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

**Fukuoka City, Fukuoka, Japan, May 20th – 24th, 2024**

**Agenda item:** 9.3.2

**Source:** Moderator (CMCC)

**Title:** Summary#1 on SBFD random access operation

**Document for:** Discussion/decision

# Introduction

The New WID: Evolution of NR duplex operation: Sub-band full duplex (SBFD) was approved in RAN plenary #112 meeting [1].

In this contribution, we summarized the related issues and proposals based on the contributions submitted in RAN1#117 under the agenda item 9.3.2 [2]–[39].

The following sections are structured as follows. We categorize the key issues raised by contributions and some sections may cover more than one sub-issue. For each issue/sub-issue, the related submitted proposals, the summary and initial proposals/questions suggested by moderator are provided in sub-sections. For each identified proposal/question, one table is provided.

# Issue#1: Random access in CONNECTED mode

## Issue#1-1: PRACH configuration, RO validation, and SSB-RO mapping (4-step RA)

### Submitted proposal

#### **Common**

##### **RACH configuration options**

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| **Company** | **Proposals** |
| **New H3C** | **Proposa11: the following work assumption should be confirmed.** |
| **Tejas Networks** | **Proposal 10: If Option 1 with Alt 1-1 does not create a new RO in SBFD symbols and if Option 2 is present, then UE has to support Option 2 for SBFD operation.** |
| **LG Electronics** | **Proposal 3: The working assumption on RACH configuration options should be confirmed.** |
| **Ericsson** | 1. Confirm WA on supporting both a single RACH configuration, only based on the existing parameters of the single RACH configuration, and two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration.
2. Support configuration of prioritization between SBFD and legacy ROs for both single and dual RACH configurations.
3. Network enabling of SBFD RACH is indicated in RRC for the single RACH configuration.
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| **Spreadtrum, BUPT** | 1. **To simplify the discussion, legacy (valid) ROs and additional (valid) RO can be defined as:**
* **For Option 1 Alt 1-1 RACH configuration, the legacy valid RO means the valid RO in non-SBFD symbols and the valid ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon. Additional valid RO refers to the valid ROs in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon.**
* **For Option 2, the legacy valid RO is valid RO configured by legacy RACH configuration. Additional valid RO is valid RO configured by additional RACH configuration.**
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| **ZTE** | **Proposal 1: The** **UL usable PRBs for RACH procedure can be determined as intersection between cell-specific UL subband and active UL BWP in DL symbols with subband configuration.** * **FFS: UL usable PRBs determination in flexible symbols with subband configuration.**

**Proposal 2: Confirm the following working assumption:****For SBFD aware UEs in RRC CONNECTED state, both RACH configuration Option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration) and RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) are supported. Enabling both options at the same time for a UE is not supported.*** **For Option 1 with Alt 1-1, FFS whether/how to reinterpret msg1-FrequencyStart in rach-ConfigCommon,** **RO validation rules and SSB-RO mapping rules, etc.**
* **For Option 2, FFS the RO validation rules, SSB-RO mapping rules, whether all the parameters currently in rach-ConfigCommon are necessary to be included in the additional RACH configuration, etc.**

**UE is not required to support both options.****Proposal 3: The UE behavior should be defined in the case that the configuration option used by the gNB is different from that supported by a UE, e.g., the UE can only initialize the RACH procedure in legacy mode.****Proposal 4: The following options can be considered for addressing the overlapping ROs issue, i.e., ROs in SBFD symbols configured via different RACH configuration options overlapping with each other.** * **Option 1: RO priority is defined for different configuration options and ROs configured by a configuration option with a lower priority will be dropped.**
* **Option 2: UE does not expect the ROs configured by different configuration options are overlapped with each other.**
* **Option 3: Only one configuration option can be used at a time by a gNB.**
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| **InterDigital** | **Proposal 4. Confirm the working assumption with modification on supporting both Option 1 (single config but with Alt 1-2 configuring additional parameters, e.g., time offset) and Option 2 (two separate config), for RACH configurations for SBFD-aware UEs.** |
| **TCL** | **Proposal 1: Support to confirm the following WA*** **For SBFD-aware UEs in RRC CONNECTED state, both RACH configuration Option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration) and RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) are supported. Enabling both options at the same time for a UE is not supported.**
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| **Samsung** | Proposal 8: Confirm the RAN1#116bis WA that both RACH configuration Option 1 with Alt 1-1 and RACH configuration Option 2 are supported. |
| **vivo** | Proposal 7: For random access operation in RRC\_CONNECTED mode, the working assumption can be confirmed that for SBFD-aware UEs both RACH configuration Option 1 with Alt 1-1 and RACH configuration Option 2 are supported.  |
| **Apple** | **Proposal 1: The network indicates the feature working on RACH resources in the SBFD sub-band.** |
| **Sharp** | **Proposal 1: RAN1 supports reinterpretation of msg1-FrequencyStart which further is capped by a mod function. Otherwise, RAN1 does not support Option 1 with Alt 1-1 (revert the working assumption).**  |
| **CMCC** | **Proposal 2: Confirm the working assumption on support both RACH configuration Option 1 with Alt 1-1 and RACH configuration Option 2 for SBFD-aware UEs in RRC CONNECTED state.** |
| **Sony** | **Proposal 1: Confirm the following working assumption.****Proposal 9: The following methods are used to distinguish an SBFD UE from a legacy UE at the gNB:*** **PRACH from SBFD slot comes from SBFD UE**
* **Distinguished using different RO, i.e., PRACH from RO belonging to SBFD PRACH configuration comes from SBFD UE, whilst PRACH from RO belonging to legacy PRACH configuration comes from legacy UE.**
* **If the SBFD UE and legacy UE share an RO in an UL slot, preamble partitioning is used on these ROs to distinguish between SBFD UEs and legacy UEs.**
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| **MediaTek Inc.** | 1. **For RACH configuration Option 1, Alt 1-2 can also be supported.**
* **New frequency domain parameters (e.g., msg1-FDM\_sbfd and msg1-FrequencyStart\_sbfd) can be provided within rach-ConfigCommon**
* **If the new frequency domain parameters are not provided, UE can be instructed to adopt Alt 1-1**
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| **Xiaomi** | 1. Confirm the following working assumption with modification.

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| **Working Assumption****For SBFD-aware UEs in RRC CONNECTED state, both RACH configuration Option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration) and RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) are supported. ~~Enabling both options at the same time for a UE is not supported.~~*** **For Option 1 with Alt 1-1, FFS whether/how to reinterpret msg1-FrequencyStart in rach-ConfigCommon, RO validation rules and SSB-RO mapping rules, etc.**
* **For Option 2, FFS the RO validation rules, SSB-RO mapping rules, whether all the parameters currently in rach-ConfigCommon are necessary to be included in the additional RACH configuration, etc.**

**~~UE is not required to support both options.~~** |

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| **NEC** | **Proposal 3:** * **Consider following two approaches by which a UE determines whether ROs configured by legacy RACH configuration are valid during SBFD symbols.**
	+ **Option-1: Define a parameter in PRACH configuration for Alt-1-1 which indicates to the UE whether ROs in SBFD symbols are considered valid.**
	+ **Option-2: UE always assumes that ROs configured by legacy RACH configuration are valid during SBFD symbols if UL subband configuration is provided to the UE and UE is not configured with additional RACH configuration for SBFD symbols based on Alt-2.**
 |
| **Lenovo** | **Proposal 1: Confirm the following working assumption as agreement.**  |
| **Langbo** | **Proposal 1: Confirm the working assumption, i.e., both RACH configuration Option 1 and Option 2 are supported.****Proposal 2: Only Alt 1-1 is supported for Option 1, i.e., the single RACH configuration is only based on the existing parameters of the single RACH configuration (e.g., prach-ConfigurationIndex, msg1-FDM and msg1-FrequencyStart in rach-ConfigCommon).** |
| **Google** | 1. **Adopt the following option allowing for two different PRACH configurations in SBFD-aware UEs and non-SBFD aware UEs:**
* **Option 2: Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration**
1. **If Option 1, using a single RACH configuration, is supported then support:**
* **Alt 1-2: based on the existing parameters of the single RACH configuration (e.g., prach-ConfigurationIndex, msg1-FDM and msg1-FrequencyStart in rach-ConfigCommon) and newly introduced parameter(s).**
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| **NTT DOCOMO** | **Proposal 2: For SBFD-aware UEs in RRC CONNECTED state, support RACH configuration option 2 (i.e. two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration).** |
| **Nokia, NSB** | Proposal 6 RAN1 confirms the work assumption “For SBFD-aware UEs in RRC CONNECTED state, both RACH configuration Option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration) and RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) are supported. Enabling both options at the same time for a UE is not supported.* For Option 1 with Alt 1-1, FFS whether/how to reinterpret msg1-FrequencyStart in rach-ConfigCommon, RO validation rules and SSB-RO mapping rules, etc.
* For Option 2, FFS the RO validation rules, SSB-RO mapping rules, whether all the parameters currently in rach-ConfigCommon are necessary to be included in the additional RACH configuration, etc.

UE is not required to support both options.”  |
| **Qualcomm** | **Observation 2: single RACH configuration would enable SBFD random access operation for both SBFD-aware UE and legacy UE without extra signalling overhead.*** **It requires proper gNB configuration of the PRACH time and frequency resources to have same valid ROs and consistent SSB-to-RO mapping for both legacy and SBFD-aware UE.**

**Observation 3: Additional SBFD-specific PRACH configuration will enable SBFD random access operation only for SBFD-aware UE. It requires extra signalling overhead and limits the benefits of SBFD random access only to SBFD-aware UE.** * **This will enable separate and flexible configuration of the PRACH format, PRACH time/frequency resource, power control targeting UL link quality in SBFD symbols.**
 |
| **ASUSTeK** | **Proposal 1: RAN1 further investigate how to indicate additional PRACH resources (which could not be utilized by non-SBFD UE) to SBFD UE on top of existing PRACH configuration.****Proposal 2: SBFD UE and non-SBFD UE use separate PRACH resource to initiate random access procedure.** **Proposal 3: At least RACH configuration option 2 is supported to indicate separate Ros specifically for SBFD-aware UE.** |

##### **RO across SBFD symbols and non-SBFD symbols**

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| **Company** | **Proposals** |
| **Tejas Networks** | **Proposal 7: If an RO duration starts from SBFD symbols and ends in flexible symbols of TDD UL DL Config Common (non-SBFD symbols), then these ROs should be considered valid.** |
| **LG Electronics** | **Proposal 8: RAN1 to support option 1 (a valid RO can only be on SBFD symbol or on non-SBFD symbols). RAN1 to discuss on whether a RO across SBFD symbol and non-SBFD symbol within a slot or across SBFD slot and non-SBFD slot could be regarded as valid under the specific conditions.** **Proposal 18: In accordance with the current specification, the same UE Tx power should be consistent within a PRACH transmission occasion, even if different PRACH transmit powers for RO in SBFD symbol and RO in non-SBFD symbol are supposed generally for SBFD random access process.** |
| **Spreadtrum, BUPT** | 1. **A valid RO can only be on SBFD symbols or on non-SBFD symbols. For the case of the** **RO across SBFD and non-SBFD symbols in a PRACH slot, this RO is invalid.**
 |
| **Korea Testing Laboratory** | 1. **For SBFD-aware UEs in RRC CONNECTED state, support option 1 a valid RO can only be on SBFD symbols or non-SBFD symbols.**
 |
| **TCL** | **Proposal 8: For RO validation in SBFD symbols, support option 2 (i.e. a valid RO can be across SBFD and non-SBFD symbols in the same slot or across slots)** |
| **Samsung** | Proposal 14: For SBFD-aware UEs in RRC CONNECTED state, support Option 1 where a valid RO can only be on SBFD symbols or on non-SBFD symbols. |
| **vivo** | **Proposal 4: For SBFD-aware UEs in RRC\_CONNECTED mode, a valid RO can only be on SBFD symbols or on non-SBFD symbols.** |
| **CATT** | **Proposal 6: Postpone the decision between Option 1 and Option 2 after we conclude whether transition period between non-SBFD and SBFD symbols is needed for SBFD aware UEs.** |
| **Sony** | **Proposal 8: A valid RO can be across SBFD and non-SBFD symbols in the same slot or across slots.** |
| **Panasonic** | **Proposal 3: For valid RO for SBFD symbols and non-SBFD symbols, support Option 1 (a valid RO can only be on SBFD symbols or on non-SBFD symbols).** |
| **Xiaomi** | 1. For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state,
* **No enhancements for the RO validation rule for the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon (if any).**
	+ **The ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.**
	+ **It’s up to network configuration to ensure the ROs in SBFD symbols configured asflexible by tdd-UL-DL-ConfigurationCommon, which are valid for non-SBFD aware UEs based on legacy RO validation rule, are also valid for SBFD aware UEs (i.e., the configured ROs in SBFD symbols, if configured as flexible by tdd-UL-DL-ConfigurationCommon, are within the UL usable PRBs)**
* **The RO in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon is valid if at least:**
	+ **Time and frequency resource of the RO are fully within UL usable PRBs, and not overlapped with SSB (Ngap can be 0 for all preamble SCS), not across SBFD symbols and non-SBFD symbols within a slot or across slots**
	+ **Other legacy RO validation conditions for non-SBFD aware UE.**
1. For RACH configuration Option 2 to support random access operation for SBFD-aware UEs in RRC CONNECTED state, Alt 2-3 is supported:
* **Alt 2-3:**
	+ **The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD aware UEs.**
	+ **The case where the additional-ROs partially overlap with non-SBFD symbols is invalid for SBFD aware UE.**
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| **NEC** | **Proposal 15:** * **Support PRACH occasions where a single PRACH occasion spans both SBFD and non-SBFD symbols**

**Proposal 16:*** **Indications need to be made to UE as to whether its PRACH will transition between non-SBFD and SBFD symbols.**

**Proposal 17:*** **If PRACH cannot cross-slot into SBFD slots, indications to the UE will need to include whether UE is to drop the PRACH after SBFD slots or continue with the PRACH after the SBFD slot.**
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| **Hyundai** | **Proposal #2:** * **RAN1 needs to consider allowing UE to readjust configured the number of repeated preamble sequences and it can transmit as many as possible when configured preamble format may not be used properly due to the limited time duration.**
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| **ETRI** | **Proposal 2: Further discuss whether or how to support ROs with only non-SBFD symbols.****Proposal 3: Support configurability of allowing valid ROs with both SBFD and non-SBFD symbols.** |
| **Transsion Holdings** | **Proposal 3: A valid RO can only be on the SBFD symbols or non-SBFD symbols.** |
| **OPPO** | **Proposal 1: A valid RO can be on either SBFD symbols only or non-SBFD symbols only; a configured RO across both SBFD symbols and non-SBFD symbols in the same slot or across slots is invalid.**  |
| **NTT DOCOMO** | **Proposal 1: Not support a valid RO across SBFD symbols and non-SBFD symbols.*** **A valid RO can only be on SBFD symbols only or on non-SBFD symbols only.**
 |
| **Qualcomm** | **Proposal 9: A configured RO across SBFD and non-SBFD symbols is considered as invalid RO.**  |

##### **RA events**

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| **Company** | **Proposals** |
| **ZTE** | **Proposal 18: RAN1 can focus on the potential enhancement to support SBFD random access operation triggered by PDCCH order.*** **Other triggering events, which may have no RAN1 impacts, can be discussed in RAN2.**
 |
| **NEC** | **Proposal 1:*** **PRACH transmission in SBFD symbols during RRC\_CONECTED mode should be supported at least for the following use case:**
	+ **Handover procedure**
	+ **Beam failure recovery**
	+ **PDCCH order**
	+ **UL data arrival with no availability of SR resources**
	+ **SR failure**
 |
| **Qualcomm** | **Proposal 1: RAN1 to further discuss which triggering events to be supported for CBRA and CFRA in SBFD symbols. e.g. BFR, SR failure, handover/mobility, SI request, etc.** |

#### **RACH configuration option 1**

##### **RACH resource**

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| **Company** | **Proposals** |
| **New H3C** | **Proposal 6: Unified configuration on PRACH by RRC signalling can be supported.****Proposal 7: Frequency start offset for SBFD which is relative to the original PRACH frequency starting point is supported for determining frequency start of PRACH Occasion in SBFD.** |
| **Tejas Networks** | **Proposal 1: If a single RACH configuration is selected to support RACH in both SBFD and non-SBFD symbols (Option 1), then additional parameters are required along with existing parameters to give flexibility in configuring RO.****Proposal 2: The start RB of the SBFD ROs can be indicated by the additional parameter ‘SBFDmsg1-frequency offset’ in Option 1 – it is a frequency offset from the start of the non-SBFD RO expressed in terms of PRB.****Proposal 3: The start time of the SBFD RO can be indicated by the additional parameter ‘SBFDmsg1\_timeoffset in Option 1– it is the time offset from the beginning of the non-SBFD RO.****Proposal 4: Parameters on Frequency offset and time offset for the SBFD RO can be made part of ‘RACH-ConfigCommon’ in Option 1.** **Proposal 6: The advantage of low signalling overhead in option 1 in comparison to option 2 needs to be discussed further considering the additional parameters required to represent RO in SBFD symbols (option 1).** **Proposal 11: If only Option 1 with no additional parameters does not create a new RO in SBFD, then a new PCI needs to be chosen by the network.**  |
| **LG Electronics** | **Proposal 6: For Option 1, discuss if the mechanism to manage the proper number of valid ROs should be supported.** |
| **Ericsson** | 1. For ROs within SBFD symbols, msg1-FrequencyStart indicates the offset of the 1st RO in relation to the start of the UL subband. The start of the nth RO is determined by the legacy start of the nth RO modulus of the UL subband less the RO bandwidth such that all ROs are always comprised within the UL subband.
 |
| **Huawei, HiSilicon** | **Proposal 1: For RACH configuration Option 1 with Alt 1-1, the following new rules are introduced*** **PRACH resource for SBFD aware UEs starts from the starting point of UL subband and has N FDM-ROs, where N is the largest number belonging to {1,2,4,8} that is not greater than the maximum number of ROs that can be carried in UL subband and the number of FDM-ROs for non-SBFD aware UEs to ensure that the PRACH resources are confined within the UL subband.**
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| **ZTE** | **Proposal 5: For SBFD symbols, the frequency domain reference point of 'msg1-FrequencyStart' can be re-interpreted as the lowest PRB of the UL usable PRBs.**  |
| **Spreadtrum, BUPT** | 1. **Option 1 (Alt 1-1) is one single RACH configuration and only based on the existing parameters of the single RACH configuration, without any interpretations.**
 |
| **InterDigital** | **Proposal 1. Support Alt 1-2 for introducing extra parameters in configuring ROs in SBFD symbols based on Option 1 (using one single RACH configuration), for which indicated time offsets could be used for determining ROs in SBFD symbols based on configured ROs in non-SBFD (legacy) symbols.** |
| **Korea Testing Laboratory** | 1. **For Option 1, support Alt 1-1 only based on the existing parameters of the single RACH configuration configuration (e.g., prach-ConfigurationIndex, msg1-FDM and msg1-FrequencyStart in rach-ConfigCommon).**
 |
| **TCL** | **Proposal 2: For RACH configuration in SBFD symbols with option 1, consider enhancement in the following parameters:*** **The maximum number of ROs FDMed (msg1-FDM) in UL subband**
* **Offset of the lowest ROs (msg1-FrequencyStart)**
* **Preamble transmission power in SBFD symbols**
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| **Samsung** | Proposal 9: For RACH configuration Option 1 with Alt 1-1, a single value for msg1-FDM and a single value for msg1-FrequencyStart is signaled to UEs. SBFD-aware UEs don’t validate ROs located outside the SBFD UL subband on SBFD symbols. |
| **Sharp** | **Proposal 1: RAN1 supports reinterpretation of msg1-FrequencyStart which further is capped by a mod function. Otherwise, RAN1 does not support Option 1 with Alt 1-1 (revert the working assumption).**  |
| **CATT** | **Proposal 1: For RACH configuration Option 1 with Alt 1-1, if reinterpretation of msg1-FrequencyStart is supported, it is not applicable to all the cases.** * **Explicit or implicit scheme needs to be defined for SBFD aware UEs to determine whether to reinterpret msg1-FrequencyStart.**

