI-RS-RLM*. This applies only to non-shared spectrum channel access. For shared spectrum channel access, *csi-RS-RLM-r16* applies. | UE | Yes | No | Yes |
| ***beamManagementSSB-CSI-RS***Defines support of SS/PBCH and CSI-RS based RSRP measurements. The capability comprises signalling of- *maxNumberSSB-CSI-RS-ResourceOneTx* indicates maximum total number of configured one port NZP CSI-RS resources and SS/PBCH blocks that are supported by the UE to measure L1-RSRP as specified in TS 38.215 [13] within a slot and across all serving cells (see NOTE). On FR2, it is mandatory to report >=8; On FR1, it is mandatory with capability signalling to report >=8.- *maxNumberCSI-RS-Resource* indicates maximum total number of configured NZP-CSI-RS resources that are supported by the UE to measure L1-RSRP as specified in TS 38.215 [13] across all serving cells (see NOTE). It is mandated to report at least n8 for FR1.- *maxNumberCSI-RS-ResourceTwoTx* indicates maximum total number of two ports NZP CSI-RS resources that are supported by the UE to measure L1-RSRP as specified in TS 38.215 [13] within a slot and across all serving cells (see NOTE).- *supportedCSI-RS-Density* indicates density of one RE per PRB for one port NZP CSI-RS resource for RSRP reporting, if supported. On FR2, it is mandatory to report either "three" or "oneAndThree"; On FR1, it is mandatory with capability signalling to report either "three" or "oneAndThree".- *maxNumberAperiodicCSI-RS-Resource* indicates maximum number of configured aperiodic CSI-RS resources across all serving cells (see NOTE). For FR1 and FR2, the UE is mandated to report at least n4.NOTE: If the UE sets a value other than *n0* in an FR1 band, it shall set that same value in all FR1 bands. If the UE sets a value other than *n0* in an FR2 band, it shall set that same value in all FR2 bands. The UE supports a total number of resources equal to the maximum of the FR1 and FR2 value, but no more than the FR1 value across all FR1 serving cells and no more than the FR2 value across all FR2 serving cells. | Band | Yes | N/A | FD |

**Option B-1-1: SSB outside active BWP without interruption**The option B-1-1 can be summarized as following.* Option B) Perform BM/RLM/BFD based on SSB outside active BWP
	+ Option B-1) UE’s capability not requiring additional measurement gap for BM/RLM/BFD
		- Option B-1-1) Using larger BW covering SSB outside active BWP without interruptions

The motivation is to address the issue when UE reports *bwp-WithoutRestriction*, the new UE capability for option B-1-1 can be a per UE capability since the existing *bwp-WithoutRestriction* is already a per band capability.

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| ***bwp-WithoutRestriction***Indicates support of BWP operation without bandwidth restriction. The Bandwidth restriction in terms of DL BWP for PCell and PSCell means that the bandwidth of a UE-specific RRC configured DL BWP may not include the bandwidth of CORESET #0 (if configured) and SSB. For SCell(s), it means that the bandwidth of DL BWP may not include SSB. | Band | No | N/A | N/A |

***Proposal 2****: Introduce the following UE capability for option B-1-1.*

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| Index | Feature group | Components | Type | Prerequisite feature groups | Mandatory/Optional |
| B-1-1 | Perform BM/RLM/BFD based on SSB outside active BWP without interruption | Perform BM/RLM/BFD based on SSB outside active BWP.* UE’s capability not requiring additional measurement gap for BM/RLM/BFD
* Using larger BW covering SSB outside active BWP without interruptions
 | per UE | 6-1a | Optional |

**Option C: NCD-SSB for non-RedCap UEs**Option C requires UE to support of BM/RLM/BFD based on NCD-SSB within active BWP for non-RedCap UEs. Similar as the following UE capability for RedCap UE, a per UE capability can be introduced for non-RedCap UEs.

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| ***supportOfRedCap-r17***Indicates that the UE is a RedCap UE with comprised of at least the following functional components:- Maximum FR1 RedCap UE bandwidth is 20 MHz;- Maximum FR2 RedCap UE bandwidth is 100 MHz;- Support of RedCap early indication based on Msg1, MsgA (if UE indicated support of t*woStepRACH-r16*) and Msg3 for random access;- Separate initial UL BWP for RedCap UEs;- Separate initial DL BWP for RedCap UEs;- UE-specific RRC-configured DL BWP with CD-SSB or NCD-SSB;- NCD-SSB based measurements in RRC-configured DL BWP.A RedCap UE shall set the field to *supported*. | UE | CY | No |

***Proposal 3****: Introduce the following UE capability for option C.*

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| Index | Feature group | Components | Type | Prerequisite feature groups | Mandatory/Optional |
| C | Support of active BWP without CD-SSB but with NCD-SSB for non-RedCap UEs | 1. Support of active BWP without CD-SSB but with NCD-SSB for non-RedCap UEs
 | UE | 6-1a | Optional |

**Option B-1-2: SSB outside active BWP with interruption**The details of option B-1-2 can be summarized as following.* + support of BM/RLM/BFD based on SSB outside the active BWP with interruptions with the following conditions
		- The UE shall be allowed to use B-1-2 only if there is no CSI-RS, no NCD SSB and no CD SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s) to be measured; and
	+ UE shall support option (C) NCD-SSB (subject to IoDT availability).

***Proposal 4****: Introduce the following UE capability for option B-1-2.*

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| Index | Feature group | Components | Type | Prerequisite feature groups | Mandatory/Optional |
| B-1-2 | Perform BM/RLM/BFD based on SSB outside active BWP with interruption | support of BM/RLM/BFD based on SSB outside the active BWP with interruptions with the following conditions* The UE shall be allowed to use B-1-2 only if there is no CSI-RS, no NCD SSB and no CD SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s) to be measured; and
 | per UE | 6-1a andOption C | Optional |

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| Nokia, Nokia Shanghai Bell [5] | As described in the WID, “*BWP operation without CD-SSB (FG 6-1a) is optional feature introduced in Rel-15, however, the specification support for this feature is not yet fully complete.*” Hence, we assume new FGs are required for each of the options listed as objectives in the WID, and that at least FG 6-1a will a pre-requisite to all FGs originated from this WI. **Proposal: Define new FGs for each of the options listed as objectives in the WID, where at least FG 6-1a is included as pre-requisite.**In Table 1 we propose a basic structure of UE features for BWP without restriction.