**Proposal 2: For RACH configuration Option 1 with Alt 1-1, if reinterpretation of msg1-FrequencyStart is supported and UE determines to reinterpret msg1-FrequencyStart, frequency offset of lowest RO with respective to the lowest UL usable PRB is mod (msg1-FrequencyStart, bandwidth of UL usable PRBs) in SBFD symbols configured as DL by tdd-UL-DL-ConfigurationCommon.** |
| **CMCC** | **Proposal 3: For RACH configuration Option 1 with Alt 1-1 and for SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon, the parameter msg1-FrequencyStart in rach-ConfigCommon can be interpreted as the frequency offset of lowest RO in frequency domain with respective to the lowest PRB of UL usable PRBs.** |
| **Xiaomi** | 1. msg1-FrequencyStart is directly used to determine frequency location of RO on SBFD symbols for RACH configuration Option 1 with Alt 1-1.
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| **NEC** | **Proposal 2:** * **For alt 1-1 (only based on the existing parameters of the single RACH configuration) , the definition or interpretation of the existing parameters for RACH configuration can be changed.**
 |
| **Lenovo** | **Proposal 2: For option 1 with Alt 1-1, there is no needed to reinterpret msg1-FrequencyStart in rach-ConfigCommon.** |
| **Fujitsu** | **Proposal 3: Reinterpretation of msg1-FrequencyStart is introduced for the flexibility of resource allocation of uplink channel in non-SBFD symbols.****Proposal 4: For Option 1, reinterpret msg1-FrequencyStart for ROs within DL SBFD symbols and An RO across DL SBFD symbols and flexible SBFD symbols.*** **For those ROs, the offset indicated by msg1FrequencyStart refers to the offset between the lowest RO in frequency domain and the lowest PRB of the UL usable PRBs.**
 |
| **Transsion Holdings** | **Proposal 1: the time and frequency resources of the configured ROs in SBFD symbols should be derived from the existing parameters of the single RACH configuration and newly introduced parameter(s).** |
| **OPPO** | **Proposal 2: For option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration), support using different reference points to interpret msg1-FrequencyStart for SBFD-DL symbols (SBFD symbols configured as downlink) and UL/flexible symbols.**  |
| **ITRI** | **Proposal 2:*** **For RACH configuration option 1 for SBFD-aware UEs, introducing new parameters or reinterpretation is unnecessary.**
 |
| **Qualcomm** | **Proposal 2: For SBFD random access operation using option 1, support the following:*** **The start-RBs of the ROs in SBFD-DL symbols can be interpreted with respect to the first usable PRB in the uplink subband.**
* **FFS: Separate power control parameters for PRACH transmission in SBFD symbols.**
 |
| **WILUS Inc.** | * **Proposal 2: For RACH configuration Option 1, it is suggested to consider an implicitly different RO resource setting from the legacy UE’s RO resource setting by reinterpreting at least msg1-FrequencyStart to configure the RO in the UL sub-band using additional parameters such as semi-statically configured frequency location of UL subband, UL BWP size, and UL subband size, while also considering a reinterpretation of additional parameters such as msg1-FDM and ssb-perRACH-OccasionAndCB-PreamblesPerSSB.**
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| **KT Corp.** | **Proposal 1. Consider the RACH configuration with newly introduced parameters for RACH configuration Option 1.** |

##### **RO validation**

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| **Company** | **Proposals** |
| **New H3C** | **Proposal 13: For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state,** * **no enhancements for the RO validation rule for the ROs in non-SBFD symbols and the ROs in SBFD symbols configured ~~indicated~~ as flexible by tdd-UL-DL-ConfigurationCommon (if any).**
	+ **FFS: the ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.**
	+ **FFS: It’s up to network configuration to ensure the ROs in SBFD symbols configured ~~indicated~~ asflexible by tdd-UL-DL-ConfigurationCommon, which are valid for non-SBFD aware UEs based on legacy RO validation rule, are also valid for SBFD aware UEs (i.e., the configured ROs in SBFD symbols, if configured ~~indicated~~ as flexible by tdd-UL-DL-ConfigurationCommon, are within the UL usable PRBs).**
* **the RO in SBFD symbols configured ~~indicated~~ as downlink by tdd-UL-DL-ConfigurationCommon is valid if at least:**
	+ **Time and frequency resource of the RO are fully within UL usable PRBs, ~~and not overlapped with SSB.~~**
	+ **FFS: Other condition.**

**Note: For the case that all the SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon, there is no restriction that all the configured ROs in SBFD symbols should be within the UL usable PRBs.** |
| **Tejas Networks** | **Proposal 8: Depending on the network configuration, to program RO validation rule is not a reliable option. RO validation rule should be a predefined rule for the SBFD-aware UE.** **Proposal 9: For the RO in SBFD symbols, RO starts at least** $N\_{gap}$ **symbols after the SSB block and should not overlap.**  |
| **LG Electronics** | **Proposal 9: For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, support further RO validation rule for the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon (if any).*** **The ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.**
* **It’s up to network configuration to ensure the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon, which are valid for non-SBFD aware UEs based on legacy RO validation rule, are also valid for SBFD aware UEs (i.e., the configured ROs in SBFD symbols, if configured as flexible by tdd-UL-DL-ConfigurationCommon, are within the UL usable PRBs)**

**Proposal 12: For dynamic or semi-static DL vs. valid RO,** * **Reuse the existing collision handling principles for HD-FDD RedCap UE, i.e. leave to UE implementation.**
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| **ZTE** | **Proposal 6: The ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs, and preamble-level partition should be supported between non-SBFD aware UEs and SBFD aware UEs.** **Proposal 7: SBFD configuration can be invalidated in case that a collision between SBFD aware UEs and non-SBFD aware UEs on the validation of ROs in flexible symbols occurs.** **Proposal 8: For a configured RO in downlink symbols,** * **The frequency location of a valid RO should be contained within the UL usable PRBs;**
* **The frequency domain gap between a valid RO and the UL usable PRBs boundary should be larger than or equal to a predefined threshold.**
 |
| **Spreadtrum, BUPT** | 1. **For RACH configuration Option 1 Alt 1-1, the additional ROs are valid if their time and frequency resource of the RO are fully within UL usable PRBs and not overlapped with SSB in SBFD symbols configured as downlink, and start at least** $N\_{gap}$ **symbols after a last downlink symbol which is not configured as SBFD or SSB symbols.**
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| **InterDigital** | **Proposal 5. For SBFD RACH configuration based on Option 1 (use one single RACH config) support the ROs in non-SBFD symbols that are valid for non-SBFD UEs to be valid for SBFD UEs to enable PRACH fallback, repetition, etc.** |
| **TCL** | **Proposal 3: The ROs configure in non-SBFD symbols that are valid for legacy UEs are also valid for SBFD aware UEs.**  |
| **Samsung** | Proposal 15: For RACH configuration Option 1, for ROs in SBFD symbols configured as flexible, the ROs in non-SBFD symbols that are valid for non-SBFD aware UEs should be invalid for SBFD aware UEs. |
| **vivo** | **Proposal 1: For Option 1 of RACH configuration, the ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs. It’s up to network configuration to ensure the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon, which are valid for non-SBFD aware UEs based on legacy RO validation rule, are also valid for SBFD aware UEs (i.e., the configured ROs in SBFD symbols, if configured as flexible by tdd-UL-DL-ConfigurationCommon, are within the UL usable PRBs)****Proposal 3: For SBFD aware UEs and for RACH configuration Option 2, Alt 2-3 is preferred, i.e., the additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs. For RACH configuration Option 1 with alt 1-2, the additional-ROs in non-SBFD symbols configured by additional parameters are invalid for SBFD-aware UEs.**Proposal 5: The following RO validation rule can be considered for RACH configuration Option 1 and Option 2: If a UE is provided tdd-UL-DL-ConfigurationCommon, a PRACH occasion in UL subband is valid if at least:**- its’ time and frequency resource are fully within UL usable PRBs, and** **- it starts at least** $X$ **symbols after a last downlink non-SBFD symbol, and****- it is not overlapped with SS/PBCH block symbol, and****- it does not precede a SS/PBCH block in the PRACH slot****- FFS whether Y symbols gap is needed between a PRACH occasion and the earliest non-SBFD symbols after the PRACH occasion** |
| **Apple** | **Proposal 2: For Option 1 (i.e., use one single RACH configuration with possible enhancement), the network ensures the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon are within the UL usable PRBs.** |
| **Sharp** | **Proposal 3: ROs overlapping with SSB in the time domain is invalid for Option 1 with Alt 1-1.** |
| **CATT** | **Proposal 7: For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state,** * **No enhancements for the RO validation rule for the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon (if any).**
* **The ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.**
* **It’s up to network configuration to ensure the valid ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon based on legacy RO validation rule, are within the UL usable PRBs.**
* **The RO in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon is valid if at least:**
* **Frequency resources of the RO are fully within UL usable PRBs and start at least Ngap symbols after a last non-SBFD downlink symbol.**
* **FFS the RO overlapped with a SS/PBCH block.**
 |
| **China Telecom** | **Proposal 5: It’s RAN1’s common understanding that “Time and frequency resource of the RO are fully within UL usable PRBs, and not overlapped with SSB” in the above agreement means “Time and frequency resource of the RO are fully within UL usable PRBs, and time resource of the RO is not overlapped with SSB”** |
| **CMCC** | **Proposal 4:** **For RACH configuration Option 1 with Alt 1-1, no other conditions are needed to define the valid RO in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon.****Proposal 5: For RACH configuration Option 1 with Alt 1-1 and for legacy-ROs (including the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon), further study whether separate preambles can be allocated to SBFD aware UEs and non-SBFD aware UEs for** **early identification of SBFD-aware UEs.** |
| **MediaTek Inc.** | 1. **For RACH configuration Option 1, the ROs on non-SBFD symbols that are valid for non-SBFD aware UE can also be considered valid for SBFD aware UE.**
 |
| **Xiaomi** | 1. For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state,
* **No enhancements for the RO validation rule for the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon (if any).**
	+ **The ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.**
	+ **It’s up to network configuration to ensure the ROs in SBFD symbols configured asflexible by tdd-UL-DL-ConfigurationCommon, which are valid for non-SBFD aware UEs based on legacy RO validation rule, are also valid for SBFD aware UEs (i.e., the configured ROs in SBFD symbols, if configured as flexible by tdd-UL-DL-ConfigurationCommon, are within the UL usable PRBs)**
* **The RO in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon is valid if at least:**
	+ **Time and frequency resource of the RO are fully within UL usable PRBs, and not overlapped with SSB (Ngap can be 0 for all preamble SCS), not across SBFD symbols and non-SBFD symbols within a slot or across slots**
	+ **Other legacy RO validation conditions for non-SBFD aware UE.**
 |
| **Lenovo** | **Proposal 2: No restrictions on the RO frequency allocations should be introduced.****Proposal 3: If legacy ROs are configured in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon, and if the ROs are configured outside of UL subband, these symbols are available for SBFD.**  |
| **Langbo** | **Proposal 3: The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.****Proposal 4: The frequency position of an RO within UL subband in SBFD symbols is considered for determining validity of the RO.****Proposal 5: RAN1 to discuss whether the transition delay between SBFD and non-SBFD symbols will affect the RO validation in SBFD symbols.****Proposal 6: RAN1 to discuss the impact of SBFD configuration pattern on the determination of valid ROs in SBFD symbols.** |
| **ETRI** | **Proposal 1: The validity test introduces frequency resource of an RO in SD symbols.****Proposal 4: Strive to support a consistent way for both connected and non-connected UEs of validating ROs**Proposal 5: Strive to a unified framework for RO validation and SSB-RO mapping rule for both options, for connected UEs.**Proposal 7: It should be clarified whether an RO having multiple duplex types may be valid or not in the connected mode.**  |
| **Fujitsu** | **Proposal 1: For Option 1, RO validation rule for ROs in SBFD symbols are:** * **If the UE is provided a higher layer parameter indicating that PRACH transmission is allowed in SSB symbols, an RO within DL SBFD symbols or an RO across DL SBFD symbols and flexible SBFD symbols is valid if it is fully within UL usable PRBs**
* **Otherwise, the RO is valid if it is fully within UL usable PRBs and not overlapped with SSB indicated by ssb-PositionsInBurst in SIB1 or in ServingCellConfigCommon.**

**Proposal 2: Consider adopting one or more of the following options to avoid the PRACH collisions in RO in non-SBFD symbols:*** **Option 1) Preamble partitioning between UEs supporting SBFD and non-SBFD.**
* **Option 2) Restrict SBFD-aware UEs from using ROs in non-SBFD symbols.**
 |
| **OPPO** | **Proposal 3: For option 1 with Alt 1-1, the ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.****Proposal 4: For option 1 with Alt 1-1, it’s up to network configuration to ensure the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon (if any), which are valid for non-SBFD aware UEs based on legacy RO validation rule, are within the UL usable PRBs (i.e., being valid for SBFD-aware UE).** |
| **ITRI** | **Proposal 3:** * **For RACH configuration Option 1, ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.**

**Proposal 4:** * **For RACH configuration Option 1, it’s up to network configuration to ensure the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon, which are valid for non-SBFD aware UEs based on legacy RO validation rule, are also valid for SBFD aware UEs.**
 |
| **Qualcomm** | **Proposal 7: For option 1 (Single PRACH configuration), support the following:** * **The ROs in non-SBFD symbols that are valid for non-SBFD aware Ues are also valid for SBFD aware Ues.**
* **It’s up to network configuration to ensure the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon, which are valid for non-SBFD aware Ues based on legacy RO validation rule, are also valid for SBFD aware Ues (i.e., the configured ROs in SBFD symbols, if configured as flexible by tdd-UL-DL-ConfigurationCommon, are within the UL usable PRBs).**

**Proposal 8: Relax the Ng symbols between last SSB and an RO such that a configured RO in SBFD-DL symbols that is proceeding SSB symbols is considered valid if there is enough timeline to switch from Rx to Tx.** |
| **WILUS Inc.** | * **Proposal 9: Regardless of which RACH configuration option is applied, the following conditions should be further considered as in legacy NR system.**
	+ **If a SBFD aware UE is not provided tdd-UL-DL-ConfigurationCommon, a RO in a PRACH slot on SBFD symbols is valid if it does not precede a SS/PBCH block in the PRACH slot and starts at least N\_gap symbols after a last SS/PBCH block symbol.**
	+ **If a SBFD aware UE is provided tdd-UL-DL-ConfigurationCommon, a RO in a PRACH slot on SBFD symbols is valid if it does not precede a SS/PBCH block in the PRACH slot and starts at least N\_gap symbols after a last downlink symbol and at least N\_gap symbols after a last SS/PBCH block symbol.**
 |
| **KT Corp.** | **Proposal 2. For RACH configuration Option 1, ROs in non-SBFD symbols that are valid for non-SBFD aware UEs should be also valid for SBFD aware UEs.** |

##### **SSB-RO mapping**

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| **Company** | **Proposals** |
| **New H3C** | **Proposal 3: Mapping SSB to RO in SBFD symbol and SSB to RO in non-SBFD symbol separately should be supported.****Proposal 4: If supporting unified mapping SSB to RO in SBFD symbol and non-SBFD symbol, dedicated preamble allocation for SBFD-aware UE should be considered.** |
| **Tejas Networks**  | **Proposal 12: For both option 1 and option 2, the SSB to RO mapping rule should be separate for SBFD symbols and non-SBFD symbols.**  |
| **LG Electronics** | Proposal 13: For Option 1, reuse legacy mapping rule applied to each legacy-ROs and SBFD-ROs where separate SSB-RO mapping is agreed to be used respectively. |
| **Huawei, HiSilicon** | **Proposal 3: For RACH configuration Option 1 with Alt 1-1, the SSB-RO mapping order of PRACH resource for SBFD aware UEs in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon, is different from the SSB-RO mapping order of PRACH resource for non-SBFD aware UEs, i.e., the SSB-RO mapping with descending order of SSB index.**  |
| **InterDigital** | **Proposal 7. Support SSB-RO mapping in ROs in SBFD symbols based on descending order of SSB indexes.** |
| **TCL** | **Proposal 9: Consider the following alternative options for SSB to ROs mapping:*** **Option 1: Separate SSB to ROs mapping of ROs configured in SBFD symbols and ROs configured in non-SBFD symbols.**
* **Option 2: Joint ROs configured in SBFD symbols with ROs in non-SBFD symbols based on their indexes and map to SSBs.**
 |
| **Sharp** | **Proposal 2: Independent SSB-to-RO mapping applied among the additional ROs is supported for Option 1 with Alt 1-1.** |
| **CATT** | **Proposal 11: For RACH configuration Option 1, legacy SSB-to-RO mapping rule is reused for** **the additional valid ROs in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon.** |
| **CMCC** | **Proposal 6: For RACH configuration Option 1 with Alt 1-1 and for the ROs in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon, take Alt 1 as the starting point, and Alt 2 can be considered if obvious benefits can be observed.*** **Alt 1: reuse legacy SSB-RO mapping rules.**
* **Alt 2: enhanced SSB-RO mapping rules, e.g., SS/PBCH block indexes are mapped to valid ROs in descending order of SS/PBCH block indexes.**
 |
| **Sony** | **Proposal 2: For PRACH configuration Option 1 with Alt 1-1 (i.e., use one single PRACH configuration, and only based on the existing parameters of the single RACH configuration), the SBFD UE performs two SSB-RO associations using legacy (Rel-18) SSB-RO association method, on ROs validated using different RO validation rules, i.e.:*** **1st SSB-RO association is performed on ROs validated using legacy (Rel-18) RO validation rules**
* **2nd SSB-RO association is performed on ROs validated using new (Rel-19) RO validation rules, where a RO is valid if it is fully contained with usable UL PRB and does not overlap with SSB**
 |
| **Hyundai** | **Proposal #1:** * **For single RACH configuration, RAN #1 needs to consider following procedures for less specification impact.**
	+ **Legacy SSB to RO mapping rule needs to be carried out before appling validation rule for ROs.**
	+ **Allowing UE to transmit msg1 through the one RO among the valid ROs even though RO associated with best RSRP is not included.**
 |
| **OPPO** | **Proposal 5: For option 1 with Alt 1-1, legacy SSB-RO mapping is applied for ROs configured in SBFD symbols configured as downlink.** |
| **Nokia, NSB** | Proposal 10. For RACH configuration Option 1, RAN1 to confirm whether new SSB-to-RO mapping rule is introduced or not by down-selecting one of the following alternatives:* **Alt. 1: Legacy SSBs to ROs mapping rules are used separately on the SBFD ROs.**
* **Alt. 2: Legacy SSBs to ROs mapping rules are used to continue the mapping for SBFD-ROs starting from the SSB index/indices associated with the latest legacy RO (i.e., previous legacy RO with highest frequency index).**
* **Alt. 3: For each frequency index, applying the same SSB index/indices of the latest legacy RO for the subsequent SBFD-RO(s).**
 |
| **ITRI** | **Proposal 1:** * **For RACH configuration Option 1 with Alt 1-1, the current SSB-RO mapping rule could be reused for the separate mapping of ROs in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon.**
 |
| **Qualcomm** | **Proposal 10: For Option-1, reuse the legacy SSB-RO mapping rule for mapping SSBs to the valid ROs in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon.*** **FFS: the start index of the first SSB and the subsets of SSBs.**

**Proposal 11: For both option-1 and option-2 of PRACH configuration, RAN1 to study the determination of the association period and association period pattern for the SBFD-ROs.**  |
| **WILUS Inc.** | * **Proposal 4: For RACH configuration Option 1, we propose to support legacy SSB to RO mapping rule for validated ROs within UL subband for Rel-19 SBFD aware UEs considering BW size difference between RO’s BW size of UL subband and legacy RO’s BW size for non-SBFD aware UEs.**
* **Proposal 5: For RACH configuration Option 1, we propose to have separate SS/PBCH block index to RO mapping for new validated ROs in SBFD symbols within UL subband for SBFD aware UEs, regardless of being configured as flexible or downlink by tdd-UL-DL-ConfigurationCommon.**
 |