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| Proposed FG | Description | Pre-requisites | Motivation |
| <Option A> | Support of BM/RLM/BFD based on CSI-RS within active BWP  | 6-1a: BWP wo restriction1-6: CSI-RS based RS-SINR measurement1-13: Maximal number of CSI-RS resources for RRM and RS-SINR measurement across all measurement frequencies per slot1-14: Maximal number of CSI-RS resources within a slot per PCell/PSCell for CSI-RS based RLM | From [1]: * For Option A
	+ Study and specify if any clarifications of the existing requirements are needed, e.g., applicability of requirements, conditions of gap configuration etc. (RAN4)

Hence, the network needs to understand if the UE actually supports all related functionality and requirements to support option A. |
| <Option B-1-1> | Support of BM/RLM/BFD based on SSB outside the active BWP without interruptions. | 6-1a: BWP wo restriction1-2: SS block based SINR measurement (SS-SINR)1-3: SS block based RLM | Measurements are supposed to be based on SSB even if that is not included in the active BWP.  |
| <Option C> | 1. Support of BM/RLM/BFD based on NCD-SSB within active BWP for non-RedCap UEs
2. UE-specific RRC configured DL BWP with NCD-SSB
3. NCD-SSB based measurements in RRC-configured DL BWP
 | 6-1a: BWP wo restriction1-2: SS block based SINR measurement (SS-SINR)1-3: SS block based RLM | Option C implies measurements based on SSB, hence the pre-requisites. Items 2 and 3 in the description are taken from FG 28-1 (RedCap) |
| <Option B-1-2> | Support of BM/RLM/BFD based on SSB outside the active BWP with interruptions | <Option A><Option C>If not already covered by above pre-requisites:1-2: SS block based SINR measurement (SS-SINR)1-3: SS block based RLM | From [1]:* The UE shall be allowed to use B-1-2 only if there is no CSI-RS, no NCD SSB and no CD SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s) to be measured; and
* UE shall support option (C) NCD-SSB (subject to IoDT availability).
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| MediaTek Inc. [6] | First of all, we would like to clarify that the WI is targeted at normal (i.e. non-RedCap) UEs and hence these new UE feature groups should not be applicable to RedCap UEs. Proposal 1: (As a conclusion) These new UE feature groups are not applicable to RedCap UEs.For Option C with NCD-SSB, as agreed for RedCap UEs (see below), we propose that a normal UE may be configured with multiple NCD-SSBs provided that for each BWP the UE is configured with only one SSB.

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| RAN2 #117e1. A RedCap UE may be configured with multiple NCD-SSBs provided that each BWP is configured with at most one SSB |

Proposal 2: For FG 40-3 (i.e. Option C with NCD-SSB), a UE may be configured with multiple NCD-SSBs across different BWPs in a cell but for each BWP the UE is configured with only one SSB.As to Option B-1-1 and Option B-1-2, we don’t see a need for a UE to indicate the support for both UE feature groups. If a UE is capable of supporting B-1-1 without any interruption, why does it want to indicate the support for B-1-2 with interruption. Proposal 3: UE can indicate at most one of FG 40-1 (i.e. B-1-1) and FG 40-2 (i.e. B-1-2).Finally, to support RLM/BM/BFD measurements using CD-SSB outside active BWP without any interruption, as discussed in RAN4 previously [R4-2214355], UE can operate using larger BW covering SSB outside active BWP or UE can utilize a additional separate RF chain [R4-2214355]. In this regard, FG 40-1 in the table below should be supported as “Per-FSPC” type. Proposal 4: FG 40-1 (i.e. B-1-1) should be supported as “Per-FSPC” type.

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| 40. NR\_BWP\_wor | 40-1 | Support RLM/BM/BFD measurements based on CD-SSB outside active BWP without interruptions  | Support RLM/BM/BFD measurements based on CD-SSB outside active BWP without interruptions when the non-RedCap UE indicates support of BWP operation without restriction* Rules and conditions to apply B-1-1 are to be discussed in RAN4.
 | TBD | Yes | n/a | UE cannot support RLM/BM/BFD measurements based on CD-SSB outside active BWP without interruptions when the UE indicates support of BWP operation without restriction | Per FSPC | No | No | n/a | 1. 40-1 is applicable to 6-1, 6-2, 6-3, or 6-4.
	* For example, if UE indicates the support for 6-4 and 40-1, it means UE can support 40-1 with different numerologies between the active BWP and the BWP containing CD-SSB.
2. This FG is not applicable to RedCap UEs.
3. UE indicates at most one of FG 40-1 and FG 40-2.
 | Optional with capability signalling |
| 40. NR\_BWP\_wor | 40-2 | Support RLM/BM/BFD measurements based on CD-SSB outside active BWP with interruptions  | Support RLM/BM/BFD measurements based on CD-SSB outside active BWP with interruptions when the non-RedCap UE indicates support of BWP operation without restriction* This feature only applies if there is no CSI-RS, no NCD- SSB, and no CD-SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s) to be measured
 | 1-7, 2-24, 2-31, 40-3, and (6-1, 6-2, 6-3, or 6-4) | Yes | n/a | UE cannot support RLM/BM/BFD measurements based on CD-SSB outside active BWP with interruptions when the UE indicates support of BWP operation without restriction | Per Band | No | No | n/a | 1. 40-2 is applicable to 6-1, 6-2, 6-3, or 6-4.
	* For example, if UE indicates the support for 6-4 and 40-1, it means UE can support 40-1 with different numerologies between the active BWP and the BWP containing CD-SSB.
2. This FG is not applicable to RedCap UEs.
3. UE indicates at most one of FG 40-1 and FG 40-2.
 | Optional with capability signalling |
| 40. NR\_BWP\_wor | 40-3 | Support RLM/BM/BFD measurements based on NCD-SSB within active BWP  | Support RLM/BM/BFD measurements based on NCD-SSB within active BWP when the non-RedCap UE indicates support of BWP operation without restriction* A UE may be configured with multiple NCD-SSBs across different BWPs in a cell provided that for each BWP the UE is configured with only one SSB (CD-SSB or NCD-SSB).
 | 6-1, 6-2, 6-3, or 6-4 | Yes | n/a | UE cannot support RLM/BM/BFD measurements based on NCD-SSB within active BWP when the UE indicates support of BWP operation without restriction | Per Band | No | No | n/a | 1. 40-3 is applicable to 6-1, 6-2, 6-3, or 6-4.
2. This FG is not applicable to RedCap UEs.
 | Optional with capability signalling |

 |
| Qualcomm Incorporated [7] | We consider Option A does not have a RAN1 spec impact. Since there have been UE capabilities for CSI-RS based BM/RLM/BFD within active DL BWP already, new UE features for Option A (at least from RAN1 point of view) would not be necessary.**Observation 1:*** Option A does not require RAN1 spec impact or new UE feature.

In the past, UE features for BWP without restriction based on SSB outside active DL BWP have been proposed (e.g., in RP-222067). Considering that this is no longer R16/17 maintenance, there is no need to prerequisite the legacy UE feature for BWP without restriction (FG6-1a). It was observed in the past that companies have different understandings on FG6-1a, e.g., regarding whether or not CSI-RS based BM/RLM/BFD is enabled, etc. Specifying new FGs can resolve such issue in Rel-18.In terms of the SSB location, it is necessary to clarify where it can actually be located (was not clear in FG6-1a). Obviously, the SSB shall still be within the carrier bandwidth configured for the UE. In addition, the case where the SSB is not within any DL BWP of the carrier must be invalid scenario. Therefore, we propose to clarify that the SSB is within a bandwidth of at least one DL BWP of the carrier for the UE. More specifically, we further propose to clarify following: (i) If the UE has one UE-specific DL BWP configuration for the cell, the SSB is within a bandwidth of either initial DL BWP or UE-specific DL BWP; (ii) If the UE has more than one UE-specific DL BWP configurations for the cell, the SSB is within a bandwidth of either of the UE-specific DL BWPs.**Proposal 1:*** UE capability for Option B-1-1 does not prerequisite FG6-1a ‘*bwp-WithoutRestriction*’
* For Option B-1-1, clarify that the SSB outside the active DL BWP is still within a bandwidth of at least one DL BWP of the carrier.
	+ If the UE has one UE-specific DL BWP configuration, the SSB is within a bandwidth of either initial DL BWP or UE-specific DL BWP
	+ If the UE has more than one UE-specific DL BWP configurations, the SSB is within a bandwidth of either of the UE-specific DL BWPs
* Adopt following as FG for Option B-1-1

| ***Capability-bwp-wor-b-1-1***Indicates support of BM/RLM/BFD based on SSB outside the active DL BWP without interruptions. If the UE has one UE-specific DL BWP configuration, the SSB is within a bandwidth of either initial DL BWP or UE-specific DL BWP. If the UE has more than one UE-specific DL BWP configurations, the SSB is within a bandwidth of either of the UE-specific DL BWPs. | Band | No | N/A | N/A |
| --- | --- | --- | --- | --- |

As for specification impact, we consider following should be the starting point as presented in RP-222067.**Proposal 2:*** For Option B-1-1, consider following as the starting point of TS38.213 updates

|  |
| --- |
| 5 Radio link monitoringThe downlink radio link quality of the primary cell is monitored by a UE for the purpose of indicating out-of-sync/in-sync status to higher layers. Except for SSB based radio link monitoring for a UE supporting [*Capability-bwp-wor-b-1-1* or *Capability-bwp-wor-b-1-2*], t~~T~~he UE is not required to monitor the downlink radio link quality in DL BWPs other than the active DL BWP, as described in clause 12, on the primary cell. If the active DL BWP is the initial DL BWP and for SS/PBCH block and CORESET multiplexing pattern 2 or 3, as described in clause 13, the UE is expected to perform RLM using the associated SS/PBCH block when the associated SS/PBCH block index is provided by *RadioLinkMonitoringRS*.If the UE is configured with a SCG, as described in [12, TS 38.331], and the parameter *rlf-TimersAndConstants* is provided by higher layers and is not set to release, the downlink radio link quality of the PSCell of the SCG is monitored by the UE for the purpose of indicating out-of-sync/in-sync status to higher layers. Except for SSB based radio link monitoring for a UE supporting [*Capability-bwp-wor-b-1-1* or *Capability-bwp-wor-b-1-2*], t~~T~~he UE is not required to monitor the downlink radio link quality in DL BWPs other than the active DL BWP on the PSCell. |

Same as for Option B-1-1, Option B-1-2 should not prerequisite FG6-1a. SSB location should be within a bandwidth of at least one DL BWP, same as for Option B-1-1. The only differences between Option B-1-2 and Option B-1-1 are (1) interruption related aspects and (2) CSI-RS based and NCD-SSB based BM/RLM/BFD have to be enabled. In our understanding, these basically do not appear in the RAN1 specifications. (1) should be up to RAN4. (2) can be clarified as part of UE feature description of Option B-1-2.**Proposal 3:*** UE capability for Option B-1-2 does not prerequisite FG6-1a ‘*bwp-WithoutRestriction*’
* For Option B-1-2, clarify that the SSB outside the active DL BWP is still within a bandwidth of at least one DL BWP of the carrier.
	+ If the UE has one UE-specific DL BWP configuration, the SSB is within a bandwidth of either initial DL BWP or UE-specific DL BWP
	+ If the UE has more than one UE-specific DL BWP configurations, the SSB is within a bandwidth of either of the UE-specific DL BWPs
* Adopt following as FG for Option B-1-2
	+ Other details including potential other UE capabilities for interruptions are up to RAN4

| ***Capability-bwp-wor-b-1-2***Indicates support of BM/RLM/BFD based on SSB outside the active DL BWP with interruptions. If the UE has one UE-specific DL BWP configuration, the SSB is within a bandwidth of either initial DL BWP or UE-specific DL BWP. If the UE has more than one UE-specific DL BWP configurations, the SSB is within a bandwidth of either of the UE-specific DL BWPs. The UE shall be allowed to use SSB outside the active DL BWP with interruptions only if there is no CSI-RS, no NCD SSB and no CD SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s). The UE supporting this feature shall indicate support of *Capability-bwo-wor-c* (subject to IoDT availability). | Band | No | N/A | N/A |
| --- | --- | --- | --- | --- |