##### **PRACH power control**

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| **Company** | **Proposals** |
| **Tejas Networks** | **Proposal 5: For option 1, it is recommended to have a separate IE for SBFD RO, as configuration for power parameters in SBFD RACH needs to be added in this IE; i.e., Preamble Received Target Power, Maximum Preamble Transmission and Power Ramping Step.**  |
| **LG Electronics** | **Proposal 16: For option 1, support single PRACH power control parameters configuration in SBFD symbols and non-SBFD symbols with re-interpretation.** |
| **Ericsson** | 1. Support separate power control for SBFD ROs for both single and dual RACH configurations.
 |
| **ZTE** | **Proposal 16: For PRACH transmission of SBFD aware UEs in RRC CONNECTED state, support separate PRACH power control parameters configuration in SBFD symbols and non-SBFD symbols.** * **The separate PRACH power control parameters configuration can be an absolute value of a power control parameter;**
* **The separate PRACH power control parameters can be derived based on a relative value, e.g., a power offset.**
* **The above mechanism should applicable to both of RACH configuration Option 1 with Alt 1-1 and RACH configuration Option 2.**
 |
| **InterDigital** | **Proposal 8. Support configuring different PRACH power control parameters for SBFD and non-SBFD ROs, also for FDM-ed SBFD ROs that are closer or farther from DL subband edges, in consideration of potential CLI caused by PRACH transmission.** |
| **Korea Testing Laboratory** | 1. **For SBFD-aware UEs in RRC CONNECTED state, distinguish power control parameters (e.g., PREAMBLE\_RECEIVED\_TARGET\_POWER) for SBFD and non-SBFD symbols.**
2. **For SBFD-aware UEs in the RRC CONNECTED state, consider PRACH repetition gain and antenna configuration to set power control parameters for SBFD and non-SBFD symbols.**
 |
| **Apple** | **Proposal 3: For RACH configuration Option 1 (i.e., use one single RACH configuration with possible enhancement), separate PRACH power control parameters can be configured for transmission in SBFD symbols.** |
| **China Telecom** | **Proposal 7: Support separate configuration of** $P\_{PRACH,target,f,c}$ **for SBFD operation.** |
| **CMCC** | **Proposal 7: For RACH configuration Option 1 with Alt 1-1,** **single set of PRACH power control parameters, including preambleReceivedTargetPower, preambleTransMax and powerRampingStep, can be used for legacy-ROs (including the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon) and SBFD-ROs (the ROs in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon) for SBFD-aware UEs.** |
| **Xiaomi** | 1. Separate PRACH power control parameters configuration in SBFD symbols and non-SBFD symbols may be needed to enable gNB-gNB CLI and UE-UE CLI mitigation if RA in SBFD symbols is supported.
 |
| **NEC** | **Proposal 9:*** **Power control for PRACH enhancements on SBFD symbols should be considered.**
 |
| **Lenovo** | **Proposal 9: Separate power control parameters are supported for PRACH transmission in SBFD symbols and non-SBFD symbols.** |
| **Langbo** | **Proposal 7: Support separate PRACH power control parameters configuration in SBFD symbols and non-SBFD symbols.** |
| **ETRI** | Proposal 6: Regarding Alt 1-1, some power control parameters are separately applied for different symbol types. |
| **Fujitsu** | **Proposal 7: Separate configuration/parameter of maximum PRACH transmission power and preambleReceivedTargetPower in SBFD and non-SBFD symbols is supported to mitigate the CLI.** |
| **Qualcomm** | **Proposal 2: For SBFD random access operation using option 1, support the following:*** **The start-RBs of the ROs in SBFD-DL symbols can be interpreted with respect to the first usable PRB in the uplink subband.**
* **FFS: Separate power control parameters for PRACH transmission in SBFD symbols.**
 |
| **KT Corp.** | **Proposal 4. Support separate PRACH power control parameters in SBFD symbols and non-SBFD symbols.****Proposal 5. Discuss how to enhance the PRACH power control for PRACH transmission in SBFD symbols for PRACH configuration Option 1.** |

#### **RACH configuration option 2**

##### **RACH resource**

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| **Company** | **Proposals** |
| **New H3C** | **Proposal 8: Separated configuration on PRACH by RRC signalling can be supported.****Proposal 9: Frequency start parameter for SBFD is supported for determining frequency start of PRACH Occasion in SBFD.** |
| **LG Electronics** | **Proposal 4: For two separate RACH configurations, different preamble formats by each PRACH configuration index can be configured by gNB.** |
| **Ericsson** | 1. Do not specify an additional msg1-FrequencyStart and instead use the same reinterpretation as for single configuration.
 |
| **Huawei, HiSilicon** | **Proposal 2: For RACH configuration Option 2, all parameters in RACH-ConfigCommon are included in the additional RACH configuration, and consider updating the candidate set of following parameters** * **Add {3,5,6,7} into the candidate set of msg1-FDM,**
* **Add {n1, n2} into the candidate set of preambleTransMax.**

**introduce the following parameters*** **Multiple parameters preambleReceivedTargetPower to set target power for FDM-ROs**
* **Multiple parameters preamblemaxOutputPower to limit maximum power for FDM-ROs.**
 |
| **ZTE** | **Proposal 14: Parameters in currently rach-ConfigCommon except for the following can be reused for the additional RACH configuration.** * **preambleTransMax, ra-ResponseWindow, groupBconfigured, ra-ContentionResolutionTimer and** **rsrp-ThresholdSSB-SUL**
 |
| **Spreadtrum, BUPT** | 1. **Parameters in additional RACH configuration in Option 2 have three types:**
* **Type1: parameters should be included, such as rach-ConfigGeneric**
* **Type2: parameters cannot be included, and the same parameters in legacy RACH configuration always applied. E.g rsrp-ThresholdSSB/rsrp-ThresholdSSB-SUL, msg1-SubcarrierSpacing, msg3-transformPrecoder**
* **Type3: parameters may or may not be included. If included, they are applied, if not, the same parameters are reused.**
 |
| **Samsung** | Proposal 7: SBFD aware UE and non-SBFD aware UE can use different PRACH preamble formats.Proposal 11: For RACH configuration Option 2, separate values for msg1-FDM, msg1-FrequencyStart are signaled for the new/additional SBFD configuration and the legacy RACH configuration. SBFD-aware UEs don’t validate ROs located outside the SBFD UL subband on SBFD symbols. |
| **Sharp** | **Proposal 4: Discuss potential signalling overhead reduction in Option 2.** |
| **CATT** | **Proposal 3: For RACH configuration Option 2, all the parameters currently in rach-ConfigCommon are included in additional RACH configuration.** |
| **MediaTek Inc.** | 1. **For RACH configuration Option 2, do not provide all parameters in rach-ConfigCommon in the additional RACH configuration**
* **RAN1 to further discuss which parameters are included in the additional RACH configuration**
* **If a parameter is not provided in the additional RACH configuration, UE uses the corresponding parameter in the legacy RACH configuration**
 |
| **Xiaomi** | 1. With option 2, either same or different preamble format can be configured via separate PRACH configuration.
 |
| **Fujitsu** | **Proposal 5: Possible parameters to be separately configured for SBFD aware UEs are prach-ConfigurationIndex, msg1-FDM, ssb-perRACH-OccasionAndCB-PreamblesPerSSB and msg1-FrequencyStart.** |
| **NTT DOCOMO** | **Proposal 3: Following parameters are included in the additional RACH configuration:*** **Parameters for RO time domain resources: prach-ConfigurationIndex**
* **Parameters for RO frequency domain resources: msg1-FDM, msg1-FrequencyStart**
* **Parameters for SSB-to-RO mapping: ssb-perRACH-OccasionAndCB-PreamblesPerSSB, totalNumberOfRA-Preambles**
 |
| **Nokia, NSB** | Proposal 4 For Option 2, in case the legacy ROs and the additional ROs have the same value for one of the RACH configuration parameters. Only the legacy RACH configuration will be configured with this parameter.Proposal 5 For Option 2, in case the SBFD aware UEs did not receive a dedicated parameter in the additional RACH configuration, the SBFD-aware UEs determine this dedicated parameter from the legacy RACH configuration. |
| **Qualcomm** | **Proposal 3: For SBFD random access operation using option 2, support the following PRACH parameters for the additional PRACH configuration:** * **Time resource configuration**
* **Freq. resource configuration**
* **Power control parameters**
* **SSB-RO mapping parameters**
* **SSB parameters**
* **PRACH subcarrier spacing.**
 |
| **WILUS Inc.** | * **Proposal 3: For RACH configuration Option 2, it may be advisable to include parameters such as msg1-FrequencyStart, msg-FDM, ssb-perRACH-OccasionAndCB-PreamblesPerSSB, which are deemed to require reinterpretation in Option 1, and prach-ConfigurationIndex for setting RO resources on the time domain in an additional RACH configuration.**
 |

##### **RO validation**

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| **Company** | **Proposals** |
| **New H3C** | **Proposal 10: For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, the following alternatives 2-3 is supported:*** **Alt 2-3:**
	+ **The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.**
	+ **FFS: The case where the additional-ROs partially overlap with non-SBFD symbols**

**Proposal 11: If partial or all frequency resources of RO falls outside of UL BWP frequency resource or UL SBFD frequency resource, the RO is considered as invalid.****Proposal 12: For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state,*** **for the additional-ROs in SBFD symbols configured by additional RACH configuration, they are valid if at least:**
	+ **time and frequency resource of the RO are fully within UL usable PRBs**
	+ **FFS: Other condition.**
 |
| **Tejas Networks** | **Proposal 8: Depending on the network configuration, to program RO validation rule is not a reliable option. RO validation rule should be a predefined rule for the SBFD-aware UE.** **Proposal 9: For the RO in SBFD symbols, RO starts at least** $N\_{gap}$ **symbols after the SSB block and should not overlap.****Proposal 13: Before down selection, UE in the RRC\_IDLE/RRC\_INACTIVE state has to be considered, as overlap RO is crucial in SBFD RACH performance improvement.** **Proposal 14: If the additional RO is partially overlapping with flexible symbols of TDD-UL-DL\_ConfigCommon, then these ROs should be considered valid, i.e., we support Alt2-3.** |
| **LG Electronics** | Proposal 10: RAN1 to support Option 2-4 since it provides more configuration flexibility and less specification impact.Proposal 11. For Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state,* for the additional-ROs in SBFD symbols and non-SBFD symbols configured by additional RACH configuration, they are valid if at least,
	+ time and frequency resource of the RO are fully within UL usable PRBs, and not overlapped with SSB

**Proposal 12: For dynamic or semi-static DL vs. valid RO,** * **Reuse the existing collision handling principles for HD-FDD RedCap UE, i.e. leave to UE implementation.**
 |
| **Ericsson** | 1. For the additional RACH configuration, support further RO validation restrictions, e.g., by an RO puncturing bitmap.
2. For RO validation of the additional RACH configuration, ROs in SBFD symbols are valid and ROs in non-SBFD symbols are invalid for SBFD-aware UEs (Alt. 2-3).
 |
| **Huawei, HiSilicon** | **Proposal 5: For RACH configuration Option 2, the ROs of the PRACH resources for SBFD aware UEs in non-SBFD symbols and in SBFD symbols occupying flexible symbols should be considered as invalid. And, a valid RO is not allowed to be across SBFD symbols and non-SBFD symbols.**  |
| **ZTE** | **Proposal 9: The additional ROs in non-SBFD symbols configured by additional RACH configuration can be valid for SBFD-aware UEs** * **FFS: the frequency domain location of the additional ROs are adjusted by defining the frequency domain reference point as the PRB0 of the UL BWP.**

**Proposal 10: For an additional RO in non-SBFD symbols configured by additional RACH configuration,** * **If it is FDMed with a legacy RO, it can be defined as a valid RO even if the FDMed ROs associated with different SSBs.**
* **If it is overlapped with a legacy RO, it can be defined as an invalid RO.**
 |
| **Spreadtrum, BUPT** | 1. **For RACH configuration Option 2,** **the additional-ROs configured by additional RACH configuration are valid if time and frequency resource of the RO are fully within UL usable PRBs in SBFD symbols, and not overlapped with SSB, and they start at least** $N\_{gap}$ **symbols after a last downlink symbol which is not configured as SBFD or SSB symbols**
* **Alt 2-3 is adopted. The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.**
 |
| **InterDigital** | **Proposal 6. For RACH config Option 2 (based on two separate RACH configs), support Alt 2-4 to allow SBFD UEs to use additional-ROs that overlap with non-SBFD symbols.** |
| **TCL** | **Proposal 4: For RACH configuration option 2, support Alt 2-3: The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.****Proposal 5: For RACH configuration option 2, the additional RACH configuration can be used to configure ROs in SBFD symbols only.**  |
| **Samsung** | Proposal 10: For RACH configuration Option 2, support Alt 2-3 where the additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs and mixed/partially overlapped ROs are invalid. |
| **vivo** | **Proposal 3: For SBFD aware UEs and for RACH configuration Option 2, Alt 2-3 is preferred, i.e., the additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs. For RACH configuration Option 1 with alt 1-2, the additional-ROs in non-SBFD symbols configured by additional parameters are invalid for SBFD-aware UEs.**Proposal 5: The following RO validation rule can be considered for RACH configuration Option 1 and Option 2: If a UE is provided tdd-UL-DL-ConfigurationCommon, a PRACH occasion in UL subband is valid if at least:**- its’ time and frequency resource are fully within UL usable PRBs, and** **- it starts at least** $X$ **symbols after a last downlink non-SBFD symbol, and****- it is not overlapped with SS/PBCH block symbol, and****- it does not precede a SS/PBCH block in the PRACH slot****- FFS whether Y symbols gap is needed between a PRACH occasion and the earliest non-SBFD symbols after the PRACH occasion** |
| **Apple** | **Proposal 5: For RACH configuration Option 2, the additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.****Proposal 8: For RACH configuration Option 2, for additional ROs configured in SBFD symbols by additional RACH configuration, the valid RO should be within SBFD UL symbols, fully within the SBFD UL subband, and not overlapped with the SSB.** |
| **Sharp** | **Proposal 5: Alt 2-4 is supported (i.e., the additional-ROs in non-SBFD symbols configured by additional RACH configuration can be valid for SBFD-aware UEs).****Proposal 6: ROs overlapping with SSB in the time domain is invalid for Option 2.** |
| **CATT** | **Proposal 8: For RACH configuration Option 2, the** **additional ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.****Proposal 9: For RACH configuration Option 2, the RO in SBFD symbols is valid if:*** **Start at least 𝑁gap symbols after a last non-SBFD downlink symbol.**
* **FFS a RO overlapped with a SS****/PBCH block.**
* **FFS frequency resource of the RO are fully within UL usable PRBs**

**Proposal 10: For RACH configuration Option 2, the legacy ROs in non-SBFD symbols configured by the legacy RACH configuration are also valid for SBFD aware UEs.** |
| **China Telecom** | **Proposal 4: For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration), support Alt 2-3 (i.e., The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.)****Proposal 6: For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state,*** **for the additional-ROs in SBFD symbols configured by additional RACH configuration, they are valid if at least:**
	+ **time and frequency resource of the RO are fully within UL usable PRBs**
	+ **FFS: Other condition.**
 |
| **CMCC** | **Proposal 8: For RACH configuration Option 2, support Alt 2-3.*** **Alt 2-3:**
	+ **The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.**
	+ **FFS: The case where the additional-ROs partially overlap with non-SBFD symbols**

**Proposal 9: For** **RACH configuration Option 2, for the additional-ROs in SBFD symbols configured by additional RACH configuration, they are valid if time and frequency resource of the ROs are fully within UL usable PRBs.** |
| **Sony** | **Proposal 3: For PRACH configuration Option 2 (i.e., Use two separate PRACH configurations, including one legacy PRACH configuration and one additional PRACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state:*** **Alt 2-4: The additional-ROs in non-SBFD symbols configured by additional PRACH configuration can be valid for SBFD-aware UEs.**
 |
| **Panasonic** | **Proposal 1: For the additional-ROs in non-SBFD symbols configured by additional RACH configuration, support Alt 2-3.** |
| **Xiaomi** | 1. For RACH configuration Option 2 to support random access operation for SBFD-aware UEs in RRC CONNECTED state, Alt 2-3 is supported:
* **Alt 2-3:**
	+ **The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD aware UEs.**
	+ **The case where the additional-ROs partially overlap with non-SBFD symbols is invalid for SBFD aware UE.**
1. For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state,
* **For the additional-ROs in SBFD symbols configured by additional RACH configuration, they are valid if at least:**
	+ **Time and frequency resource of the RO are fully within UL usable PRBs, and not overlapped with SSB (Ngap can be 0 for all preamble SCS), not across SBFD symbols and non-SBFD symbols within a slot or across slots**
	+ **Other legacy RO validation conditions for non-SBFD aware UE**
 |
| **NEC** | **Proposal 4:** * **For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration), support Alt 2-3.**

**Proposal 5:** * **For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration), an RO configured by additional RACH configuration is considered invalid if it overlaps in time domain with a valid RO configured by legacy RACH configuration.**
 |
| **Lenovo** | **Proposal 5: For option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration), the additional ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs. (Alt 2-3)****Proposal 6: For option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration),*** **RO validation rule for the additional configuration is same as the one for option 1 with Alt 1-1.**
* **FFS: how to handle the collision between legacy valid ROs and additional valid ROs.**
 |
| **Langbo** | **Proposal 4: The frequency position of an RO within UL subband in SBFD symbols is considered for determining validity of the RO.****Proposal 5: RAN1 to discuss whether the transition delay between SBFD and non-SBFD symbols will affect the RO validation in SBFD symbols.****Proposal 6: RAN1 to discuss the impact of SBFD configuration pattern on the determination of valid ROs in SBFD symbols.** |
| **ETRI** | **Proposal 1: The validity test introduces frequency resource of an RO in SD symbols.****Proposal 4: Strive to support a consistent way for both connected and non-connected UEs of validating ROs**Proposal 5: Strive to a unified framework for RO validation and SSB-RO mapping rule for both options, for connected UEs.**Proposal 8: Alt 2-3 is supported as baseline to simplify SSB-RO mapping of additional RACH configuration.****Proposal 9: Regarding Alt 2-3, support configurability whether an overlapped RO is valid or not.** |
| **Fujitsu** | **Proposal 6: When both legacy PRACH configuration and additional PRACH configuration for SBFD RA are provided, only the additional PRACH configuration can configures ROs in DL SBFD symbols.** |
| **Transsion Holdings** | **Proposal 2：The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.** |
| **OPPO** | **Proposal 6: For RACH configuration Option 2, Alt 2-3 is adopted, i.e., the additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.** **Proposal 7: For RACH configuration Option 2, the additional-ROs in SBFD symbols configured by additional RACH configuration are valid if at least:*** + **time and frequency resource of the RO are fully within UL usable PRBs, and not overlapped with SSB**
	+ **FFS other conditions.**
 |
| **Google** | 1. **If Option 2, using two RACH configurations, is supported then support:**
* **Alt 2-3:**
	+ **The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.**
1. **Additional ROs are not expected to partially overlap with non-SBFD symbols**
2. **For RACH configuration Option 2, the additional-ROs in SBFD symbols configured by additional RACH configuration are valid if the ROs time and frequency resources are fully within the UL usable PRBs and not overlapped with SSBs.**
 |
| **NTT DOCOMO** | **Proposal 6: For RACH configuration Option 2 (i.e., additional RACH configuration), for the ROs in SBFD symbols configured by additional RACH configuration, they are valid if at least:*** **time and frequency domain resource of the RO are fully within UL usable PRBs, and**
* **time domain resource of the RO does not overlap with SSB symbol**

**Proposal 7: For RACH configuration Option 2 (i.e., additional RACH configuration), the ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.** |
| **Nokia, NSB** | Proposal 11 For RACH configuration Option 2, RAN1 considers additional-ROs in non-SBFD symbols configured by additional RACH configuration as valid ROs for SBFD-aware UEs. |
| **ITRI** | **Proposal 5:** * **A RO in the additional RACH configuration for SBFD-aware UEs should be considered invalid if the RO occurs in a non-SBFD symbol.**

**Proposal 6:** * **If enabled, SBFD-aware UEs should comply with the additional RACH configuration for the RACH procedure to leverage the corresponding enhancements.**
 |
| **Qualcomm** | **Proposal 4: Support Alt 2-3 for PRACH configuration option 2 where the additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.****Proposal 5: For RACH configuration Option 2, SBFD-aware UE first determine valid legacy ROs in non-SBFD symbols (UL and FL symbols) then UE determines valid ROs by the additional PRACH configuration in SBFD-symbols.** * **SBFD-RO in FL symbols that overlap with legacy-ROs are considered invalid.**

**Proposal 8: Relax the Ng symbols between last SSB and an RO such that a configured RO in SBFD-DL symbols that is proceeding SSB symbols is considered valid if there is enough timeline to switch from Rx to Tx.** |
| **WILUS Inc.** | * **Proposal 7: For RACH configuration Option 2, we propose to set the RACH occasion in non-SBFD symbols as valid according to both the legacy RACH configuration and the additional RACH configuration by validity check of the PRACH slot as the legacy manner. (i.e., Alt 2-4)**
	+ **However, it should be further configured that the SSB-RO mapping in valid RO for legacy UEs and in valid RO across SBFD and non-SBFD symbols for SBFD-aware UEs should be set identically in the same symbols.**
* **Proposal 8: For RACH configuration Option 2, it is suggested that the configured ROs in SBFD symbols configured by additional RACH configuration are valid if at least time and frequency resource of the RO are fully within UL usable PRBs, and not overlapped with SSB as the same manner with RACH configuration Option 1.**
* **Proposal 9: Regardless of which RACH configuration option is applied, the following conditions should be further considered as in legacy NR system.**
	+ **If a SBFD aware UE is not provided tdd-UL-DL-ConfigurationCommon, a RO in a PRACH slot on SBFD symbols is valid if it does not precede a SS/PBCH block in the PRACH slot and starts at least N\_gap symbols after a last SS/PBCH block symbol.**
	+ **If a SBFD aware UE is provided tdd-UL-DL-ConfigurationCommon, a RO in a PRACH slot on SBFD symbols is valid if it does not precede a SS/PBCH block in the PRACH slot and starts at least N\_gap symbols after a last downlink symbol and at least N\_gap symbols after a last SS/PBCH block symbol.**
 |
| **KT Corp.** | **Proposal 3. For RACH configuration Option 2, the additional-ROs in non-SBFD symbols configured by additional RACH configuration should be invalid for SBFD-aware UEs.** |