There is no additional RAN1 specification impact for Option B-1-2 compared to those for Option B-1-1.**Observation 2:*** RAN1 spec impact for Option B-1-2 is the same as for Option B-1-1

In Option C, a UE uses NCD-SSB within active DL BWP for BM/RLM/BFD in the same way as for RedCap UE. However, for Option C for non-RedCap UEs, there could be following cases:* For a UE supporting Option C only, the active DL BWP contains both CD-SSB and NCD-SSB
* For a UE supporting both Option C and Option B-1-1/B-1-2, the active DL BWP contains NCD-SSB while does not contain CD-SSB which is located outside in the carrier.

For these cases, it is beneficial to make sure that the UE meets the requirements based on NCD-SSB as long as it is configured. The spec does not need to mandate UE to use the NCD-SSB. This can be clarified in either RAN1/RAN4 spec, or in the corresponding UE feature descrition. Below, we take the option that clarifies this in the UE feature. If we take the other approach, the clarification should be done in RAN1 or RAN4 spec.**Proposal 4:*** Adopt following as FG for Option C

| ***Capability-bwp-wor-c***Indicates support of BM/RLM/BFD based on NCD-SSB in the active DL BWP that is configured by [NonCellDefiningSSB] under BWP-DownlinkDedicated. If the UE is configured with NCD-SSB by [NonCellDefiningSSB] within the active DL BWP, the UE meets the requirements based on the NCD-SSB for BM/RLM/BFD.  | Band | No | N/A | N/A |
| --- | --- | --- | --- | --- |

**Proposal 5:*** For Option C, consider following as the starting point of TS38.213 updates

|  |
| --- |
| 12 Bandwidth part operation […]If a UE is configured to operate with receiving an SS/PBCH block from the SS/PBCH blocks provided by [*NonCellDefiningSSB*] in *BWP-DownlinkDedicated* for an active DL BWP, the UE assumes that the active DL BWP includes the SS/PBCH blocks provided by [*NonCellDefiningSSB*]. The SS/PBCH blocks provided by [*NonCellDefiningSSB-r18*] and the SS/PBCH blocks that the UE used to obtain SIB1 have the same QCL properties, if they have the same index*.*For a UE indicated presence of SS/PBCH blocks within an active DL BWP by *[NonCellDefiningSSB*], collision handling between downlink receptions or uplink transmissions and the SS/PBCH blocks are same as described for a UE indicated presence of SS/PBCH blocks by *ssb-PositionsInBurst* in *SIB1* or in *ServingCellConfigCommon* described in all other clauses, unless otherwise stated.For monitoring of a PDCCH candidate by a UE configured with [*NonCellDefiningSSB*], if the UE- does not monitor PDCCH candidates in a Type0-PDCCH CSS set, and - at least one RE for a PDCCH candidate overlaps with at least one RE of a candidate SS/PBCH block corresponding to a SS/PBCH block index provided by [*NonCellDefiningSSB*], the UE is not required to monitor the PDCCH candidate. |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| x. BWP without restriction | x-1 | Indicates support of BM/RLM/BFD based on SSB outside the active DL BWP without interruptions | Indicates support of BM/RLM/BFD based on SSB outside the active DL BWP without interruptions. If the UE has one UE-specific DL BWP configuration, the SSB is within a bandwidth of either initial DL BWP or UE-specific DL BWP. If the UE has more than one UE-specific DL BWP configurations, the SSB is within a bandwidth of either of the UE-specific DL BWPs. | 6-1 |  |  |  |  |  |  |  |  |  |
|  | x-2 | Indicates support of BM/RLM/BFD based on SSB outside the active DL BWP with interruptions | Indicates support of BM/RLM/BFD based on SSB outside the active DL BWP with interruptions. The SSB is still within the bandwidth of at least one DL BWP of the carrier. If the UE has one UE-specific DL BWP configuration, the SSB is within a bandwidth of either initial DL BWP or UE-specific DL BWP. If the UE has more than one UE-specific DL BWP configurations, the SSB is within a bandwidth of either of the UE-specific DL BWPs.The UE shall be allowed to use SSB outside the active DL BWP with interruptions only if there is no CSI-RS, no NCD SSB and no CD SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s). The UE supporting this feature shall indicate support of FG x-2 (subject to IoDT availability). | 6-1, x-2 |  |  |  |  |  |  |  |  |  |
|  | x-3 | Indicates support of BM/RLM/BFD based on NCD-SSB within the active DL BWP  | Indicates support of BM/RLM/BFD based on NCD-SSB in the active DL BWP that is configured by [NonCellDefiningSSB] under BWP-DownlinkDedicated. If the UE is configured with NCD-SSB by [NonCellDefiningSSB] within the active DL BWP, the UE meets the requirements based on the NCD-SSB for BM/RLM/BFD.  | 6-1 |  |  |  |  |  |  |  |  |  |

 |
| NTT DOCOMO, INC. [8] | For Option B-1-1, a new UE capability signalling to report the support of BM/RLM/BFD based on SSB outside the active BWP without interruption is necessary. It is not necessary to define separate capabilities for BM, RLM and BFD. SSB-based BFD (FG2-31, maxNumberSSB-BFD) is mandatory with capability signalling for FR2 and optional with capability signalling for FR1, and SSB-based BM (FG2-24, beamManagementSSB-CSI-RS) is also mandatory with capability signalling. Therefore, BFD/BM based on SSB outside the active BWP can be supported if the UE supports SSB-based BFD/BM and the new capability. The reporting type could be per band (same as bwp-WithoutRestriction).**Proposal 1: Introduce a new UE capability signalling for the support of BM/RLM/BFD based on SSB outside the active BWP without interruption*** **If a UE supports SSB based BFD/BM and this capability, the UE supports BM/BFD based on SSB outside the active BWP without interruption.**
* **The reporting type is per band.**

For Option C, a new UE capability signalling to report the support of BM/RLM/BFD based on NCD-SSB within the active BWP for non-RedCap UEs is necessary. Same as Proposal 1 for Option B-1-1, it is not necessary to define separate capabilities for BM, RLM and BFD based on NCD-SSB. The reporting type can also be per band.**Proposal 2: Introduce a new UE capability signalling for the support of BM/RLM/BFD based on NCD-SSB within the active BWP*** **If a UE supports SSB based BFD/BM and this capability, the UE supports BM/BFD based on NCD-SSB within the active BWP.**
* **The reporting type is per band.**

For Option B-1-2, a new UE capability signalling to report the support of BM/RLM/BFD based on SSB outside the active BWP with interruptions is necessary. This capability should be separated from the capability for Option B-1-1 as this capability for Option B-1-2 has several conditions according to the WID that are not applicable to Option B-1-1. **Proposal 3: Introduce a new UE capability signalling for the support of BM/RLM/BFD based on SSB outside the active BWP with interruptions*** **If a UE supports SSB based BFD/BM and this capability, the UE supports BM/BFD based on SSB outside the active BWP with interruptions.**
* **The reporting type is per band.**
* **UE supporting this capability shall also support BM/RLM/BFD based on NCD-SSB within the active BWP (subject to IoDT availability).**
* **UE supporting this capability shall be allowed to perform BM/RLM/BFD based on SSB outside the active BWP with interruptions only if there is no CSI-RS, no NCD SSB and no CD SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s) to be measured.**
 |
| Huawei, HiSilicon [9] | On Opt. B-1-1: Support of BM/RLM/BFD based on SSB outside the active BWP without interruptionsIn our view, supporting measurements based on SSB outside the active BWP without interruptions requires a UE to either keep larger bandwidth than the active BWP to receive SSB and other DL transmission within the active BWP simultaneously, or use separate RFs as discussed in RAN4. In the former case, it is not good for UE power consumption. In the latter case, the RFs that are used for separate handling of SSB and other DL transmissions could have certain BW range for each. Thus, to accommodate the above, a limitation for the bandwidth on which a UE can perform measurement based on SSB without interruptions is needed.  Only when the total frequency span of the SSB and active BWP is no larger than the limitation, UE can perform related measurements without interruptions; otherwise, the UE should rely on other schemes to perform related measurement, such Opt. A, Opt. C, or, Opt.B-1-2. The limitation should be no larger than the carrier bandwidth, such as 40 MHz, 60 MHz, etc., similar to the UE dedicated channel BW. From UE implementation point of view, a UE is allowed to report its supported (max) value from a series of predefined values (e.g. channel BW).***Proposal 1: Introduce candidate values, or allow to report a maximum value, for indicating the total frequency span of SSB and an active BWP on which a UE can perform measurement based on SSB without interruptions.**** ***Candidate values can be (a subset of) current UE channel BWs.***

On Opt. C: Support of BM/RLM/BFD based on NCD-SSB within active BWP for non-RedCap UEsNormally, the features designed for non-RedCap UEs are supposed to be optional (obviously, except for CA) for RedCap UEs, unless explicitly stated as not applicable. Thus, if this UE feature is not stated as non-applicable for RedCap, then gNB expects that the support of NCD-SSB from a UE should be aligned – i.e. for RedCap, UE should support both this FG and FG 28-1. So either we need to restrict this UE capability to be not applicable to RedCap, or clarify that a RedCap is expected to indicate the support of this capability. In our view, the former one may be better, since FG 28-1 is per-UE reported while this FG may be reported per band, and by the former some reporting signalling can be saved. Another consideration is the potential IoDT. This can be futher discussed whether needs to be taken into account since per-band reporting can achieve such purpose.***Proposal 2: Restrict the UE capability of supporting of BM/RLM/BFD based on NCD-SSB within active BWP to be only applicable for non-RedCap UEs.**** ***Per-band report might be preferable for IoDT consideration.***
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# Discussion/Approval Items during RAN1 #112bis-e — First Checkpoint

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following topics were identified by the moderator for discussion/approval during RAN1 #112bis-e.

**General comments**

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| --- | --- |
| Company | Comments/Questions/Suggestions |
|  |  |

# Issue 1: FG 53-1

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG/row, while keeping the yellow highlighting, if any, as shown**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 53. NR\_BWP\_wor | 53-1 | Support RLM/BM/BFD measurements based on SSB outside active BWP without interruptions | 1. UE performs RLM/BM/BFD measurements based on SSB without interruptions, where the SSB is outside active DL BWP but is within the bandwidth of the corresponding carrier(s) to be measured. 2. The UE is not expected to receive PDSCH, PDCCH, or CSI-RS outside an active DL BWP. | [6-1a] | Yes | n/a | UE cannot support RLM/BM/BFD measurements based on SSB outside active BWP without interruptions | Per band | No | No | n/a | FG 53-1 is applicable to FGs 6-1, 6-2, 6-3, or 6-4[Rules/conditions applicability and corresponding UE behavior is left to RAN4 to decide.][UE indicates at most one of FG 53-1 and FG 53-2.][This FG is not applicable to RedCap UEs.] | Optional with capability signalling |