##### **SSB-RO mapping**

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| **New H3C** | **Proposal 3: Mapping SSB to RO in SBFD symbol and SSB to RO in non-SBFD symbol separately should be supported.****Proposal 4: If supporting unified mapping SSB to RO in SBFD symbol and non-SBFD symbol, dedicated preamble allocation for SBFD-aware UE should be considered.** |
| **Tejas Networks**  | **Proposal 12: For both option 1 and option 2, the SSB to RO mapping rule should be separate for SBFD symbols and non-SBFD symbols.**  |
| **LG Electronics** | Proposal 14: For Option 2, legacy mapping rule applicable to configured ROs by legacy RACH configuration and additional RACH configuration respectively. |
| **Ericsson** | 1. Use a separate SSB-to-RO mapping for the additional RACH configuration (Option 2).
 |
| **Huawei, HiSilicon** | **Proposal 4: For RACH configuration Option 2,** **the SSB-RO mapping order of PRACH resource for SBFD aware UEs is different from the SSB-RO mapping order of PRACH resource for non-SBFD aware UEs, i.e., the SSB-RO mapping with descending order of SSB index.** |
| **ZTE** | **Proposal 12: For RACH configuration Option 2, support separate SSB-RO mapping between SBFD aware UEs and non-SBFD aware UEs.****Proposal 13: For the ROs in non-SBFD symbols configured by additional RACH configuration, if SBFD aware UE can use these ROs, joint SSB-RO mapping for ROs in SBFD symbols and ROs in non-SBFD symbols is used for SBFD aware UEs.**  |
| **Spreadtrum, BUPT** | 1. **for RACH configuration Option 2, the additional ROs in configured by additional RACH configuration, separate SSB-RO mapping will be used with legacy ROs configured by legacy RACH configuration.**
 |
| **InterDigital** | **Proposal 7. Support SSB-RO mapping in ROs in SBFD symbols based on descending order of SSB indexes.** |
| **TCL** | **Proposal 9: Consider the following alternative options for SSB to ROs mapping:*** **Option 1: Separate SSB to ROs mapping of ROs configured in SBFD symbols and ROs configured in non-SBFD symbols.**
* **Option 2: Joint ROs configured in SBFD symbols with ROs in non-SBFD symbols based on their indexes and map to SSBs.**
 |
| **Samsung** | Proposal 12: For RACH configuration Option 2, separate SSB-RO mapping is used for the ROs in SBFD symbols configured by the new/additional RACH configuration. |
| **vivo** | **Proposal 2: For Option 2 and Option 1 with Alt 1-2 for RACH configuration, support separate SSB mapping to legacy ROs and that to additional ROs.** |
| **Apple** | **Proposal 9: For RACH configuration Option 2, SSB to RO association is performed independently for ROs in the SBFD symbols.** |
| **CATT** | **Proposal 12: For RACH configuration Option 2, separate SSB-to-RO mapping is performed for the additional ROs configured by the additional RACH configuration and legacy SSB-to-RO mapping rule is reused.** |
| **CMCC** | **Proposal 11: For RACH configuration Option 2, regarding the SSB-RO mapping rules for the additional-ROs configured by additional RACH configuration, take the legacy SSB-RO mapping rule as the starting point, and other enhanced SSB-RO mapping rules can also be considered is obvious benefit can be observed.** |
| **Sony** | **Proposal 4: For PRACH configuration Option 2 (i.e., Use two separate PRACH configurations, including one legacy PRACH configuration and one additional PRACH configuration), the SBFD UE performs two legacy SSB-RO associations, one on each PRACH configuration, using different RO validation rule, i.e.:*** **1st SSB-RO association performed on legacy PRACH configuration using legacy RO validation rule**
* **2nd SSB-RO association performed on the additional PRACH configuration using a new RO validation rule, where an RO is valid if:**
	+ **The RO is contained in UL OFDM symbols**
	+ **The RO is contained in useable UL PRBs**
	+ **The RO does not overlap SSB**
 |
| **MediaTek Inc.** | 1. **For RACH configuration Option 2, reuse the existing SSB-RO mapping rules.**
* **SSB-RO mapping can be performed separately for valid ROs on SBFD symbols and valid ROs on SBFD symbols**
 |
| **NEC** | **Proposal 6:** **If one SSB is associated with two RO/preamble separately on SBFD symbols and non-SBFD symbols, some rule should be defined, or some indication is needed for SBFD aware UE to determine which RO to choose to perform random access.****Proposal 7:*** **The relationship for RO in SBFD symbols and SS/PBCH block should be separately defined.**
 |
| **Lenovo** | **Proposal 7: For SBFD-aware UEs in RRC CONNECTED state, and for RACH configuration Option 2(i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration),*** **For the legacy-ROs, including the ROs configured by legacy configuration in non-SBFD symbols and the ROs configured by the additional ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon (if any), the legacy SSB-RO mapping is followed.**
* **For the additional ROs in SBFD symbols, separate SSB-RO mapping will be used.**
 |
| **OPPO** | **Proposal 9: For RACH configuration Option 2, support separate SSB-RO mapping for ROs configured by legacy RACH configuration and ROs configured by additional RACH configuration.** |
| **Google** | 1. **Two separate SSBs to ROs mapping can be used for the SBFD and the non-SBFD UL/F symbols**
 |
| **NTT DOCOMO** | **Proposal 8: The SSB-to-RO mapping for valid ROs in SBFD symbols configured by the additional RACH configuration is separate from SSB-to-RO mapping of valid ROs configured by the legacy RACH configuration.** * **Legacy SSB-to-RO mapping rule (i.e. preamble domain first, then frequency domain, then time domain) is applied.**
* **SSB-to-RO mapping parameters (e.g. ssb-perRACH-OccasionAndCB-PreamblesPerSSB, totalNumberOfRA-Preambles) configured in the additional RACH configuration are applied.**
 |
| **Nokia, NSB** | Observation 11 For RACH configuration Option 2, separate SSB-to-RO mapping can be applied on the two ROs configurations using legacy mapping rules. The motivation for adding new SSB-to-RO mapping rules for RACH configuration Option 2 is unclear. |
| **Qualcomm** | **Proposal 11: For both option-1 and option-2 of PRACH configuration, RAN1 to study the determination of the association period and association period pattern for the SBFD-ROs.**  |
| **WILUS Inc.** | * **Proposal 6: For RACH configuration Option 2, we propose to have separate SS/PBCH block index to RO mapping for new validated ROs in SBFD symbols from the SS/PBCH block index to RO mapping on the PRACH resource for legacy UEs regardless of being configured as flexible or downlink by tdd-UL-DL-ConfigurationCommon.**
 |

##### **RACH configuration table**

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| **Tejas Networks** | **Proposal 15: Alt 1 (i.e. existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211) with time offset parameter can support all possible RO in SBFD symbols.** |
| **LG Electronics** | **Proposal 7: For Option 2, support Alt 1 (i.e., use existing random access configurations table for unpaired spectrum).*** **Introduce a new parameter to configure an additional subframe/slot number.**
	+ **i.e., the additional subframe/slot number could replace or combine with the configured subframe/slot number by the PRACH configuration index from existing random access configurations table for SBFD aware UE**
 |
| **Ericsson** | 1. The additional RACH configuration uses the existing PRACH configurations tables for unpaired spectrum for both FR1 and FR2, i.e., Table 6.3.3.2-4 and Table 6.3.3.2-3, respectively (Alt. 1).
 |
| **Huawei, HiSilicon** | **Proposal 7: For RACH configuration Option 2, for FR1, reuse random access configuration tables for paired spectrum for RACH in SBFD symbols; for FR2, introduce time offsets {0,1,2,3} for slot.** |
| **ZTE** | **Proposal 11: The existing random access configuration table can be reused without additional enhancement on the table itself.** * **For PRACH format 1, 2 in FR1, the start point of a configured RO can be adjusted by considering the SBFD symbols position.**
 |
| **InterDigital** | **Proposal 2. In RACH configuration based on Option 2 (two separate RACH configuration) for configuring ROs in SBFD symbols in FR1, support Alt 1 or Alt 2 on using existing TDD or FDD RACH configuration tables, respectively. Do not support Alt 3 on adding new entries to the existing tables.** **Proposal 3. In RACH configuration based on Option 2 (two separate RACH configuration) for configuring ROs in SBFD symbols in FR2, support Alt 1 on using existing TDD RACH configuration tables. Do not support Alt 3 on adding new entries to the existing tables.** |
| **Korea Testing Laboratory** | 1. **For FR2, use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211).**
2. **For FR1, use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211).**
 |
| **TCL** | **Proposal 6: For RACH configuration option 2, RAN1 to consider a new table or enhancement to the existing tables for random access configuration in SBFD symbols for unpaired spectrum.** **Proposal 7: For Support the following options to enhance the existing random access configuration tables of unpaired spectrum for random access in SBFD symbols:*** **For FR2 support Alt 3: Introduce new entries on top of existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211)**
* **For FR1 support Alt 3: Introduce new entries on top of existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211**
 |
| **Samsung** | Proposal 5: For SBFD-aware UEs and RACH configuration Option 2 in FR1 and FR2, support Alt.1 (reuse existing TDD tables) and do not support Alt.3 (new entries/tables).Proposal 6: For SBFD-aware UEs and RACH configuration Option 2 in FR1, also support Alt.2. (allow FDD/SUL table). |
| **vivo** | Proposal 6: For random access configurations for FR1 and unpaired spectrum, both Alt 2 and Alt 3 can be considered to indicate ROs within UL SB of DL slot.  |
| **Apple** | **Proposal 6: For RACH configuration Option 2, FDD PRACH configuration table, i.e., Table 6.3.3.2-2, is used to indicate ROs in the SBFD symbols in FR1.****Proposal 7: For RACH configuration Option 2, existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211) in FR2 is used to indicate ROs in the SBFD symbols.** |
| **CATT** | **Proposal 4: Discuss whether to enhance the existing random access configuration tables for unpaired spectrum for long PRACH formats to address the following restrictions:*** **PRACH format 1/2 cannot be supported in all three typical TDD configurations according to the PRACH configurations in Table 6.3.3.2-3 in TS38.211 in case a valid RO can only be on SBFD symbols or on non-SBFD symbols.**
* **PRACH format 0/3 with periodicity of larger than 10ms cannot be supported in TDD configuration DDDSUDDDSU according to the PRACH configurations in Table 6.3.3.2-3 in case a valid RO can only be on SBFD symbols or on non-SBFD symbols.**
* **PRACH format 0/3 with periodicity of larger than 10ms cannot be supported in TDD configuration DDDSUDDSUU and DDDDDDDSUU according to the PRACH configurations in Table 6.3.3.2-3 in case an additional RO configured by additional RACH configuration is valid on SBFD symbols only.**
* **Fewer PRACH configurations with 10ms periodicity in TDD configuration DDDSUDDSUU can be supported for PRACH format 0/3 in case an additional RO configured by additional RACH configuration is valid on SBFD symbols only.**

**Proposal 5: For RACH configuration Option 2, use existing random access configurations table (i.e. Table 6.3.3.2-4 in TS38.211) for unpaired spectrum in FR2 without introducing new parameter(s) to determine the slot number for ROs in SBFD symbols.** |
| **China Telecom** | **Proposal 3: Postpone the down-selection of whether to reuse existing table or introduce new entries for Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) until decision has been made with respect to whether the additional-ROs in non-SBFD symbols configured by additional RACH configuration is valid for SBFD-aware UEs for Option 2.** |
| **CMCC** | **Proposal 12: For RACH configuration Option 2, and for interpretation of the parameter prach-ConfigurationIndex provided by the additional RACH configuration:*** **For FR1, use existing random access configurations table for paired spectrum/supplementary uplink (i.e., Table 6.3.3.2-2 in TS38.211);**
* **For FR2, use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211).**
 |
| **Sony** | **Proposal 5: For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, and for interpretation of the parameter prach-ConfigurationIndex provided by the additional RACH configuration,*** **For FR2,**
	+ **Alt 1: use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211)**
* **For FR1, support the following two alternatives:**
	+ **Alt 1: Use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211)**
	+ **Alt 2: Use existing random access configurations table for paired spectrum/supplementary uplink (i.e., Table 6.3.3.2-2 in TS38.211)**
 |
| **MediaTek Inc.** | 1. **Introduce a new parameter to provide additional subframe numbers for ROs on SBFD symbols when using the existing random access configurations table for unpaired spectrum in FR1 (i.e., Table 6.3.3.2-3 in TS38.211)**
2. **Introduce a new parameter to provide additional slot numbers for ROs on SBFD symbols when using the existing random access configurations table for unpaired spectrum in FR2 (i.e., Table 6.3.3.2-4 in TS38.211)**
 |
| **Panasonic** | **Proposal 5: For random access configuration tables for SBFD, support Alt 1 with reusing subframe/slot offset prach-ConfigurationSOffset-IAB for specified for Rel.16 IAB.**  |
| **Xiaomi** | 1. For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, and for interpretation of the parameter prach-ConfigurationIndex provided by the additional RACH configuration,
* **For FR2, adopt alt 1:**
	+ **Alt 1: use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211)**
		- **not introduce new parameter(s) to determine the slot number for ROs in SBFD symbols.**
* **For FR1, adopt alt 1 and alt 2:**
	+ **Alt 1: Use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211)**
		- **not introduce new parameter(s) to determine the subframe number for ROs in SBFD symbols**
	+ **Alt 2: Use existing random access configurations table for paired spectrum/supplementary uplink (i.e., Table 6.3.3.2-2 in TS38.211)**
 |
| **Lenovo** | **Proposal 4: For option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration),** * **for both FR1 and FR2, use existing random access configurations table for unpaired spectrum for interpretation of the parameter prach-ConfigurationIndex provided by the additional RACH configuration.(Alt 1)**
* **only part parameters currently in rach-ConfigCommon are necessary to be included in the additional RACH configuration, and some additional parameter such as a frequency offset between the starting ROs of legacy configuration and new configuration could be configured.**
 |
| **Transsion Holdings** | **Proposal 4: For RACH configuration Option 2, Alt 3 for FR2 and Alt 2/Alt 3 for FR 1 should be specified.** |
| **OPPO** | **Proposal 8: For RACH configuration Option 2 and for interpretation of the parameter prach-ConfigurationIndex provided by the additional RACH configuration:*** **For FR 1, use existing random access configurations table defined for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211);**
* **For FR 2, use existing random access configurations table defined for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211)**
 |
| **NTT DOCOMO** | **Proposal 5: For interpretation of the parameter prach-ConfigurationIndex provided by the additional RACH configuration, use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211 for FR1, and Table 6.3.3.2-4 in TS38.211 for FR2).*** **FFS the necessity of enhancements to support PRACH format 1 and format 2 in SBFD symbols.**
	+ **If the necessity is justified, slot/subframe offset parameters in the additional RACH configuration can be considered.**
 |
| **Nokia, NSB** | Proposal 7. For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, and for interpretation of the parameter prach-ConfigurationIndex provided by the additional RACH configuration,* For FR2, use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211) with a bitmap indicating the slot numbers for ROs in SBFD symbols.
	+ Details are FFS.
* For FR1, use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211) with a bitmap indicating the subframe numbers for ROs in SBFD symbols.
	+ Details are FFS.
 |
| **Qualcomm** | **Proposal 6: Support (Alt3) by introducing additional PRACH configurations to enable SBFD random access operation in FR1 and FR2 unpaired spectrum.**  |

##### **PRACH power control**

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| --- | --- |
| **Company** | **Proposals** |
| **LG Electronics** | **Proposal 17: For option 2, support separate PRACH power control parameters configuration in SBFD symbols and non-SBFD symbols.** |
| **Ericsson** | 1. Support separate power control for SBFD ROs for both single and dual RACH configurations.
 |
| **Huawei, HiSilicon** | **Proposal 11: For PRACH transmission of SBFD aware UEs, consider separate power control for different FDMed ROs of PRACH in SBFD symbols and PRACH in non-SBFD symbols, where separate parameter sets for different FDMed ROs in SBFD symbols are introduced, including target PRACH receive power and maximum transmission power.** |
| **ZTE** | **Proposal 16: For PRACH transmission of SBFD aware UEs in RRC CONNECTED state, support separate PRACH power control parameters configuration in SBFD symbols and non-SBFD symbols.** * **The separate PRACH power control parameters configuration can be an absolute value of a power control parameter;**
* **The separate PRACH power control parameters can be derived based on a relative value, e.g., a power offset.**
* **The above mechanism should applicable to both of RACH configuration Option 1 with Alt 1-1 and RACH configuration Option 2.**
 |
| **Spreadtrum, BUPT** | 1. **For RACH configuration Option 2, for PRACH transmission of SBFD aware UEs in RRC CONNECTED state, support separate PRACH power control parameters configuration in SBFD symbols and non-SBFD symbols.**
 |
| **InterDigital** | **Proposal 8. Support configuring different PRACH power control parameters for SBFD and non-SBFD ROs, also for FDM-ed SBFD ROs that are closer or farther from DL subband edges, in consideration of potential CLI caused by PRACH transmission.** |
| **Korea Testing Laboratory** | 1. **For SBFD-aware UEs in RRC CONNECTED state, distinguish power control parameters (e.g., PREAMBLE\_RECEIVED\_TARGET\_POWER) for SBFD and non-SBFD symbols.**
2. **For SBFD-aware UEs in the RRC CONNECTED state, consider PRACH repetition gain and antenna configuration to set power control parameters for SBFD and non-SBFD symbols.**
 |
| **Samsung** | Proposal 13: For RACH configuration Option 2, separate PRACH power control parameters and separate PRACH preamble configuration can be signaled for the new/additional RACH configuration.Proposal 16: For SBFD-aware UEs, support separate parameterization of preamble target receive power, power ramping step size, power ramping counter, and maximum configured transmit power for random access in SBFD symbols. |
| **Apple** | **Observation: For RACH configuration Option 2, it’s up to gNB implementation to configure separate power control parameters for PRACH transmission in SBFD symbols.** |
| **China Telecom** | **Proposal 7: Support separate configuration of** $P\_{PRACH,target,f,c}$ **for SBFD operation.** |
| **CMCC** | **Proposal 13: For RACH configuration Option 2, separate PRACH power control parameters can be configured by the legacy RACH configuration and the additional RACH configuration.** |
| **Xiaomi** | 1. Separate PRACH power control parameters configuration in SBFD symbols and non-SBFD symbols may be needed to enable gNB-gNB CLI and UE-UE CLI mitigation if RA in SBFD symbols is supported.
 |
| **NEC** | **Proposal 9:*** **Power control for PRACH enhancements on SBFD symbols should be considered.**
 |
| **Lenovo** | **Proposal 9: Separate power control parameters are supported for PRACH transmission in SBFD symbols and non-SBFD symbols.** |
| **Langbo** | **Proposal 7: Support separate PRACH power control parameters configuration in SBFD symbols and non-SBFD symbols.** |
| **Fujitsu** | **Proposal 7: Separate configuration/parameter of maximum PRACH transmission power and preambleReceivedTargetPower in SBFD and non-SBFD symbols is supported to mitigate the CLI.** |
| **OPPO** | **Proposal 12: For PRACH power control, support separate configuration of preambleReceivedTargetPower for SBFD symbol and non-SBFD symbol, FFS other parameters, e.g., powerRampingStep, preambleTransMax, etc.****Proposal 13: If UE can change the symbol type (SBFD vs. non-SBFD) between each of an initial PRACH transmission and its re-transmissions, RAN1 further studies how to handle the power ramping counter.** |
| **Google** | 1. **If Option 2, using two RACH configurations, is supported then two power control configurations parameters are configured for the legacy RACH configuration and the additional RACH configuration.**
 |
| **NTT DOCOMO** | **Proposal 4: PRACH target received power parameter (i.e. preambleReceivedTargetPower) can be optionally configured in the additional RACH configuration.** |
| **Nokia, NSB** | Proposal 12. RAN1 to considers a separate power configuration for Msg1 transmissions on SBFD symbols. |
| **Qualcomm** | **Observation 10: Separate PC parameter can be naturally supported for option-2 using SBFD-dedicated PRACH configuration.**  |
| **KT Corp.** | **Proposal 4. Support separate PRACH power control parameters in SBFD symbols and non-SBFD symbols.** |

### Summary

#### **Common**

##### **RACH configuration options**

In last RAN1 meeting, the working assumption on supporting both RACH configuration option 1 with Alt 1-1 and RACH configuration option 2 was achieved.

**Working Assumption**

For SBFD-aware UEs in RRC CONNECTED state, both RACH configuration Option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration) and RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) are supported. Enabling both options at the same time for a UE is not supported.

* For Option 1 with Alt 1-1, FFS whether/how to reinterpret *msg1-FrequencyStart* in *rach-ConfigCommon,* RO validation rules and SSB-RO mapping rules, etc.
* For Option 2, FFS the RO validation rules, SSB-RO mapping rules, whether all the parameters currently in *rach-ConfigCommon* are necessary to be included in the additional RACH configuration, etc.

UE is not required to support both options.