|  |  |
| --- | --- |
| Company | Comments/Questions/Suggestions |
| MediaTek | * 1. SSB should be changed to “CD-SSB” in all related columns.
	2. **On “Type” column**,
		1. We cannot accept “per band.” As mentioned in one of the RAN4 LSs, “without interruption” can be achieved by larger BW or a separate RF. The former solution consumes more UE power consumption than the latter solution which is hence a preferable solution to UE. But the availability of a separate RF may depend on the current band combination configured by the NW. Hence, “per band” type is not acceptable to us.
		2. **It should be left to RAN4 to decide** since this is related to RF and RAN4 has better understanding on how UE achieves this.
	3. On “Prerequisite,” we think more discussions are needed to clarify what it means to have FG 6-1a as prerequisite. **What is expected from UE to claim the support for FG6-1a?**
		1. On one hand, we prefer not to have FG 6-1a as prerequisite since what UE has to perform in order to pass IODT is not clear to us at this point.
		2. On the other hand, we think having FG6-1a as prerequisite is more aligned with the WID. In addition, it can reduce the number of possible reporting combinations and avoid unnecessary complicated discussions and spec changes.
		3. Therefore, we are open to hear more views on this.
 |
| Qualcomm | On component 1, we propose to add one yellow highlight with square bracket as “but is within the bandwidth of [the corresponding carrier(s) to be measured]”. We think it is necessary to have some discussion on where the SSB can be located. With this, we are OK to have the FG 53-1 with keeping the yellow highlights (including the additional yellow for “the corresponding carrier(s) to be measured” on component 1).On the yellow highlights, for further discussion at the next step, we would like to provide our views:* Component 1: “but is within the bandwidth of [the corresponding carrier(s) to be measured]”
	+ It is true that the SSB must be at a measurable location, but this requires some discussion. Our understanding is that there is no use-case where SSB is not within any of the DL BWP for the cell. Therefore, we propose the following:
		- If the UE has one UE-specific DL BWP configuration, the SSB is within a bandwidth of either initial DL BWP or UE-specific DL BWP
		- If the UE has more than one UE-specific DL BWP configurations, the SSB is within a bandwidth of either of the UE-specific DL BWPs
* Prerequisite field: [6-1a]:
	+ We consider FG53-1 should be a stand-alone FG that indicates support of BWP without restriction and RLM/BM/BFD using SSB outside active BWP without interruptions.
	+ On FG6-1a, it was found in the past discussion that companies have different views (e.g., whether support of CSI-RS based RLM/BM/BFD is required, etc). It should not be a good idea to use such FG6-1a as the prerequisite of new feature.
	+ Since this is a new WI, there is no specific reason to use the legacy FG as the prerequisite.
* Note field: [Rules/conditions applicability and corresponding UE behavior is left to RAN4 to decide.]
	+ We suggest to delete this sentence. Anyway RAN4 is discussing this. If it turns out that something needs to be captured in the FG note field as a consequence of RAN4 discussion, it should be added.
* Note field: [UE indicates at most one of FG 53-1 and FG 53-2.]
	+ We understand that technically FG 53-1 and FG53-2 can be mutually exclusive.
	+ However, whether these FGs are really exclusive depends on further discussion on details. We are OK to keep the text with yellow highlight and continue discussion on the FG before making decision on this sentence.
* Note field: [This FG is not applicable to RedCap UEs.]
	+ It is also our understanding that the work here is limited to non-RedCap UEs.
 |
| Ericsson | Component 2 is confusing: reception of PDSCH, PDCCH, or CSI-RS outside the active BWP is not supported in general. Propose to remove.FG 53-1 and 53-2 should be mutually exclusive, and we propose to capture that in the signaling structure. Having a note saying the “UE indicates at most one of FG 53-1 and FG 53-2.” is a bit awkward.On the note [Rules/conditions applicability and corresponding UE behavior is left to RAN4 to decide.] we agree with Qualcomm to remove that. The Redcap note is OK. |
| NTT DOCOMO | We are generally fine with the structure of FG 53-1.* Regarding [6-1a] as prerequisite FG, we share similar view with MediaTek/Qualcomm that the meaning of FG6-1a as prerequisite may be a bit unclear and it would be ok to not have FG 6-1a as prerequisite.
* Regarding the note [Rules/conditions applicability and corresponding UE behavior is left to RAN4 to decide.], we are also fine to remove it.
* Regarding the note [UE indicates at most one of FG 53-1 and FG 53-2.], we are fine to keep it.
* Regarding the note [This FG is not applicable to RedCap UEs.], we are fine to keep it.
 |
| vivo | On the component, since the new FG 53-1 is one workable FG to replace FG6-1a, we propose to add following component from FG6-1a * “BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for SCell”

On Prerequisite field: [6-1a], we share views with QC that 6-1a should not be the Prerequisite considering this new WI, and the above component we proposed to be added. On the note [Rules/conditions applicability and corresponding UE behavior is left to RAN4 to decide.], it is ok to keep or remove. On the note [UE indicates at most one of FG 53-1 and FG 53-2.], we also prefer to keep it with yellow highlight and [] for now, and make decision after more details are stable for FG53-1 and FG53-2.On the note [This FG is not applicable to RedCap UEs.], we support it, the FG is not applicable to RedCap UEs. |
| ZTE | Regarding the component 2, we share similar view as other companies, we don’t see strong motivation to have it.Regarding the prerequisite, our understanding of the relationship between 53-1/53-2 and 6-1a is that, for UE supporting 6-1a, it is not clear whether measurement gap is needed or not. For UE supporting 53-1, no measurement interruption is needed; for UE supporting 53-2, a measurement interruption is needed. For UE supporting option A (CSI-RS based measurement), UE needs to report 6-1a and the corresponding CSI-RS based RLM/BM/BFD capabilities. Thus, we think it makes sense to take 6-1a as prerequisite. If 6-1a is not taken as the prerequisite, then the components in 6-1a should be copied here for 53-1/53-2/53-3 as well, i.e., 1. *BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for Scell*

Regarding the reporting type, if 6-1a is taken as the prerequisite, we think per UE capability for 53-1 should be ok since anyway its prerequisite is already per band, it can achieve per band reporting by “6-1a + 53-1” already.Regarding the note “[This FG is not applicable to RedCap UEs.]”, we think it is good to have it. |
| Huawei, HiSilicon | 1. Also do not see the need of 2nd component.
2. Ok with 6-1a as pre-requisite.
3. Per-band may be fine. However, since this is mostly a measurement related capability, more proper to ask RAN4 to decide.
4. A similar motivation but probably different from QC’s suggestion, regarding “but is within the bandwidth of [the corresponding carrier(s) to be measured]”, our proposal is to define candidate values of a BW range/size for UE to report. We think compared to the absolute location of SSB (e.g. below or above an active BWP), it is the distance from SSB to the current frequency location of a UE’s active BWP that matters more. Therefore the following can be added for RAN4 to further review

***Introduce candidate values, or allow to report a maximum value, for indicating the total frequency span of SSB and an active BWP on which a UE can perform measurement based on SSB without interruptions.**** ***Candidate values can be (a subset of) current UE channel BWs***
 |

# Issue 2: FG 53-2

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG/row, while keeping the yellow highlighting, if any, as shown**

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| 53. NR\_BWP\_wor | 53-2 | Support RLM/BM/BFD measurements based on SSB outside active BWP with interruptions | 1. UE is allowed to performs RLM/BM/BFD measurements based on SSB outside the active BWP with interruptions, where the SSB is outside active DL BWP but is within the bandwidth of the corresponding carrier(s) to be measured, only if there is no CSI-RS, no NCD-SSB, and no CD-SSB configured for RLM/BM/BFD in the active DL BWP of the corresponding carrier(s) to be measured. 2. The UE is not expected to receive PDSCH, PDCCH, or CSI-RS outside an active DL BWP. | [6-1a, 1-7, 2-24, 2-31, 53-3] | Yes | n/a | UE cannot support RLM/BM/BFD measurements based on SSB outside active BWP and meet interruptions requirements | Per band | No | No | n/a | FG 53-2 is applicable to FGs 6-1, 6-2, 6-3, or 6-4. This feature only applies if there is no CSI-RS, no NCD- SSB, and no CD-SSB configured for RLM/BM/BFD in the active BWP of the corresponding carrier(s) to be measured. [The interruption time and corresponding UE behavior is left to RAN4 to decide.][UE indicates at most one of FG 53-1 and 53 40-2.][This FG is not applicable to RedCap UEs.] | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
| MediaTek | 1. SSB should be changed to “CD-SSB” in all related columns.
2. On Type, we think it can be left to RAN4 for discussion since there will be some relation between FG 53-1 and 53-2.
3. On having FG6-1a as prerequisite, similar comments as we made for FG 53-1.
4. On Note, a typo: “53 40-2” should be fixed as “53-2”.
 |
| Qualcomm | On component 1, we propose to add one yellow highlight with square bracket as “but is within the bandwidth of [the corresponding carrier(s) to be measured]”. We think it is necessary to have some discussion on where the SSB can be located. With this, we are OK to have the FG 53-2 with keeping the yellow highlights (including the additional yellow for “the corresponding carrier(s) to be measured” on component 1).On the yellow highlights, for further discussion at the next step, we would like to provide our views:* Component 1: “but is within the bandwidth of [the corresponding carrier(s) to be measured]”
	+ It is true that the SSB must be at a measurable location, but this requires some discussion. Our understanding is that there is no use-case where SSB is not within any of the DL BWP for the cell. Therefore, we propose the following:
		- If the UE has one UE-specific DL BWP configuration, the SSB is within a bandwidth of either initial DL BWP or UE-specific DL BWP
		- If the UE has more than one UE-specific DL BWP configurations, the SSB is within a bandwidth of either of the UE-specific DL BWPs
* Prerequisite field: [6-1a, 1-7, 2-24, 2-31, 53-3]
	+ Due to the same reason as for FG53-1, We consider FG53-2 does not need to prerequisite FG6-1a. Prefer to remove 6-1a from the list.
* Note field: [The interruption time and corresponding UE behavior is left to RAN4 to decide.]
	+ We suggest to delete this sentence. Anyway RAN4 is discussing this. If it turns out that something needs to be captured in the FG note field as a consequence of RAN4 discussion, it should be added.
* Note field: [UE indicates at most one of FG 53-1 and FG 53-2.]
	+ We understand that technically FG 53-1 and FG53-2 can be mutually exclusive.
	+ However, whether these FGs are really exclusive depends on further discussion on details. We are OK to keep the text with yellow highlight and continue discussion on the FG before making decision on this sentence.
* Note field: [This FG is not applicable to RedCap Ues.]
	+ It is also our understanding that the work here is limited to non-RedCap Ues.
 |
| Ericsson | Component 2 is confusing: reception of PDSCH, PDCCH, or CSI-RS outside the active BWP is not supported in general. Propose to remove.The pre-requisite field should be pruned: the only relevant FG to keep is 6-1a.FG 53-1 and 53-2 should be mutually exclusive, and we propose to capture that in the signaling structure. Having a note saying the “UE indicates at most one of FG 53-1 and FG 53-2.” Is a bit awkward.On the note [Rules/conditions applicability and corresponding UE behavior is left to RAN4 to decide.] we agree with Qualcomm to remove that. The note that states when the FG is applicable is unclear: the UE should be allowed to report this FG in any case, except for the pre-requisite field. Propose to remove.The Redcap note is OK. |
| NTT DOCOMO | We are generally fine with the structure of FG 53-2 and we have similar comments as for FG 53-1. |
| vivo | On component, similar as FG53-1, we propose to add following component from FG6-1a to FG53-2:* “BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for SCell”

On Prerequisite field: [6-1a, 1-7, 2-24, 2-31, 53-3]: Same reason as for FG53-1, We propose to remove 6-1a from the list.On Note field: [The interruption time and corresponding UE behavior is left to RAN4 to decide.]: We are fine to keep it or remove it. On the Note field: [UE indicates at most one of FG 53-1 and FG 53-2.]: Same as for FG53-1, we prefer to keep the yellow highlight and [] for now, and make decision after more details are stable for FG53-1 and FG53-2.On Note field: [This FG is not applicable to RedCap Ues.]: we support it, the FG is not applicable to RedCap UEs. |
| ZTE | Regarding the component 2, we share similar view as other companies, we don’t see strong motivation to have it.Regarding the prerequisite, our understanding of the relationship between 53-1/53-2 and 6-1a is that, for UE supporting 6-1a, it is not clear whether measurement gap is needed or not. For UE supporting 53-1, no measurement interruption is needed; for UE supporting 53-2, a measurement interruption is needed. For UE supporting option A (CSI-RS based measurement), UE needs to report 6-1a and the corresponding CSI-RS based RLM/BM/BFD capabilities. Thus, we think it makes sense to take 6-1a as prerequisite. If 6-1a is not taken as the prerequisite, then the components in 6-1a should be copied here for 53-1/53-2/53-3 as well, i.e., 1. *BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for Scell*

Regarding the reporting type, if 6-1a is taken as the prerequisite, we think per UE capability for 53-1 should be ok since anyway its prerequisite is already per band, it can achieve per band reporting by “6-1a + 53-1” already.Regarding the note “[This FG is not applicable to RedCap UEs.]”, we think it is good to have it. |

# Issue 3: FG 53-3

After review of contributions submitted to RAN1 #112bis-e in this agenda item, the following is proposed by the moderator. Companies submitted the following views on the moderator’s proposals.