In this meeting, companies’ views on whether to confirm it are summarized as below:

* **Confirm the working assumption:***New H3C, LGE, Ericsson, ZTE, TCL, Samsung, vivo, CMCC, Sony, Xiaomi, Lenovo, Langbo, Nokia, NSB, Qualcomm, [Sharp](reinterpretation of msg1-FrequencyStart should be supported)*
* **Other opinions:**
	+ **Support Option 1 with Alt 1-2 and Option 2:***InterDigital, [Google]*
	+ **Support Option 1 with Alt 1-1, Alt 1-2 and Option 2:** *MediaTek*
	+ **Support Option 2:** *NTT DOCOMO, ASUSTeK*

Some companies mentioned the case that both Option 1 and Option 2 are enabled from network perspective. In moderator’s understanding, the original intention of the current working assumption is to support both option 1 and option 2 from specification perspective, not from network configuration perspective. It seems not necessary for network to enable both options at the same time. Moderator suggests **Initial proposal 1-1-1**.

[Spreadtrum] proposes to define the terminology of legacy-ROs and additional-ROs for simplifying the RAN1 discussion. Moderator suggests **Initial proposal 1-1-2.**

##### **RO across SBFD symbols and non-SBFD symbols**

In RAN1#116 meeting, the following agreement was agreed.

**Agreement**

For SBFD-aware UEs in RRC CONNECTED state, further study the following two options:

* Option 1: a valid RO can only be on SBFD symbols or on non-SBFD symbols
	+ a configured RO across SBFD and non-SBFD symbols in the same slot or across slots is invalid
* Option 2: a valid RO can be across SBFD and non-SBFD symbols in the same slot or across slots

RAN1 to leverage the study in Rel-18 as baseline.

In this meeting, companies’ views on this issue are summarized as below:

* **Support Option 1:** *LGE, Huawei, HiSilicon, Spreadtrum, BUPT, vivo, OPPO, Samsung, Xiaomi, Transsion Holdings, Korea Testing Laboratory, Panasonic, Qualcomm, NTT DOCOMO, LGE, WILUS*
* **Support Option 2:** *Tejas, TCL, Ericsson, Sony, NEC, [ETRI]*

The concerns on Option 2 include:

* Transition period between SBFD and non-SBFD symbols.
	+ whether transition period between non-SBFD and SBFD symbols is needed for SBFD aware UEs is not concluded yet in AI 9.3.1
* Phase continuity maintenance across SBFD and non-SBFD symbols.
* Different transmission/reception parameters across SBFD and non-SBFD symbols.

[CATT] proposes to postpone the decision between Option 1 and Option 2 after we conclude whether transition period between non-SBFD and SBFD symbols is needed for SBFD aware UEs.

[Ericsson] provides simulation results for Option 2, and proposes the Option 2 should be supported for supporting RA in RRC\_IDLE/INATCIVE state. Moderator suggests to discuss this issue in RRC\_IDLE/INATCIVE section.

#### **RACH configuration option 1**

##### **RACH resource**

In RAN1#116bis meeting, the following agreement was made.

**Agreement**

For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, consider the following alternatives to derive the time and frequency resources of the configured ROs in SBFD symbols.

* Alt 1-1: only based on the existing parameters of the single RACH configuration (e.g., *prach-ConfigurationIndex*, *msg1-FDM* and *msg1-FrequencyStart* in *rach-ConfigCommon*).
	+ FFS the details
* FFS: Alt 1-2: based on the existing parameters of the single RACH configuration (e.g., *prach-ConfigurationIndex*, *msg1-FDM* and *msg1-FrequencyStart* in *rach-ConfigCommon*) and newly introduced parameter(s).

One FFS about RACH configuration Option 1 Alt 1-1 is whether/how to reinterpret *msg1-FrequencyStart* in *rach-ConfigCommon.* In this meeting, *co*mpanies’ views on this issue are summarized as below.

* **Not support toreinterpret *msg1-FrequencyStart* in *rach-ConfigCommon***
	+ *New H3C, Spreadtrum, BUPT, [Samsung], Xiaomi, Lenovo, ITRI*
* **Support to reinterpret *msg1-FrequencyStart* in *rach-ConfigCommon***
	+ *Ericsson, Huawei, HiSilicon, ZTE, Sharp, CATT, CMCC, NEC, Fujitsu, OPPO, Qualcomm, WILUS*
	+ Most companies propose that the parameter msg1-FrequencyStart in rach-ConfigCommon can be interpreted as the frequency offset of lowest RO in frequency domain with respective to the lowest PRB of UL usable PRBs. However, as some companies point out, there are some cases the reinterpretation of *msg1-FrequencyStart* may not be workable, e.g., the *msg1-FrequencyStart* is larger than usable PRB size.
	+ [CATT, Ericsson, Sharp] propose to add the mod operation as the following to solve this issue, but the detailed solutions are different among these companies. Moderator thinks more discussion is needed.
	+ [Huawei] proposes that PRACH resource for SBFD aware UEs starts from the starting point of UL subband and has N FDM-ROs, where N is the largest number belonging to {1,2,4,8} that is not greater than the maximum number of ROs that can be carried in UL subband and the number of FDM-ROs for non-SBFD aware UEs to ensure that the PRACH resources are confined within the UL subband.

Moderator suggests **Initial proposal 1-1-3.**

**[CATT]**

For RACH configuration Option 1 with Alt 1-1, if reinterpretation of *msg1-FrequencyStart* is supported and UE determines to reinterpret *msg1-FrequencyStart*, frequency offset of lowest RO with respective to the lowest UL usable PRB is mod (*msg1-FrequencyStart*, bandwidth of UL usable PRBs) in SBFD symbols configured as DL by *tdd-UL-DL-ConfigurationCommon*.

|  |  |
| --- | --- |
| Figure 3a: new interpretation w/o mod operation | Figure 3b: new interpretation w/ mod operation |

**[Ericsson]**

$$RB\_{start}^{ 1^{st} RO}=RB\_{start}^{UL subband}+msg1-FrequencyStart$$

where $RB\_{start}^{ 1^{st} RO}$ and $RB\_{start}^{UL subband}$ is the start of the 1st RO and the start of the UL subband, respectively. The start of the nth RB, $RB\_{start}^{n^{th} RO}$, would then be determined as a modulus operation in relation to the number of RBs of the UL subband, less the RO bandwidth,

$$RB\_{start}^{n^{th} RO}=RB\_{start}^{UL subband}+\tilde{RB}\_{start}^{n^{th} RO}mod\left(N\_{UL subband }^{size}- N\_{RO}^{size}\right)$$

where the start of the nth RO before and after adjustment is $\tilde{RB}\_{start}^{n^{th} RO}$ and $RB\_{start}^{n^{th} RO}$, respectively, and the UL subband bandwidth is $N\_{UL subband }^{size}$ and the RO size is $N\_{RO}^{size}$, such that all ROs are always fully comprised within the UL subband.



**[Sharp]**

For example, the new RB-level offset $N\_{RB}^{new}=mod\left(N\_{RB}, N\_{RB}^{UL}-N\_{RO}\right)$ where $N\_{RB}$ is the value indicated by *msg1-FrequencyStart*, $N\_{RB}^{UL}$ is the number of RBs in the UL subband, and $N\_{RO}$ is the number of RBs required for a single RO. On the other hand, gNB side RO resource management is difficult. The gNB needs to pick one value of the RB-level offset considering both ROs.



##### **RO validation**

In RAN1#116bis meeting, the following agreement was made.

**Agreement**

For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state,

* no enhancements for the RO validation rule for the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by *tdd-UL-DL-ConfigurationCommon* (if any).
	+ FFS: the ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.
	+ FFS: It’s up to network configuration to ensure the ROs in SBFD symbols configured asflexible by *tdd-UL-DL-ConfigurationCommon,* which are valid for non-SBFD aware UEs based on legacy RO validation rule, are also valid for SBFD aware UEs (i.e., the configured ROs in SBFD symbols, if configured as flexible by *tdd-UL-DL-ConfigurationCommon*, are within the UL usable PRBs)
* the RO in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon* is valid if at least:
	+ Time and frequency resource of the RO are fully within UL usable PRBs, and not overlapped with SSB
	+ FFS: Other condition.

Note: For the case that all the SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon,* there is no restriction that all the configured ROs in SBFD symbols should be within the UL usable PRBs.

Regarding the first two FFS, most companies support them in this meeting. From moderator’s understanding, these two FFS are the further explanation of the main bullet: *no enhancements for the RO validation rule for the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon (if any).*  In moderator understanding, this implies that, if some ROs in non-SBFD symbols or some ROs in SBFD symbols configured as flexible by *tdd-UL-DL-ConfigurationCommon* are valid for non-SBFD aware UEs based on legacy RO validation rules, these ROs are also valid for SBFD aware UEs. For SBFD symbols configured as flexible by *tdd-UL-DL-ConfigurationCommon*, even if some ROs are configured outside the UL usable PRBs (based on the configuration of *msg1-FDM* and *msg1-FrequencyStart* in *rach-ConfigCommon*), these ROs are still valid from non-SBFD aware UE perspective based on legacy RO validation rules. In this case, network should know that non-SBFD aware UEs may transmit preambles in these ROs although these ROs are outside the UL usable PRBs, which may cause some problems, e.g., network cannot receive preambles in these ROs. Normally, this case should be avoided by network configuration, e.g., by ensuring the configured ROs in SBFD symbols configured as flexible by *tdd-UL-DL-ConfigurationCommon* are within the UL usable PRBs, or by not configuring SBFD subbands in symbols configured with ROs and configured as flexible by *tdd-UL-DL-ConfigurationCommon*.

Moderator suggests **initial proposal 1-1-4.**

Regarding the third FFS on the other condition(s) for the validation rule of the ROs in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon*, companies’ views are summarized as below:

* **No other condition:** *CMCC*
* **RO starts at least** $N\_{gap}$ **symbols after a last downlink non-SBFD symbol:** *vivo, CATT, Spreadtrum*
* **RO starts at least** $N\_{gap}$ **symbols after the SSB block:** *Tejas, WILUS, Spreadtrum*
* **The frequency domain gap between a valid RO and the UL usable PRBs boundary should be larger than or equal to a predefined threshold:** *ZTE*
* **does not precede a SS/PBCH block in the PRACH slot:** *vivo*

Moderator suggests **initial proposal 1-1-5**.

##### **SSB-RO mapping**

In RAN1#116bis, the following agreement was made.

**Agreement**

For SBFD-aware UEs in RRC CONNECTED state, and for RACH configuration Option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration),

* For the legacy-ROs, including the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by *tdd-UL-DL-ConfigurationCommon* (if any), the legacy SSB-RO mapping is followed.
* For the ROs in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon*, separate SSB-RO mapping will be used

For RACH configuration Option 1 with Alt 1-1, it has been agreed that separate SSB-RO mapping is used for the ROs in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon* from legacy-ROs. One remaining issue is the details of the SSB-RO mapping rule for the ROs in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon*. Companies’ views are summarized as below:

* **Reuse legacy SSB-RO mapping rule**: *LG Electronics, CATT, CMCC, OPPO, Nokia, NSB, ITRI, Qualcomm, WILUS*
* **SSB-RO mapping with descending order of SSB indexes:** *Huawei, HiSilicon, InterDigital, CMCC*
* **Legacy SSBs to ROs mapping rule is used to continue the mapping for SBFD-ROs starting from the SSB index/indices associated with the latest legacy RO (i.e., previous legacy RO with highest frequency index):** *Nokia, NSB*
* **For each frequency index, applying the same SSB index/indices of the latest legacy RO for the subsequent additional RO(s):** *Nokia, NSB*

Moderator suggests **initial proposal 1-1-6** considering majority view.

##### **Power control**

Whether to support separate power control for PRACH transmission in SBFD symbols and non-SBFD symbols were discussed in the last two meetings. Considering we has the working assumption on supporting both RACH configuration options, we can discuss this issue for the two options separately. Companies’ views on the power control for RACH configuration option 1 are summarized as below.

* **Not support separate PRACH power control for RACH configuration option1 with Alt 1-1:**
	+ *LGE, CMCC*
* **Support separate PRACH power control for RACH configuration option1 with Alt 1-1:**
	+ *Tejas, Ericsson, ZTE, Apple*
* **Some companies propose to support separate PRACH power control without differentiation between RACH configuration Option 1 and Option 2**
	+ *[InterDigital?], [Korea Testing Laboratory?], [China Telecom?], [Xiaomi?], [NEC?], [Lenovo?], [Langbo?], [ETRI?], [Fujitsu?], [KT?]*

Moderator suggests **initial proposal 1-1-7**.

#### **RACH configuration option 2**

##### **RACH resource**

**Working Assumption**

For SBFD-aware UEs in RRC CONNECTED state, both RACH configuration Option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration) and RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) are supported. Enabling both options at the same time for a UE is not supported.

* For Option 1 with Alt 1-1, FFS whether/how to reinterpret *msg1-FrequencyStart* in *rach-ConfigCommon,* RO validation rules and SSB-RO mapping rules, etc.
* For Option 2, FFS the RO validation rules, SSB-RO mapping rules, whether all the parameters currently in *rach-ConfigCommon* are necessary to be included in the additional RACH configuration, etc.

UE is not required to support both options.

In last meeting, there was an FFS on whether all the parameters currently in *rach-ConfigCommon* are necessary to be included in the additional RACH configuration for RACH configuration Option 2. In this meeting, companies’ views are summarized as below:

* **Which parameters currently in *rach-ConfigCommon* should be included in the additional RACH configuration**
	+ **all paraments currently in *rach-ConfigCommon:*** *Huawei, HiSilicon, CATT*
	+ ***msg1-FDM, msg1-FrequencyStart:*** *New H3C, Samsung, Fujitsu, NTT DOCOMO, Qualcomm, WILUS*
	+ ***prach-ConfigurationIndex:*** *LG Electronics, Fujitsu, NTT DOCOMO, Qualcomm, WILUS*
	+ ***ssb-perRACH-OccasionAndCB-PreamblesPerSSB:*** *Fujitsu, NTT DOCOMO, Qualcomm, WILUS*
	+ ***totalNumberOfRA-Preambles:*** *NTT DOCOMO*
	+ ***msg1-SubcarrierSpacing:*** *Qualcomm*
	+ **not all parameters*:*** *MediaTek*
* **Which parameters currently in *rach-ConfigCommon* should be excluded for additional RACH configuration**
	+ ***msg1-FrequencyStart:*** *Ericsson*
	+ ***preambleTransMax, ra-ResponseWindow, groupBconfigured, ra-ContentionResolutionTimer, rsrp-ThresholdSSB-SUL:*** *ZTE*
	+ ***rsrp-ThresholdSSB/rsrp-ThresholdSSB-SUL, msg1-SubcarrierSpacing, msg3-transformPrecoder:*** *Spreadtrum, BUPT*

Since the sources of contributions discussing this issue are limited, moderator suggests to postpone the discussion and wait for more inputs on this issue.

##### **RO validation**

In RAN1#116bis meeting, the following agreement was made.

**Agreement**

For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, down-select (in RAN1#117) from the following alternatives:

* Alt 2-3:
	+ The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.
	+ FFS: The case where the additional-ROs partially overlap with non-SBFD symbols
* Alt 2-4:
	+ The additional-ROs in non-SBFD symbols configured by additional RACH configuration can be valid for SBFD-aware UEs.

For the legacy-ROs configured by legacy RACH configuration, the legacy RO validation rules and the legacy SSB-RO mapping rules are followed for SBFD aware UEs.

Companies’ views on down-selection between Alt 2-3 and Alt 2-4 are summarized as below:

* **Alt 2-3:** *New H3C, Ericsson, Huawei, HiSilicon, Spreadtrum, BUPT, TCL, Samsung, vivo, Apple, CATT, China Telecom, CMCC, Panasonic, Xiaomi, Lenovo, ETRI, Transsion Holdings, OPPO, Google, NTT DOCOMO, ITRI, Qualcomm, KT, [NEC]*
* **Alt 2-4:** *Tejas, LGE, ZTE, InterDigital, Sharp, Sony, Nokia, NSB, WILUS*

The concerns on Alt 2-4 include:

* the motivation is doubtful since the additional ROs in SBFD symbols have provided additional PRACH resources for SBFD aware UE;
* the handling of collision between additional ROs and legacy ROs in non-SBFD symbols, which may cause complicated SSB-RO mapping rule or gNB’s configuration restriction;
* cause UL resource fragmentation in non-SBFD symbols.

Regarding the FFS on the case where the additional-ROs partially overlap with non-SBFD symbols, the discussion is related to the discussion on whether a valid RO can be across SBFD and non-SBFD symbols in the same slot or across slots. Moderator thinks this can be discussed later.

Moderator suggests **initial proposal 1-1-8**.

Regarding the RO validation rule foradditional-ROs in SBFD symbols configured by additional RACH configuration, the controversial part is whether the valid RO can overlap with SSB. The views on whether the valid RO can overlap with SSB or not are summarized as below.

* **the valid RO should not overlap with SSB**: *Tejas, LGE, Spreadtrum, BUPT, InterDigital, vivo, Apple, Sharp, Xiaomi, OPPO, Google, NTT DOCOMO, WILUS*

In addition, some companies also propose additional conditions similar as the discussion on RO validation for the ROs in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon* for RACH configuration Option 1 with Alt 1-1. Moderator suggests **initial proposal 1-1-9**, and other conditions can be discussed after we make decision on proposal 1-1-5.

##### **SSB-RO mapping**

For RACH configuration option 2, companies’ views on the SSB-RO mapping rule for the additional-ROs configured by additional RACH configuration are summarized as below.

* **Separate SSB-RO mapping between the additional-ROs configured by additional RACH configuration and the legacy-ROs configured by legacy RACH configuration:**
	+ *New H3C, Tejas, LGE, Ericsson, Huawei, HiSilicon, Spreadtrum, BUPT, InterDigital, TCL, Samsung, vivo, Apple, CATT, CMCC, Sony, MediaTek, NEC, Lenovo, OPPO, Google, NTT DOCOMO, Nokia, NSB, WILUS*

Some companies also propose the detailed separate SSB-RO mapping rule for additional-ROs. Most companies think legacy SSB-RO mapping rule is enough for Option 2, [Huawei, IDC] suggests the SSB-RO mapping order rule for additional-ROs should be based on descending order of SSB indexes. Moderator suggests **initial proposal 1-1-10**.

##### **PRACH configuration table**

In RAN1#116bis meeting, the following agreement was made.

**Agreement**

For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, and for interpretation of the parameter *prach-ConfigurationIndex* provided by the additional RACH configuration,

* For FR2, consider from the following alternatives:
	+ Alt 1: use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211)
		- FFS whether to introduce new parameter(s) to determine the slot number for ROs in SBFD symbols.
	+ Alt 3: Introduce new entries on top of existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211)
* For FR1, consider from the following alternatives:
	+ Alt 1: Use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211)
		- FFS whether to introduce new parameter(s) to determine the subframe number for ROs in SBFD symbols.
	+ Alt 2: Use existing random access configurations table for paired spectrum/supplementary uplink (i.e., Table 6.3.3.2-2 in TS38.211)
	+ Alt 3: Introduce new entries on top of existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211)

In this meeting, companies’ views on this issue are summarized as below:

* **FR1**
	+ **Alt 1 (Use existing random access configurations table for unpaired spectrum) without new parameter(s) to determine the subframe number for ROs in SBFD symbols:**
		- *Ericsson, ZTE, InterDigital, Korea Testing Laboratory, Samsung, Sony, Xiaomi, Lenovo, OPPO, NTT DOCOMO*
	+ **Alt 1 (Use existing random access configurations table for unpaired spectrum) with new parameter(s) to determine the subframe number for ROs in SBFD symbols:**
		- *Tejas, LGE, MediaTek, Panasonic, Nokia, NSB*
	+ **Alt 2 (Use existing random access configurations table for paired spectrum/supplementary uplink):**
		- *Huawei, HiSilicon, InterDigital, Samsung, vivo, Apple, CMCC, Sony, Xiaomi, Transsion Holdings*
	+ **Alt 3 (Introduce new entries on top of existing random access configurations table for unpaired spectrum):**
		- *TCL, vivo, Transsion Holdings, Qualcomm*
* **FR2**
	+ **Alt 1 (Use existing random access configurations table for unpaired spectrum) without new parameter(s) to determine the slot number for ROs in SBFD symbols:**
		- *Ericsson, ZTE, InterDigital, Korea Testing Laboratory, Samsung, Apple, CATT, CMCC, Sony, Xiaomi, Lenovo, OPPO, NTT DOCOMO*
	+ **Alt 1 (Use existing random access configurations table for unpaired spectrum) with new parameter(s) to determine the slot number for ROs in SBFD symbols:**
		- *Tejas, LGE, Huawei, HiSilicon, MediaTek, Panasonic, Nokia, NSB*
	+ **Alt 3** **(Introduce new entries on top of existing random access configurations table for unpaired spectrum):**
		- *TCL, Transsion Holdings, Qualcomm*

Moderator suggests **initial proposal 1-1-11**.