**Proposal: Introduce the following new FG/row, while keeping the yellow highlighting, if any, as shown**

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| 53. NR\_BWP\_wor | 53-3 | Support RLM/BM/BFD measurements based on NCD-SSB within active BWP | 1. UE performs RLM/BM/BFD measurements based on NCD-SSB, where the NCD-SSB is within the active DL BWP.
2. The UE is not required to perform RLM/BM/BFD measurements with CD-SSB if it is configured with NCD-SSB within the active DL BWP
 | [6-1a] | Yes | n/a | UE cannot support RLM/BM/BFD measurements based on NCD-SSB within active BWP  | Per band | No | No | n/a | FG 53-3 is applicable to FGs 6-1, 6-2, 6-3, or 6-4[This FG is not applicable to RedCap UEs.] | Optional with capability signalling |

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| Company | Comments/Questions/Suggestions |
| MediaTek | 1. On components, we would like to further propose the following for companies to consider. A similar agreement was made for RedCap to avoid complicated UE behavior discussion.
	* **Proposal: A UE may be configured with multiple NCD-SSBs provided that each BWP is configured with at most one SSB.**
2. On Prerequisite, similar comments as we made for FG 53-1.
 |
| Qualcomm | We are OK to have the FG 53-3 with keeping the yellow highlights.On the yellow highlights, for further discussion at the next step, we would like to provide our views:* Prerequisite field: [6-1a]
	+ We consider FG53-2 does not need to prerequisite FG6-1a. Prefer to remove 6-1a from the list.
* Note field: [This FG is not applicable to RedCap Ues.]
	+ It is also our understanding that the work here is for non-RedCap Ues.
 |
| Ericsson | It is unclear what it means that a FG is applicable to FG x and Y. Propose to remove.The Redcap note is OK. |
| NTT DOCOMO | We are generally fine with the structure of FG 53-3 and we have similar comments as for FG 53-1. |
| vivo | On Prerequisite field: [6-1a, 1-7, 2-24, 2-31, 53-3]: Same reason as for FG53-1, We propose to remove 6-1a from the list.On Note field: [This FG is not applicable to RedCap Ues.]: we support it, the FG is not applicable to RedCap UEs. |
| ZTE | Regarding the prerequisite, our understanding of the relationship between 53-3 and 6-1a is that, for UE supporting 6-1a, CD-SSB may not be within the BWP. However, it may or may not contain NCD-SSB. If 53-3 is supported, then UE can be configured with NCD-SSB for RLM/BM/BFD measurements. Even if the 6-1a is not considered as the prerequisite, then the components in 6-1a should be copied here for 53-1/53-2/53-3 as well, i.e., 1. *BW of UE-specific RRC configured BWP may not include BW of the CORESET#0 (if CORESET#0 is present) and SSB for PCell/PSCell (if configured) and BW of the UE-specific RRC configured BWP may not include SSB for Scell*

Regarding the reporting type, if 6-1a is taken as the prerequisite, we think per UE capability for 53-1 should be ok since anyway its prerequisite is already per band, it can achieve per band reporting by “6-1a + 53-1” already.Regarding the note “[This FG is not applicable to RedCap UEs.]”, we think it is good to have it. |
| Huawei | For this one, perhaps 6-1a is not necessary for pre-requisite.For component 4, can clarify where is it proposed? We think it should be for UE to indicate its capability and there is no need to indicate what is ‘not required’, unless the intention is to tell that simultaneous CD-SSB based measurements is not possible for UE to perform. The UE is not required to perform RLM/BM/BFD measurements with CD-SSB if it is configured with NCD-SSB within the active DL BWP |

# Discussion/Approval Items during RAN1 #112bis-e — Second Checkpoint

Based on the comments/questions/suggestions received by the first checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 3 will not be considered]***

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Discussion/Approval Items during RAN1 #112bis-e — Third Checkpoint

Based on the comments/questions/suggestions received by the second checkpoint, the following are the revised proposals and/or proposed agreements by the moderator. Companies submitted the following views on the moderator’s proposals.

***[Please submit all comments/questions/suggestions here, late comments/questions/suggestions submitted in Section 4 will not be considered]***

**General comments**

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| Company | Comments/Questions/Suggestions |
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# Issue 1: FG

**Proposal: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Summary of Final Proposals for Agreements

This Section summarizes the final proposals for agreement in RAN1 #112bis-e by email. There are no tables for comments.

***[All comments must be directly made on the RAN1 email reflector]***

Companies can continue to update their comments in the previous Sections, however, these are no longer monitored by the moderator. Any such comments will be for archival purposes only and will not influence the outcome of this email discussion. Any objection to any of the proposals in this Section must be voiced directly on the RAN1 email reflector.

**Possible Agreement: Adopt the following changes highlighted in chromatic fonts, while keeping the yellow highlighting, if any, as shown**

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# Conclusion

After further discussion on the RAN1 email reflector the following was agreed as part of this email discussion:

# References

1. R1-2302876, Preliminary UE Features List for BWP Without Restriction, Vodafone Italia SpA/vivo
2. R1-2302415, UE features for BWP without restriction, Ericsson
3. R1-2302517, Discussion on UE features for BWP without restriction, vivo
4. R1-2302765, Discussion on UE feature for BWP without restriction, ZTE
5. R1-2302895, Initial views on UE features for BWP without restriction, Nokia/Nokia Shanghai Bell
6. R1-2303350, UE features for BWP without restriction, MediaTek Inc.
7. R1-2303623, UE features for BWP without restriction, Qualcomm Incorporated
8. R1-2303738, Discussion on UE features for BWP without restriction, NTT DOCOMO, INC.
9. R1-2303865, UE features for BWP without restriction, Huawei/HiSilicon