##### **Power control**

For RACH configuration option 2, most companies support separate power control parameters for ROs in SBFD symbols and non-SBFD symbols. From moderator’s understanding, it is natural for Option 2 to support separate power control parameters in additional RACH configuration signaling. Moderator suggests **initial proposal 1-1-12**.

### 1st Round Proposals

### Proposals related to both Option 1 and Option 2:

***Initial proposal 1-1-1:***

**Confirm the following working assumption with the update.**

**Working Assumption**

**For SBFD-aware UEs in RRC CONNECTED state, both RACH configuration Option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration) and RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) are supported. Regardless from network perspective or from UE perspective, enabling both options at the same time ~~for a UE~~ is not supported.**

* **For Option 1 with Alt 1-1, FFS whether/how to reinterpret *msg1-FrequencyStart* in *rach-ConfigCommon,* RO validation rules and SSB-RO mapping rules, etc.**
* **For Option 2, FFS the RO validation rules, SSB-RO mapping rules, whether all the parameters currently in *rach-ConfigCommon* are necessary to be included in the additional RACH configuration, etc.**

**Note 1: UE is not required to support both options.**

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
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***Initial proposal 1-1-2:***

**For RAN1 discussion purpose, the following terminologies are defined.**

* **Legacy-ROs for RACH configuration Option 1 with Alt 1-1: the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by *tdd-UL-DL-ConfigurationCommon*.**
* **Additional-ROs for RACH configuration Option 1 with Alt 1-1: the ROs in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon*.**
* **Legacy-ROs for RACH configuration Option 2: the ROs configured by legacy RACH configuration.**
* **Additional-ROs for RACH configuration Option 2: the ROs configured by additional RACH configuration.**

Companies are encouraged to provide comments in the table below.

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### Proposals related to Option 1:

***Initial proposal 1-1-3:***

**For SBFD-aware UEs in RRC CONNECTED state, and for RACH configuration Option 1 with Alt 1-1, down-select from the following alternatives:**

* **Alt-1: Support to reinterpret *msg1-FrequencyStart* in *rach-ConfigCommon*.**
	+ **FFS details of the reinterpretation.**
* **Alt-2: Not support to reinterpret *msg1-FrequencyStart* in *rach-ConfigCommon*.**

Companies are encouraged to provide comments in the table below.

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***Initial proposal 1-1-4:***

**(Conclusion) For SBFD-aware UEs in RRC CONNECTED state, and for RACH configuration Option 1 with Alt 1-1:**

* **The ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.**
* **The ROs in SBFD symbols configured as flexible by *tdd-UL-DL-ConfigurationCommon* that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.**

Companies are encouraged to provide comments in the table below.

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***Initial proposal 1-1-5:***

**For SBFD-aware UEs in RRC CONNECTED state, and for RACH configuration Option 1 with Alt 1-1, for the ROs in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon*, consider whether to support the following condition(s) for RO validation:**

* **Condition#1: A valid RO starts at least** $N\_{gap}$ **symbols after a last downlink non-SBFD symbol.**
* **Condition#2: A valid RO starts at least** $N\_{gap}$ **symbols after the SSB.**
* **Condition#3: A valid RO does not precede a SSB in the PRACH slot.**
* **Condition#4: The frequency domain gap between a valid RO and the UL usable PRBs boundary is larger than or equal to a threshold.**

Companies are encouraged to provide comments in the table below.

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***Initial proposal 1-1-6:***

**For SBFD-aware UEs in RRC CONNECTED state, and for RACH configuration Option 1 with Alt 1-1, the legacy SSB-RO mapping rule is used for the ROs in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon*.**

Companies are encouraged to provide comments in the table below.

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***Initial proposal 1-1-7:***

**For SBFD-aware UEs in RRC CONNECTED state, and for RACH configuration Option 1 with Alt 1-1, further discuss whether to support separate PRACH power control configurations in SBFD symbols and non-SBFD symbols.**

Companies are encouraged to provide comments in the table below.

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### Proposals related to Option 2:

***Initial proposal 1-1-8:***

**For SBFD-aware UEs in RRC CONNECTED state, and for RACH configuration Option 2, support Alt 2-3:**

* **Alt 2-3:**
	+ **The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.**
	+ **FFS: The case where the additional-ROs partially overlap with non-SBFD symbols**

Companies are encouraged to provide comments in the table below.

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***Initial proposal 1-1-9:***

**For SBFD-aware UEs in RRC CONNECTED state and RACH configuration Option 2, for the additional-ROs in SBFD symbols configured by additional RACH configuration, they are valid if at least:**

* **time and frequency resource of the RO are fully within UL usable PRBs**
* **FFS: Other condition.**

Companies are encouraged to provide comments in the table below.

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***Initial proposal 1-1-10:***

**For SBFD-aware UEs in RRC CONNECTED state and RACH configuration Option 2, use legacy SSB-RO mapping rule for the additional-ROs configured by the additional RACH configuration, separate from the SSB-RO mapping for the legacy-ROs configured by the legacy RACH configuration.**

Companies are encouraged to provide comments in the table below.

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***Initial proposal 1-1-11:***

**Update the following agreement made in RAN1#116-bis meeting:**

**For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, and for interpretation of the parameter *prach-ConfigurationIndex* provided by the additional RACH configuration,**

* **For FR2, consider from the following alternatives:**
	+ **Alt 1: use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211)**
		- **FFS whether to introduce new parameter(s) to determine the slot number for ROs in SBFD symbols.**
	+ **~~Alt 3: Introduce new entries on top of existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211)~~**
* **For FR1, consider from the following alternatives:**
	+ **Alt 1: Use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211)**
		- **FFS whether to introduce new parameter(s) to determine the subframe number for ROs in SBFD symbols.**
	+ **Alt 2: Use existing random access configurations table for paired spectrum/supplementary uplink (i.e., Table 6.3.3.2-2 in TS38.211)**
	+ **~~Alt 3: Introduce new entries on top of existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211)~~**

Companies are encouraged to provide comments in the table below.

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***Initial proposal 1-1-12:***

**(Conclusion) For SBFD-aware UEs in RRC CONNECTED state and RACH configuration Option 2, support separate PRACH power control parameters configuration in SBFD symbols and non-SBFD symbols.**

* **FFS whether all the power control related parameters currently in *rach-ConfigCommon* are necessary to be included in the additional RACH configuration**

Companies are encouraged to provide comments in the table below.

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## Issue#1-2: PRACH transmission procedure (4-step RA)

### Submitted proposal

#### **PRACH repetition**

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| **Company** | **Proposals** |
| **LG Electronics** | **Proposal 2: RAN1 to allow PRACH repetition to be supported in SBFD random access operation for SBFD aware UEs under coverage limited conditions.** **Proposal 15: For SBFD aware UEs in RRC CONNECTED state, at least PRACH repetition in SBFD symbols is supported.*** **FFS PRACH repetition across SBFD symbols and non-SBFDs symbols.**

**Proposal 19: Discuss whether/how to support UE PRACH transmission power switching between SBFD symbol and non-SBFD symbol based on the separate PRACH power control parameters for multiple PRACH transmission across SBFD symbol and non-SBFD symbol.** |
| **Ericsson** | 1. SBFD random access supports PRACH repetitions.
2. Repetitions among different RACH configurations is prohibited. Repetitions among SBFD ROs and legacy ROs for the same PRACH preamble format is configurable.
 |
| **Huawei, HiSilicon** | **Observation 3: Limiting the maximum transmission power in the ROs for SBFD symbols is beneficial to reduce UE-to-UE CLI while might degrade PRACH coverage. PRACH repetition can compensate transmission power reduction to guarantee the same PRACH coverage.** **Proposal 8: At least PRACH repetition on SBFD symbols is supported.** |
| **ZTE** | **Proposal 15: Regarding supportive of PRACH repetition under SBFD RACH operation,** * **PRACH repetition in SBFD symbols should be supported;**
* **PRACH repetition across SBFD symbols and non-SBFD symbols in different slots where each repetition has either all SBFD or all non-SBFD symbols can also be supported if the SBFD aware UE can use the ROs in non-SBFD symbols is allowed.**
 |
| **Spreadtrum, BUPT** | 1. **For SBFD aware UEs in RRC CONNECTED state, PRACH repetition is supported,**
* **For both Option 1 Alt 1-1 and Option 2 RACH configurations, all ROs in a RO group should be either legacy valid RO or additional valid RO, and they cannot across legacy ROs and additional ROs.**
* **And the legacy RO group determination can be applied, including ROs in a RO group are consecutive in time, use same frequency resources, and are associated with a same SS/PBCH block index**
1. **To simplify discussion, for SBFD aware UE there are legacy RO groups and additional RO groups.**
* **For Option 1 Alt 1-1 RACH configuration, the legacy RO group consists of the legacy valid RO in non-SBFD symbols and SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon. Additional RO group includes valid ROs in SBFD symbols configured as downlink by tdd-UL-DL-ConfigurationCommon.**
* **For Option 2, the legacy RO group consists of valid RO configured by legacy RACH configuration. Additional RO group contains valid RO configured by additional RACH configuration.**
 |
| **InterDigital** | **Proposal 9. Support PRACH repetition across SBFD symbols and non-SBFDs symbols.****Proposal 15. Support PRACH repetition in SBFD symbols, for both contention-based and contention-free RACH occasions.** |
| **Korea Testing Laboratory** | 1. **For SBFD-aware UEs in the RRC CONNECTED state, support PRACH repetition at least in SBFD symbols.**
2. **For SBFD-aware UEs in the RRC CONNECTED state, the PRACH detection requirements shall follow the existing minimum requirements.**
 |
| **Samsung** | Proposal 2: For SBFD-aware UEs, support Rel-18 PRACH repetition for random access in SBFD symbols.Proposal 3: For random access in SBFD symbols using Rel-18 PRACH repetition, further consider the following two options:Option 1: a RO set can only consist of SBFD RO(s) or only of non-SBFD RO(s).Option 2: a RO set can consist of SBFD RO(s) and/or non-SBFD RO(s). |
| **vivo** | Proposal 10: PRACH repetition can be supported for SBFD aware UEs. For PRACH repetitions within a RO group, the following options can be considered to determine RACH configuration(s) based on which RO resources for the RO group is determined:* **Option 1: Only a single RACH configuration, i.e., RO resources for the RO group is determined based on only legacy RACH configuration or only additional RACH configuration.**
* **Option 2: Both legacy RACH configuration and additional RACH configuration.**
 |
| **Sharp** | **Proposal 9: Support of longer PRACH formats should be prioritized for SBFD aware UEs. If the support of longer PRACH formats is determined not enough for coverage, PRACH repetition can also be discussed.** |
| **CATT** | **Proposal 15: For SBFD aware UEs in RRC\_CONNECTED state, support PRACH repetition in SBFD symbols.*** **FFS whether PRACH repetition can across SBFD symbols and non SBFD symbols.**
* **FFS whether PRACH repetition mechanism can be reused in SBFD random access.**
 |
| **China Telecom** | **Proposal 2: Support PRACH repetitions for SBFD related random access operation.** |
| **Sony** | **Proposal 6: Support SBFD for PRACH repetitions.****Proposal 7: A set of ROs for PRACH repetitions can contain SBFD RO and non-SBFD RO.** |
| **MediaTek Inc.** | 1. **Support the use of valid ROs on SBFD symbols for PRACH repetitions**
2. **A SBFD aware forms RO sets for PRACH repetitions separately for SBFD and non-SBFD symbols.**
3. **Define new rules to allow/disallow transmission of PRACH repetitions on SBFD symbols**
* **Similar rules as the one presented in Proposal 3 can be adopted.**
 |
| **Panasonic** | **Proposal 7: For PRACH repetition in SBFD symbol, discuss how to configure RO group.** |
| **Xiaomi** | 1. **PRACH repetition on extra valid RO in SBFD slots should be supported.**
2. **If PRACH repetition across SBFD symbol and non-SBFD symbol is allowed, further study the interaction between PRACH repetition and separate power control parameters for different symbol type.**
 |
| **Lenovo** | **Proposal 8: PRACH repetitions across valid ROs in SBFD symbols and non-SBFD symbols should be supported.**  |
| **ETRI** | **Proposal 10: Defer the study of preamble repetitions, and resume after issues about a single transmission have a more progress.** |
| **Fujitsu** | **Proposal 8: Support PRACH repetition in SBFD operation.****Proposal 9: RACH repetition across SBFD and non-SBFD is not supported.** |
| **Google** | 1. **Support PRACH repetition in SBFD symbols.**
 |
| **NTT DOCOMO** | **Proposal 13: Support PRACH repetitions in SBFD symbols.****Proposal 14: Not support PRACH repetitions across SBFD symbols and non-SBFD symbols.** * **RO groups in SBFD symbols are determined from valid ROs in SBFD symbols.**
* **RO groups in non-SBFD symbols are determined from valid ROs in non-SBFD symbols.**
 |
| **Nokia, NSB** | Proposal 9. For SBFD aware UEs, PRACH with repetition is supported in SBFD symbols. PRACH repetitions can span across ROs in SBFD symbols and ROs in non-SBFDs symbols. |
| **Qualcomm** | **Observation 11: PRACH repetition across SBFD-ROs and legacy-ROs can further reduce the latency of PRACH repetition and/or improve PRACH coverage. However, it requires further discussion how to handle PRACH repetition when SBFD-ROs are associated with different Power control parameters and procedure to determine the number of repetitions.****Proposal 13: Rel-18 PRACH repetition can be reused at least to support PRACH repetition across SBFD-ROs.** * **FFS: PRACH repetition across SBFD-ROs and legacy-ROs.**
 |

#### **PRACH resource selection**

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| **Company** | **Proposals** |
| **LG Electronics** | **Proposal 5: For two separate RACH configurations, RAN1 consider to study the selection rule and/or selection timing (and switching rule/timing if provided).** |
| **Huawei, HiSilicon** | **Proposal 9: The PRACH resources for non-SBFD aware UEs can be used by SBFD aware UEs****, where SBFD aware UEs shall fall back to the PRACH resources for non-SBFD aware UEs** **when the PRACH transmission in the PRACH resources for SBFD aware UEs fails for a given number of times.****Proposal 10: The PRACH selection rules between SBFD symbols and non-SBFD symbols and within SBFD symbols should be studied further.** |
| **ZTE** | **Proposal 17: If a valid RO in SBFD symbols is selected for the PRACH transmission, it is better to limit the subsequent uplink transmissions during the RACH procedure also in the SBFD symbols if shared-Tx/Rx antenna array are used at gNB side.**  |
| **vivo** | Proposal 8: Further discuss RO selection rule between legacy ROs and additional ROs for SBFD aware UEs.  |
| **Apple** | **Proposal 4: RACH re-attempt should be in the SBFD symbols as the first PRACH transmission.** |
| **CATT** | **Proposal 13: Following RO selection rules from legacy ROs and additional ROs can be further discussed.*** **Option 1: Prioritize additional ROs for the first set of RACH attempts and fallback to legacy ROs when fallback condition is met.**
	+ **FFS additional criteria to select additional ROs**
* **Option 2: Select a RO from additional ROs and legacy ROs in each RACH attempt.**
	+ **FFS details on RO selection**
 |
| **CMCC** | **Proposal 10: For RACH configuration Option 2, further study how SBFD aware UE switches between PRACH transmission on additional-ROs and PRACH transmission on legacy-ROs.** |
| **MediaTek Inc.** | 1. **Define the following new rules to allow/disallow PRACH transmission on SBFD symbols.**
* **Rule 1: UE can transmit PRACH on SBFD symbols only for certain PRACH configurations/formats.**
* **Rule 2: UE can transmit PRACH on SBFD symbols only if the PRACH transmit power is below a defined transmit power threshold.**
* **Rule 3: UE can transmit PRACH on SBFD symbols only if the PRACH occasion is below a predefined frequency offset form the centre of the UL subband.**
 |
| **NEC** | **Proposal 18:*** **For failed PRACH attempts in SBFD slots, the UE will wait for dedicated UL slots to re-attempt PRACH.**
 |
| **Hyundai** | **Proposal #3:** * **For the sake of fairness between SBFD-aware UE and legacy UE (Between msg1 transmission on SBFD symbols and msg1 transmission on non-SBFD symbols), RAN1 needs to consider following additional power control mechanism for msg1 (re)transmission:**
	+ **The ramping counter for msg1 transmission on SBFD symbols is operated separately from non-SBFD symbols.**

**The transmission counter increases in accordance with actual number of msg1 transmission.** |
| **OPPO** | **Proposal 10: For both RACH configuration Option 1 and Option 2, RAN1 further studies the selection/prioritization among available valid ROs (e.g., additional ROs configured in SBFD symbols and legacy ROs) for SBFD-aware UE.****Proposal 11: RAN 1 further discusses whether the symbol type can be changed between PRACH initial transmission and the corresponding re-transmission, with the following options:*** **Option 1: The initial PRACH transmission and its re-transmissions are restricted to one same type (SBFD vs. non-SBFD) of symbols;**

**Option 2: UE can change the symbol type (SBFD vs. non-SBFD) between each of an initial PRACH transmission and its re-transmissions.** |
| **NTT DOCOMO** | **Proposal 9: At least for the first RACH attempt, following conditions can be considered for RO selection between SBFD and non-SBFD:*** **If DL-RSRP is above a RSRP threshold indicated by gNB, UE selects valid RO in SBFD symbols. Otherwise, UE selects valid RO in non-SBFD symbols.**
* **If the selected SSB/CSI-RS index is within a set of SSB/CSI-RS indexes indicated by gNB, UE selects valid RO in SBFD symbols. Otherwise, UE selects valid RO in non-SBFD symbols.**

**Proposal 10: For RACH re-attempts, further study whether to allow switching between ROs in SBFD symbols and ROs in non-SBFD symbols.****Proposal 11: If switching between ROs in SBFD symbols and ROs in non-SBFD symbols is not allowed, separate configuration of powerRampingStep and preambleTransMax can be configured in the additional RACH configruation.****Proposal 12: If switching between ROs in SBFD symbols and ROs in non-SBFD symbols is allowed, further study power ramping rule for following cases:*** **Case 1: The pervious RACH failure is in SBFD symbols and the subsequent RACH is in non-SBFD symbols.**
* **Case 2: The pervious RACH failure is in non-SBFD symbols and the subsequent RACH is in SBFD symbols.**
 |
| **Nokia, NSB** | Proposal 3 For Option 2, in case two RACH configurations with two different PRACH formats lengths, SBFD aware UEs selects the best PRACH format length configured by the legacy or the additional RACH configuration for the initial access based at least on SSB-RSRP threshold(s) . Details FFS.**Proposal 8. A SBFD-aware UE indicates its capability, if needed, by selecting RO from a set of ROs in SBFD symbols.** |
| **Qualcomm** | **Observation 8: To reduce the RA latency of the PRACH (re)-transmission of CBRA, the SBFD-aware UE selects the nearest RO in either SBFD or non-SBFD symbols. Alternatively, the SBFD-aware UE may select SBFD-ROs to reduce the probability of RACH collision.****Proposal 12: For CBRA, to reduce the latency for PRACH (re)-transmission for SBFD-aware UE, the UE can select the nearest RO, either the SBFD-RO or TDD-RO.** |
| **KT Corp.** | **Proposal 6. Discuss whether SBFD-aware UEs can use both ROs in SBFD symbols and non-SBFD symbols in a single PRACH transmission.****Proposal 7. Discuss whether the symbol type can be switched between PRACH transmission and the corresponding retransmission.** |

### Summary

#### **PRACH repetition**

In RAN1#116, the following agreement was made.

**Agreement**

For SBFD aware UEs in RRC CONNECTED state, at least PRACH without repetition is supported in SBFD symbols.

* FFS PRACH repetition in SBFD symbols.
* FFS PRACH repetition across SBFD symbols and non-SBFDs symbols.

In this meeting, regarding the PRACH repetition, companies’ views are summarized as the following:

* **Support** **PRACH repetition:** *LGE, Huawei, HiSilicon, Ericsson, Spreadtrum, BUPT, InterDigital, Korea Testing Laboratory, Samsung, vivo, [Sharp], CATT, China Telecom, Sony, MediaTek, Panasonic, Xiaomi, Lenovo, Fujitsu, Google, NTT DOCOMO, Nokia, NSB, Qualcomm*
	+ **Support** **PRACH repetition only/at least in SBFD symbols:** *LGE, Ericsson, Spreadtrum, BUPT, Korea Testing Laboratory, MediaTek, Google, NTT DOCOMO, Qualcomm*
	+ **Support PRACH repetition in SBFD symbols and PRACH repetition across SBFD symbols and non-SBFD symbols:** *ZTE, InterDigital, Sony, Xiaomi, Lenovo, Fujitsu, Nokia, NSB*
	+ **FFS:***Samsung, vivo, CATT*
* **Deprioritized:** *ETRI*

Regarding whether the PRACH repetition can across SBFD symbols and non-SBFD symbols, the views are diverged.

* **Reasons for not support PRACH repetition across SBFD symbols and non-SBFDs symbols:** more specification effort, time-domain overlap between different PRACH occasion sets which may cause network cannot identify the number of repetitions and the PRACH occasion index of each PRACH transmission.

Moderator suggests the **initial proposal 1-2-1.**

#### **PRACH resource selection**

For both RACH configuration option 1 and option 2, both legacy-ROs and additional-ROs can be used for SBFD-aware UEs. Regarding how to select the RO for initial PRACH transmission and PRACH re-transmission, companies’ views are summarized as the following:

* **For PRACH initial transmission in one RACH procedure:**
	+ **Option 1-1: Always prioritize ROs in SBFD symbols**
	+ **Option 1-2: select ROs in SBFD symbols or non-SBFD symbols based on some conditions**
		- **FFS conditions**
* **For PRACH re-transmission in the same RACH procedure:**
	+ **Option 2-1: use ROs in the same symbol type as the previous PRACH transmission for the rest of RACH procedure**
	+ **Option 2-2: use ROs in the same symbol type as the previous PRACH transmission for a certain number of times, and if some conditions are met, switch to use ROs in the other symbol type for the rest of RACH procedure**
		- **FFS conditions**
	+ **Option 2-3: select ROs in SBFD symbols or non-SBFD symbols for each PRACH re-transmission**

Moderator suggests to defer the discussion in this meeting.

### 1st Round Proposals

***Initial proposal 1-2-1:***

**For SBFD aware UEs in RRC CONNECTED state, at least PRACH repetition in SBFD symbols is supported.**

* **FFS PRACH repetition across SBFD symbols and non-SBFD symbols.**

Companies are encouraged to provide comments in the table below.

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| **Company** | **Comment** |
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## Issue#1-3: Msg2/Msg3/Msg4 PDCCH enhancement (4-step RA)

* + 1. Submitted proposal

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| **Company** | **Proposals** |
| **LG Electronics** | Proposal 20: RAN1 to need to keep the discussion on RA specific or RA optimized enhancements for SBFD aware UE to evaluate benefits for Msg2/Msg3/Msg4 related transmission/reception in SBFD symbols.* Enhancements on the interpretation on the frequency domain resource assignment field and/or frequency hopping for Msg 3 PUSCH transmission within UL usable PRBin SBFD symbol.
* Enhancements on the PUCCH resource sets before dedicated PUCCH resource configuration in time domain and/or frequency domain (e.g., frequency hopping) for Msg4 HARQ-ACK PUCCH transmission within UL usable PRB in SBFD symbol.
 |
| **Ericsson** | 1. RAN1 to discuss the justification of DL/UL subband support for Msg2, 3, 4.
2. For RACH-specific enhancements of Msg2, 3, 4, await further progress in AI 9.3.1.
 |
| **Huawei, HiSilicon** | **Observation 6: Solutions for PDSCH and PUSCH discussed in AI 9.3.1 can be reused for Msg2/Msg4 PDSCH and Msg3 PUSCH respectively with necessary modification.** |
| **Spreadtrum, BUPT** | 1. **For a CORESET associated with Type-1 CSS, whether or not it can overlap with the boundary of a DL subband in SBFD symbols follow the discussion in 9.3.1.**
2. **MSG 2 reception can be postponed the discussion until there is clear conclusion that CORESET associated with Type-1 CSS can overlap with boundary of DL subband.**
3. **For MSG 3 transmission, the frequency hopping in SBFD symbols follow the discussion in 9.3.1.**
 |
| **TCL** | **Proposal 10: RAN1 to study the reception of Msg2 in the SBFD symbols.** **Proposal 11: For Msg3 in SBFD symbols study the following separate parameters:** * **Separate FDRA for Msg3 PUSCH in SBFD and non-SBFD symbols.**
* **Separate FH for Msg3, in SBFD and non-SBFD symbols.**
 |
| **Samsung** | Proposal 17: For RACH Msg.2 reception by SBFD-aware UEs in the SBFD DL subband, further consider both common and dedicated CORESET/Search Space Set configuration and RA-RNTI/C-RNTI.Proposal 18: For SBFD-aware UEs, support enhancements to UL frequency resource allocation and frequency hopping behavior for transmission of RACH Msg.3 (PUSCH) and PUCCH A/N associated with RACH Msg.4 (PDSCH). |
| **vivo** | Proposal 10: It can be discussed whether a single configuration or separate configurations are used to determine Msg.3 PUSCH transmission power. |
| **Apple** | **Proposal 11: Msg3 PUSCH and its retransmission can be scheduled in the SBFD sub-band.** |
| **Sharp** | **Proposal 10: For msg3 PUSCH, in frequency hopping offset determination,** $N\_{BWP}^{size}$ **is set to the value of the size of UL subband.****Proposal 11: Msg3 PUSCH repetition is supported in UL subbands.** |
| **CATT** | **Proposal 16: Reuse the enhancements on DL receptions in non RACH procedure for Msg2 and Msg4 PDSCH if needed.****Proposal 17: The enhancements on PUSCH transmission in non RACH procedure can be reused for Msg3 PUSCH with or without frequency hopping.****Proposal 18: Update the definition of available slot counting by taking the subband frequency location into account in SBFD symbols for Msg3 repetition.** |
| **CMCC** | **Proposal 14: The interpretation of frequency domain resource allocation in UL grant provided by RAR and the frequency offset of the second hop of Msg3 PUSCH provided in Table 8.3-1 in TS 38.213 should be determined based on size of SBFD UL subband if Msg3 is transmitted in SBFD symbols.****Proposal 15: Separate power control parameters can be configured for Msg3 transmission in SBFD symbols and non-SBFD symbols.*** **FFS which parameters can be separately configured, e.g., msg3-DeltaPreamble and msg3-Alpha.**
 |
| **MediaTek Inc.** | 1. **Define new rules for Msg3 transmission on SBFD symbols to address CLI issues in CBRA operation**
* **Similar rules as the one presented in Proposal 3 can be adopted.**
1. **Support separate frequency domain allocations for Msg3 repetitions and/or frequency hopping on SBFD and non-SBFD symbols.**
2. **Support Msg3 frequency hopping only on non-SBFD symbols**
3. **Define new frequency domain validation rules for Msg3 repetitions on SBFD symbols**
* **Msg3 allocation may be considered as invalid if it overlaps (partially or fully) with DL subband(s)**
 |
| **Xiaomi** | 1. If frequency hopping is enabled for Msg3 PUSCH, further study the mechanisms to guarantee hop located in SBFD slot does not exceed UL subband. The following aspects could be considered as starting point:
* **FH offset applied to SBFD symbols and non-SBFD symbols with updating FH formula, e.g., mod operation is based on total number of UL RBs in SBFD symbols and non-SBFD symbols, respectively.**
* **The frequency hopping pattern in time domain is determined per slot type or across different slot types.**
1. For additional PUSCH occasions in SBFD symbols, they are valid if at least:
* **Time and frequency resource of the PUSCH occasion are fully within UL usable PRBs, and not overlapped with SSB (Ngap can be 0 for all preamble SCS), not across SBFD symbols and non-SBFD symbols within a slot or across slots**
* **Other legacy PUSCH occasion validation conditions for non-SBFD aware UE.**
 |
| **NEC** | **Proposal 8:****For Msg3 PUSCH enhancements, the following aspects can be considered.*** **PUSCH frequency hopping offset can be based on the UL subband size.**
* **PUSCH repetition transmission across SBFD symbols and non-SBFD symbols**
 |
| **Langbo** | **Proposal 8: Support PRACH/Msg3 repetition in SBFD symbols while PRACH repetition cannot be across SBFD symbols and non-SBFDs symbols in Rel-19.****Proposal 9: RAN1 to discuss solutions to address the problem of mismatched spatial setting when a Msg2/MsgB transmission and its spatially associated SSB/CSI-RS/PDCCH order are of different symbol types (SBFD symbol vs non-SBFD symbol).** |
| **ETRI** | **Proposal 11: Strive to design a unified design for both connected and non-connected modes provided that non-connected mode supports SBFD operations, and remove bracket for Msg4.** |
| **OPPO** | **Proposal 14: For Msg3 (re)transmission with frequency hopping in SBFD symbols, the frequency offset for the second hop and/or the number of bits of** $N\_{UL,hop}$ **are determined based on the UL subband size (the size of UL usable PRBs).**  |
| **NTT DOCOMO** | **Proposal 15: For Msg 2 and Msg 4 PDSCH reception in DL subband(s), wait for progress in AI 9.3.1.****Proposal 16: For Msg3 PUSCH and Msg4 HARQ-ACK PUCCH frequency resource allocation, frequency hopping and power control, wait for progress in AI 9.3.1.** |
| **Qualcomm** | **Proposal 14: The reception of MSG2/4 in SBFD symbols should follow the same design approach for PDSCH reception (Type 1 FDRA) in SBFD symbols in AI 9.3.1.****Proposal 15: RAN1 to discuss how to enable efficient Msg3 PUSCH frequency hopping in the UL-subband of SBFD symbols.****Proposal 16: RAN1 to discuss the design objectives and motivations for separate MSG3 power control parameters in SBFD and non-SBFD symbols including separate Po.****Proposal 17: MSG3 repetition across SBFD and/or non-SBFD symbols should follow the same design approach for PUSCH repetition Type-A in AI 9.3.1.** |

### Summary

In RAN1#116 meeting, the following agreement was made.

**Agreement**

For SBFD-aware UEs in RRC CONNECTED state, at least further study whether/how to enable Msg2, Msg3 and Msg4 related transmission/reception in SBFD symbols taking into account the following aspects:

* Msg2[/Msg4 PDSCH] reception in DL subband(s)
* Msg3 PUSCH[/Msg4 HARQ-ACK PUCCH] frequency resource allocation and frequency hopping
* Msg3 repetition
* Msg3 PUSCH[/Msg4 HARQ-ACK PUCCH] power control
* FFS whether/how gNB to identify whether a UE is SBFD aware UE or non-SBFD aware UE

Note: Strive to make progress in accordance to the discussion in AI 9.3.1.

Companies provide some further solutions in this meeting and most of them prefer to follow the progress in AI 9.3.1, considering the situation, moderator suggests to defer the discussion on this issue after more progress is made in AI 9.3.1.

## Issue#1-4: 2-step RA enhancement

* + 1. Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| **New H3C** | **Proposal 2: MsgA RO and MsgA PUSCH for Type-2 random access procedure is supported to be configured in semi-static SBFD resource.** |
| **LG Electronics** | **Proposal 1: RAN1 to allow 2-step RACH to be supported in SBFD symbols for SBFD aware UEs to fit into the latency limited conditions.**  |
| **ZTE** | **Proposal 19: About SBFD random access operation in RRC CONNECTED mode, the discussion on 2-step RA type should be deprioritized.**  |
| **InterDigital** | **Proposal 10. Support 2-step RACH in SBFD ROs.** |
| **Samsung** | Proposal 1: For SBFD-aware UEs, support the Type-2 random access procedure in SBFD symbols. |
| **Apple** | **Proposal 10: Support both 4-step RACH and 2-step RACH procedure in SBFD sub-band at least for RRC CONNECTED UE.** |
| **Xiaomi** | 1. For SBFD aware UE in RRC CONNECTED state, support Type-2 random access procedure (2-step RACH) in SBFD symbols.
2. The enhancements considered for 4-step CBRA and 2-step CBRA should also be applied to CFRA with 4-step RA type and CFRA with 2-step RA type.
 |
| **NEC** | **Proposal 11:*** **Both 4-step RACH and 2-step RACH can be supported on SBFD symbols.**

**Proposal 12:*** **The following aspects should be considered for 2-step RACH enhancements on SBFD symbols:**
	+ **PO configuration and valid determination in the UL subband of SBFD symbols**
	+ **The RO mapping relationship with PRU in SBFD symbols**
	+ **Power control for PUSCH for MsgA**
 |
| **Lenovo** | **Proposal 10: The discussion on whether/how to support type 2 random access procedure in SBFD symbol could be postponed.** |
| **Langbo** | **Proposal 10: 2-step random access in SBFD symbols can be considered if the TU allocation is permitted.**  |
| **NTT DOCOMO** | **Proposal 18: Support Type-2 RACH in SBFD symbols.****Proposal 19: For Type-2 RACH, support two separate Msg A PRACH configurations, including one legacy Msg A PRACH configuration and one additional Msg A PRACH configuration.** * **Msg A ROs in UL subband in SBFD symbols configured by the additional Msg A PRACH configuration are determined as valid Msg A ROs.**
* **SBFD aware UE can use the valid Msg A ROs in SBFD symbols configured by the additional Msg A PRACH configuration and valid Msg A ROs in non-SBFD symbols configured by the legacy Msg A PRACH configuration.**
* **Support separate SSB-to-RO mapping between valid Msg A ROs in SBFD symbols configured by the additional Msg A PRACH configuration and valid Msg A ROs in non-SBFD symbols configured by the legacy Msg A PPRACH configuration.**

**Proposal 20: For Type-2 RACH, support two separate Msg A PUSCH configurations, including one legacy Msg A PUSCH configuration and one additional Msg A PUSCH configuration.** * **Msg A POs in UL subband in SBFD symbols configured by the additional Msg A PUSCH configuration are determined as valid Msg A POs.**
* **Valid Msg A ROs in SBFD symbols configured by the additional Msg A PUSCH configuration are mapping to valid POs in SBFD symbols configured by the additional Msg A PUSCH configuration.**
* **Valid Msg A ROs in non-SBFD symbols configured by the legacy Msg A PUSCH configuration are mapping to valid POs in non-SBFD symbols configured by the legacy Msg A PUSCH configuration.**
 |
| **Qualcomm** | **Proposal 18: RAN1 to discuss the following two design options for msgA PRACH/PUSCH configurations for SBFD random access operation.*** **Single msgA PRACH /PUSCH configuration for both legacy and SBFD-aware UE with ROs/POs in both UL and SBFD symbols.**
* **SBFD-aware UEs are configured with additional msgA PRACH/PUSCH configuration.**

**Proposal 19: RAN1 to discuss the determination of valid PUSCH occasions (PO) in the uplink subband of SBFD symbols.** |

### Summary

In RAN1#116 meeting, the following agreement was made.

**Agreement**

For SBFD aware UEs in RRC CONNECTED state, support Type-1 random access procedure (4-step RACH) in SBFD symbols.

* FFS Type-2 random access procedure (2-step RACH)

Companies’ views on whether to support 2-step RA are summarized as below:

* **Support:** *New H3C, LGE, InterDigital, Samsung, Langbo (if TU is permitted), Xiaomi, NEC, Apple, NTT DOCOMO, Qualcomm*
* **Not support or deprioritized:** *ZTE, Lenovo*

More companies prefer to support 2-step RA in SBFD symbols, but there are still some companies prefer to deprioritize it. The reasons for deprioritizing 2-step RACH include: the justification of 2-step RA is not clear since the 2-step RA is applied in good RSRP condition, 2-step RACH is optional features, PRACH repetitions is not supported in 2-step RACH which means 2-step RACH cannot enhance uplink coverage. Moderator suggests to defer the discussion until the basic design principle is decided.

## Issue#1-5: CLI handling

* + 1. Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| **vivo** | **Proposal 12: The potential impact on RA due to UE-to-UE CLI should be considered.** |
| **Panasonic** | **Proposal 6: Discuss CLI handling scheme for PRACH transmission.** |

# Issue#2: Random access in IDLE/INACTIVE mode

## Issue#2-1: Justification to support RA in IDLE/INACTIVE mode

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| **New H3C** | **Proposal 12: Random access in inactive/idle mode should be supported in Rel-19 and is reported to RAN plenary.** |
| **LG Electronics** | **Proposal 21: RAN1 to support random access in SBFD symbols for SBFD aware UEs in RRC\_IDLE/INACTIVE mode.** |
| **Ericsson** | [Observation 3 For a UE in RRC\_IDLE there is no alternative to PRACH to connect to the network. Consistent and predictable PRACH performance is hence fundamental to network operation and planning.](#_Toc166256769)[Observation 4 Detection sensitivity is substantially higher for ROs composed of SBFD and UL symbols using MRC-like non-coherent combining, compared to ROs composed of only SBFD symbols.](#_Toc166256770)Observation 5 Detection performance, and thereby cell coverage, in ROs composed of SBFD and UL symbols using MRC-like non-coherent combining has a much weaker dependency on network load compared to ROs composed of only SBFD symbols.Observation 6 SBFD symbols differ to UL symbols in that network load will significantly affect PRACH performance, and, consequently, cell coverage if applied in RRC\_IDLE.1. Support SBFD ROs spanning both SBFD symbols and UL/F symbols with the following conditions:
	1. The same frequency resources are used for both the SBFD segment and UL/F segment of the PRACH.
	2. The same transmit power is used for both the SBFD and UL/F segments of the PRACH.
	3. There are no phase coherency requirements on the UE between the SBFD and UL/F segments of the PRACH.
2. Support RRC\_IDLE/INACTIVE provided consistent and predictable PRACH detection performance can be achieved.
 |
| **Huawei, HiSilicon** | **Proposal 12: Support random access in SBFD symbols for UEs in RRC\_IDLE/INACTIVER mode and allow gNB to enable/disable random access in SBFD symbols for UEs in RRC\_IDLE/INACTIVER mode.** |
| **ZTE** | **Proposal 20: RAN1 supports SBFD operation to UE in RRC\_IDLE/INACTIVE mode for random access.** |
| **Spreadtrum, BUPT** | 1. **Put ROs in the middle of UL subband is an effective way to suppress UE-to-UE CLI if random access in RRC\_IDLE/INACTIVE mode is supported.**

**Observation 1: In Urban Macro scenario for FR1, the mean DL Average-UPT loss caused by PRACH CLI can be more than 10% when ROs are put at the edge of UL subband.****Observation 2: In Urban Macro scenario for FR1, the mean DL Average-UPT loss decreases when ROs are in the middle of UL subband.** |
| **InterDigital** | **Proposal 12. Support random access in SBFD symbols for UEs in RRC-IDLE/INACTIVE mode.** |
| **TCL** | **Proposal 15: Support random access in SBFD symbols for UEs in RRC idle/inactive mode.**  |
| **Samsung** | Observation 1: The primary motivation and use case to support random access in SBFD symbols in RRC\_IDLE/INACTIVE modes is spectrum flexibility.Observation 2: UL coverage for PRACH transmissions is sufficiently improved when the long preamble format F0 can be used in ROs configured within SBFD slots.Observation 3: Support of mixed (SBFD/non-SBFD) ROs is not required during random access in RRC\_IDLE/INACTIVE modes.Proposal 4: For SBFD-aware UEs in RRC\_IDLE/INACTIVE modes, support random access in SBFD symbols. |
| **vivo** |  **Proposal 13：For RA in RRC\_IDLE/INACTIVE mode, at least SBFD time/frequency resources should be provided to UEs with SBFD capability by SIB.** Proposal 14: Strive for unified solution for RA in RRC\_CONNECTED mode and RRC\_IDLE/INACTIVE mode. |
| **Sharp** | **Proposal 7: CBRA in RRC IDLE mode UEs is supported.****Proposal 8: SIB1 includes SBFD configurations.** |
| **CATT** | **Proposal 20: Support SBFD operation to UE in RRC\_IDLE/INACTIVE mode for random access.*** **Common design can be used for random access in SBFD symbols by UEs in both in RRC\_CONNECTED mode and in RRC\_IDLE/INACTIVE mode.**
 |
| **China Telecom** | **Proposal 1: Support SBFD operation in RRC\_IDLE/INACTIVE mode for RA.** |
| **CMCC** | **Proposal 1:** **Support random access in SBFD symbols for UEs in RRC\_IDLE/INACTIVE mode.** |
| **Sony** | **Proposal 10: Support SBFD for RACH in Idle Mode/Inactive State.** |
| **MediaTek Inc.** | 1. **Similar issues exist for CBRA procedure both in RRC CONNECTED and RRC IDLE/INACTIVE mode. The same solutions adopted for CBRA in RRC CONNECTED mode can be reused to enable random access in RRC IDLE/INACTIVE mode.**
2. **Support random access operation in RRC IDLE/INACTIVE mode by adopting the same solutions for CBRA operation in RRC CONNECTED mode.**
 |
| **Panasonic** | **Proposal 2: If option 1 of single RACH configuration is used, support PRACH in SBFD symbols for SBFD aware UEs in RRC\_IDLE/INACTIVE mode. If option 2 of two separate RACH configurations is used, additional RACH configuration can be limited to RRC\_CONNECTED and can be configured by dedicated RRC signaling.** |
| **Xiaomi** | 1. For SBFD aware UEs in RRC\_IDLE/INACTIVE state, PRACH transmission in SBFD symbols is supported.
 |
| **NEC** | **Proposal 13:*** **Support random access in SBFD symbols for UEs in RRC\_IDLE/INACTIVE mode.**
 |
| **SK Telecom** | 1. In order to successfully commercialize of SBFD in mid band TDD, we propose that basic operations such as SBFD random access in RRC IDLE/INACTIVE mode should be included in Rel-19 WI scope as normative work, and then further discussions and studies be conducted on enhancement technologies.
 |
| **Lenovo** | **Proposal 11: Random access in UL subband for SBFD-aware UEs in RRC\_IDLE/INACTIVE mode should be supported in Rel-19.** **Observation 1: Some side-information at network, like location of hotspot areas can be utilized to obtain more efficient RA configurations in SBFD UL subband and limit impact of inter-UE CLI.** **Proposal 12: RAN1 to discuss solutions to limit impact of inter-UE CLI, if it is agreed to allow RA operations in SBFD UL subband.**  |
| **Langbo** | **Proposal 11: Support PRACH transmission in SBFD symbols for SBFD-aware UEs in RRC\_IDLE/INACTIVE mode.** |
| **ETRI** | **Proposal 12: Support a unified design between connected mode RA and non-connected mode RA for SBFD UEs** |
| **Fujitsu** | **Proposal 10: Both time and frequency locations of subbands for SBFD operation are also known to the SBFD aware UE in RRC\_IDLE/INACTIVE state.****Proposal 11: The SBFD configuration for time and frequency resources can be provided by SIB1.****Proposal 12: For SBFD aware UE in RRC\_IDLE/INACTIVE state, gNB does not have to separately indicate the transmission direction of Msg1/2/3/4 on SBFD symbols.** |
| **Transsion Holdings** | **Proposal 5: Support random access in SBFD symbols for UEs in RRC\_IDLE/INACTIVE mode.** |
| **OPPO** | **Observation 2: The UE-to-UE CLI as well as gNB-to-gNB CLI caused by CBRA are more severe and less predictable than those caused by CFRA, while CBRA is the only choice in RRC IDLE/INACTIVE mode except for on-demand SI.****Proposal 16: RAN1 should strive for unified design of SBFD random access in both RRC\_IDLE/INACTIVE mode (if supported for SBFD RA) and RRC\_CONNECTED mode.** |
| **Google** | 1. **Random access in SBFD symbols for UEs in RRC\_IDLE/INACTIVE mode is to be supported in Rel-19. The new RACH design for RRC CONNECTED is to be used as baseline.**
 |
| **NTT DOCOMO** | **Proposal 21: Support random access in SBFD symbols by UE in RRC idle/in-active mode.** |
| **Nokia, NSB** | Proposal 1. RAN1 supports SBFD operation in RRC\_IDLE/INACTIVE mode for initial access.Proposal 2. RAN1 to strive for a unified solution for RRC\_IDLE and RRC\_CONNECTED modes, which would help reducing redundant discussions for future meetings and having less specification impacts. |
| **Qualcomm** | **Proposal 21: Support SBFD random access operation for RRC Idle/Inactive UEs. The design of SBFD random access operation for RRC Idle/Inactive should leverage the same RACH design of for RRC-Connected UE with the following consideration:*** **SIB indication of the time/freq. locations of the SBFD**
* **For PRACH configuration option 2, SIB indication of the additional PRACH configuration for SBDD random access,**
* **For PRACH configuration option 1, SIB indication whether the configured ROs in SBFD-symbols are valid or not.**
 |
| **ASUSTeK** | **Proposal 4: Supporting SBFD operation for RRC idle/inactive mode UE for random access is justified from RAN1 perspective and recommend RAN Plenary to start the corresponding normative work after RAN#104.**  |
| **WILUS Inc.** | * **Proposal 1: We support to specify SBFD operation of UE in RRC\_IDLE/INACTIVE mode for random access.**
 |

### Summary

In RAN1#116, the following conclusion was made.

**Conclusion**

If PRACH is allowed in SBFD symbols for SBFD-aware UEs in RRC\_IDLE/INACTIVE mode, RAN1 observed the following:

* The benefits include at least one or more of the following:
	+ reduced random access latency
	+ reduced PRACH collision probability or allowing more contiguous frequency resources for PUSCH in UL slots
	+ improved coverage of PRACH with sparse UL resources
	+ increased cell range of PRACH with sparse UL resources
* PRACH transmissions in UL subband in SBFD symbols may cause UE-to-UE CLI (similar to the case of RRC connected mode UEs) for some deployment scenarios. Initial studies based on two companies’ evaluation results, the DL performance degradation due to UE-to-UE CLI caused by PRACH transmission in SBFD symbols is not significant for indoor office scenario and Urban Macro scenario.

In RAN1#116bis, the following proposal was heavily discussed but with no consensus.

**Proposal**

Support random access in SBFD symbols for UEs in RRC\_IDLE/INACTIVE mode.

* Supported by 24 companies: New H3C, CMCC, ZTE, IDC, Xiaomi, HW/HiSi, Samsung, Nokia, NEC, Google, TCL, Sharp, Wilus, LGE, Fujitsu, ETRI, Sony, QC, Lenovo, SKT, MTK, CATT, Panasonic
* Objected by Ericsson

In this meeting, based on contributions, following companies propose to support random access in SBFD symbols for UEs in RRC\_IDLE/INACTIVE mode.

* **Supported:** *New H3C, CMCC, LGE, HW/HiSi, ZTE, IDC, TCL, Samsung, Xiaomi, Nokia, Sharp, CATT, China Telecom, Sony, MTK, Panasonic, NEC, SKT, Lenovo, Langbo, ETRI, QC, Fujitsu, Transsion Holdings, Google, NTT DOCOMO, ASUSTeK, Wilus*

***[Ericsson]***

**[Ericsson] observes that:**

* Observation 3: For a UE in RRC\_IDLE there is no alternative to PRACH to connect to the network. Consistent and predictable PRACH performance is hence fundamental to network operation and planning.
* Observation 4: Detection sensitivity is substantially higher for ROs composed of SBFD and UL symbols using MRC-like non-coherent combining, compared to ROs composed of only SBFD symbols.
* Observation 5: Detection performance, and thereby cell coverage, in ROs composed of SBFD and UL symbols using MRC-like non-coherent combining has a much weaker dependency on network load compared to ROs composed of only SBFD symbols.
* Observation 6: SBFD symbols differ to UL symbols in that network load will significantly affect PRACH performance, and, consequently, cell coverage if applied in RRC\_IDLE.

**[Ericsson] also provides the following simulation results in R1-2403912 to justify the above observations.**

 

Figure 2: Performance results for PRACH format 0 for (left) low network loads, and (right) high network loads. For a missed detection rate of 10-2, false alarm rate of 10-3 and a low load, the difference in detection performance between the mixed SBFD and UL symbols using non-coherent combining (red dashed line) and MRC-like combining and SBFD symbols using equal gain combining (green solid line) is 15 dB. The corresponding figure for high load is approximately 24 dB.

Table 1: Difference in PRACH detection performance between low load and high load networks for a missed detection rate of 10-2. There is a 1 dB difference in detection rate between low and high load for coherent detection in UL only symbols. For non-coherent MRC-like combining of mixed SBFD and UL symbols, the difference is 2 dB. For equal gain combining of SBFD and UL symbols, and SBFD symbols only, the difference is 11 dB.

|  |  |  |  |
| --- | --- | --- | --- |
| **RO composition/detection** | **Low load**$\left.SNR\right|\_{P\_{miss}=10^{-2}}$**, [dB]** | **High load**$\left.SNR\right|\_{P\_{miss}=10^{-2}}$**, [dB]** | **Difference High-Low**$\left.SNR\right|\_{P\_{miss}=10^{-2}}$**, [dB]** |
| UL only (**‒ϴ‒**) | -9 | -8 | **1** |
| SBFD/UL, MRC-like (**--x--**) | -7 | -5 | **2** |
| SBFD/UL, equal gain (**‒□‒**) | 7 | 18 | **11** |
| SBFD only, equal gain (**‒\*‒**) | 8 | 19 | **11** |

**Therefore, [Ericsson] provides the following proposals:**

* Proposal 1: Support SBFD ROs spanning both SBFD symbols and UL/F symbols with the following conditions:
	+ The same frequency resources are used for both the SBFD segment and UL/F segment of the PRACH.
	+ The same transmit power is used for both the SBFD and UL/F segments of the PRACH.
	+ There are no phase coherency requirements on the UE between the SBFD and UL/F segments of the PRACH.
* Proposal 2: Support RRC\_IDLE/INACTIVE provided consistent and predictable PRACH detection performance can be achieved.

***[Samsung]***

**On the other hand, regarding the same issue, [Samsung] has the following observations:**

* Observation 3: The performance gap between PRACH format B4 detection in the UL slot and the SBFD slot at 1% missed detection probability is < 4.5 dB based on Rel-18 LLS Option 1 and ~5dB under pessimistic assumptions.
* Observation 4: Support of mixed (SBFD/non-SBFD) ROs is not required during random access in RRC\_IDLE/INACTIVE modes.

**[Samsung] also provides the following simulation results in R1-2405349 to justify the above observations. The details are as following:**

In order to evaluate the PRACH detection performance for PRACH format B4 when transmitted in the UL slot to that of B4 transmitted in the SBFD slot, we conducted link level evaluations for PRACH, where the gNB-gNB CLI is modeled as in Option 1 Example-1 and Example-2 from the Rel-18 link level evaluations.

We reuse the existing link level evaluation methodology from TR 38.858 to determine the interference-to-noise rise (INR) for the SBFD slot and UL slot, respectively. More details are provided by our earlier contribution R1-2307674, which contains our final Rel-18 SBFD system and link level evaluation results and corresponding evaluation methodology.

For Option 1 Example-1 (link budget analysis): *I*UE-gNB and *I*gNB-gNB are derived based on a certain assumption of the topology of gNBs and UEs. In the UL symbol, the INR is derived from the UE-to-gNB interference power. In the SBFD symbol, the total INR is derived from the sum of self-interference, co-site CLI, gNB-gNB CLI and UE-gNB interference. Note that for the INR contribution from SI, the 1 dB de-sense target is assumed. Furthermore, the sum of the co-site spatial isolation value and the digital isolation value is assumed to 93dB.

Table 1 presents the resulting total INR for each symbol type (UL or SBFD) based on link budget analysis R1-2307674.

The observed UE-to-gNB interference still dominates. In consequence, the other interference contributors have marginal influence on the total INR.

The observed INR difference between the UL only symbol and the SBFD symbol is less than 1 dB.

**Table 1: INR in UL-only symbols and SBFD symbols for Rel-18 LLS Option 1 Example-1 [R1-2307674]**

|  |  |  |  |
| --- | --- | --- | --- |
| Frequencyrange | UL only symbol (A)$$I\_{TDD}/N\_{0}=I\_{UE-gNB}/N\_{0}$$ | SBFD symbol (B)$$I\_{SBFD}/N\_{0}=(I\_{SI}+I\_{co-site}+I\_{gNB-gNB}+I\_{UE-gNB})/N\_{0}$$ | Difference (B-A) |
| FR1 | 23.30 [dB] | 23.96 or 24.20 [dB] | 0.66 or 0.90 [dB] |
| FR2-1 | 22.44 [dB] | 22.47 or 23.30 [dB] | 0. 03 or 0.86 [dB] |

For Option 1 Example-2(derived from SLS based statistics): $∆=10\*log\_{10}\left(N\_{SBFD}^{}\right)-10\*log\_{10}\left(N\_{TDD}^{}\right)$ is derived based on statistic in SLS, and then $∆$ is used in the LLS to increase the Gaussian noise power in the SBFD symbol compared to TDD UL symbol.

A value of delta ($∆$) can be derived from the SLS depending on the load level. Our results for low/medium/high load scenarios are shown in Table 2.

The observed INR difference between the UL only symbol and the SBFD symbol is still less than 2 dB.

**Table 2: The value of** $∆$ **for Rel-18 LLS Option 1 Example-2 [R1-2307674]**

|  |  |  |  |
| --- | --- | --- | --- |
| Load | Low | Medium | High |
| $$∆$$ | 0.31 [dB] | 0.43 [dB] | 1.76 [dB] |

In summary, we see less than 1 dB INR difference from the link budget analysis (Option 1 Example-1) and less than 2 dB from the SLS based statistics (Option 1 Example-2).

We therefore evaluate the PRACH detection performance for PRACH format B4 when transmitted in the UL slot to that of B4 transmitted in the SBFD slot using an INR difference between UL and SBFD slot of 1 or 2 dB. We also evaluate the case of 3 dB as a worst case assumption (Figure 1).

It can be seen from Figure 1 that for INR = 1 dB, **the performance gap between PRACH format B4 in the UL slot and the SBFD slot at 1% missed detection probability is < 4dB and for INR = 2 dB < 4.5 dB. Even when the more pessimistic assumption of INR = 3 dB is made, the performance gap between B4 in the UL slot and the SBFD slot does not exceed 5dB.**

In addition, [Samsung] also raise that gNB can further reduce self-interference and/or gNB-gNB interference on SBFD ROs by proper gNB’s scheduler implementation.



Figure 1: PRACH format B4 detection performance in UL slot and SBFD slot

***[ZTE]***

[ZTE] also provided PRACH evaluation results in R1-2400301, the details are as below.

PRACH format B4 is used for both of legacy TDD and SBFD. For SBFD as shown in Figure-6, multiple PRACH transmissions with 2 times (Case 1-1) or 4 times (Case 1-2) are achieved within a TDD frame structure period by using SBFD symbols, and coherent combination detection is used by the gNB for reception of the multiple PRACH transmissions. For legacy TDD, only the last UL slot can be used for PRACH transmission and single PRACH transmission can be performed within the TDD frame structure period. In addition, the performance of multiple PRACH transmissions with 2 times and 4 times spanning multiple TDD frame structure periods are also evaluated. For these cases (Case 2-2 and 2-3), only non-coherent combination detection can be used by the gNB. The impact of the gNB-to-gNB CLI on the PRACH reception within the SBFD symbols is not considered in the simulation.

Table-2: Evaluation cases

|  |  |  |
| --- | --- | --- |
| **Case** | **PRACH transmission scheme** | **Detection method** |
| Case 1-1 | Multiple PRACH transmissions with 2 times in SBFD symbols | Coherent combination detection |
| Case 1-2 | Multiple PRACH transmissions with 4 times in SBFD symbols | Coherent combination detection |
| Case 2-1 | Single PRACH transmission in UL slot | Non-coherent combination detection |
| Case 2-2 | Multiple PRACH transmissions with 2 times in UL slots | Non-coherent combination detection |
| Case 2-3 | Multiple PRACH transmissions with 4 times in UL slots | Non-coherent combination detection |

The simulation results are showed in Figure-7 and Table-3.



Figure-7: Performance for PRACH transmission under different cases

Table-3: Performance gains(dB) of required SNR to satisfy PRACH missed detection probability <1% (False alarm <=0.1%)

|  |  |  |
| --- | --- | --- |
| Performance gains (dB) for PRACH transmission in SBFD symbols | Case 1-1 (Rep =2, SBFD) | Case 1-2 (Rep =4, SBFD) |
| Case 2-1 (single, UL symbols) | 3.04 | 5.94 |
| Case 2-2 (Rep =2, UL symbols) | 0.7 | 3.6 |
| Case 2-3 (Rep =4, UL symbols) | - | 1.05 |

In addition, regarding whether or not a valid RO can be across SBFD and non-SBFD symbols in the same slot or across slots, as summarized in issue 1-1, the argument on supporting RA in RRC\_IDLE/IANCIVE is whether to support RO across SBFD symbols and non-SBFD symbols, companies’ views are as the following:

* **Support Option 1 (****a valid RO can only be on SBFD symbols or on non-SBFD symbols):** *LGE, Huawei, HiSilicon, Spreadtrum, BUPT, vivo, OPPO, Samsung, Xiaomi, Transsion Holdings, Korea Testing Laboratory, Panasonic, Qualcomm, NTT DOCOMO, LGE, WILUS*
* **Support Option 2 (a valid RO can be across SBFD and non-SBFD symbols in the same slot or across slots):** *Tejas, TCL, Ericsson, Sony, NEC, [ETRI]*

The concerns on Option 2 include:

* Transition period between SBFD and non-SBFD symbols.
* Phase continuity maintenance across SBFD and non-SBFD symbols.
* Different transmission/reception parameters across SBFD and non-SBFD symbols.

On the one hand, the key concern from [Ericsson] is that SBFD symbols differ to UL symbols since network load will significantly affect PRACH performance and cell coverage if applied in RRC\_IDLE. On the other hand, [Samsung] observes the performance gap between PRACH format B4 detection in the UL slot and the SBFD slot at 1% missed detection probability is < 4.5 dB based on Rel-18 LLS Option 1 and ~5dB under pessimistic assumptions. At the same time, majority view is that a valid RO can only be on SBFD symbols or on non-SBFD symbols. **Considering the situation, moderator propose to first discuss initial proposal 2-1-1 to check whether companies have consensus that the PRACH detection performance difference between SBFD symbols and UL symbols can be as large as 15dB or probably less than 5dB.**

### 1st Round Proposals

***Initial proposal 2-1-1:***

**Support a valid RO can be across SBFD symbols and non-SBFD symbols in the same slot or across slots with the following conditions:**

* **The same frequency resources are used for both the SBFD segment and non-SBFD segment of the PRACH.**
* **The same transmit power is used for both the SBFD segment and non-SBFD segment of the PRACH.**
* **There are no phase coherency requirements on the UE between the SBFD segment and non-SBFD segment of the PRACH.**

Companies are encouraged to provide comments in the table below.

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  |  |
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|  |  |

## Issue#2-2: Msg4 HARQ-ACK PUCCH enhancement (4-step RA)

* + 1. Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| **LG Electronics** | Proposal 20: RAN1 to need to keep the discussion on RA specific or RA optimized enhancements for SBFD aware UE to evaluate benefits for Msg2/Msg3/Msg4 related transmission/reception in SBFD symbols.* Enhancements on the interpretation on the frequency domain resource assignment field and/or frequency hopping for Msg 3 PUSCH transmission within UL usable PRBin SBFD symbol.
* Enhancements on the PUCCH resource sets before dedicated PUCCH resource configuration in time domain and/or frequency domain (e.g., frequency hopping) for Msg4 HARQ-ACK PUCCH transmission within UL usable PRB in SBFD symbol.
 |
| **Huawei, HiSilicon** | **Observation 7: Separate common PUCCH resource sets on SBFD symbols and non-SBFD symbols and additional frequency offset can be considered for Msg4 HARQ-ACK PUCCH transmission.** |
| **TCL** | **Proposal 12: Define a new table for "cell-specific PUCCH resource common" that can be used for the transmission of HARQ-ACK for Msg4/MsgB in SBFD symbols.****Proposal 13: To define a new table for the cell-specific PUCCH used for HARQ-ACK transmission of Msg4/MsgB in SBFD symbols, the following options can be considered:*** **Option 1: Consider the starting RB of the UL subband as a starting point and keep the existing RB offset values in table 9.2.1-1 in TS 38.213.**
* **Option 2: Introduce new RB offset values in a new table to align and position the cell –specific PUCCH within the bandwidth of the UL subband.**

**Proposal 14: For cell-specific PUCCH in SBFD symbols, consider a separate intra-slot frequency hopping (intra-SlotFH) configuration in PUCCH-configCommon.**  |
| **vivo** | Proposal 11: It can be discussed whether a single configuration or separate configurations are used for PUCCH carrying HARQ-ACK for Msg. 4 reception between SBFD symbols and non-SBFD symbols. |
| **Sharp** | **Proposal 12: For msg4 HARQ-ACK PUCCH, in frequency resource offset determination,** $N\_{BWP}^{size}$ **is set to the value of the size of UL subband.** |
| **CATT** | **Proposal 19: Consider enhancements on PUCCH for Msg4 in RACH procedure to ensure PUCCH transmission in UL subband in SBFD symbols.**  |
| **CMCC** | **Proposal 16: The interpretation of PRB locations of first hop and second hop for Msg4 HARQ-ACK feedback on PUCCH in SBFD symbols should be determined based on size of SBFD UL subband.****Proposal 17: Separate power control parameters can be configured for Msg4 HARQ-ACK feedback on PUCCH transmission in SBFD symbols and non-SBFD symbols.*** **FFS which parameters can be separately configured, e.g., p0-nominal.**
 |
| **MediaTek Inc.** | 1. **Support frequency hopping for PUCCH in response to Msg4 only on non-SBFD symbols**
2. **Support separate FDRA for SBFD and non-SBFD symbols when frequency hopping enabled for PUCCH in response to Msg4.**
 |
| **NEC** | **Proposal 10:*** **PUCCH carrying HARQ-ACK for Msg. 4 should be within the UL subband of SBFD symbols.**
 |
| **OPPO** | **Proposal 15: For PUCCH transmission of HARQ-ACK for Msg4 in SBFD symbols, re-interpret the PUCCH PRB offset with respective to the lowest PRB of the UL subband (UL usable PRBs) and re-interpret the PUCCH frequency resources with respective to the UL subband size (the size of UL usable PRBs).** |
| **Qualcomm** | **Proposal 23: RAN1 to discuss how to enable efficient PUCCH frequency hopping in SBFD symbols for RRC idle/inactive UE.** |

### Summary

Companies provide some solutions on the Msg4 HARQ-ACK PUCCH enhancement, similar to issue 1-3, most companies propose to follow the discussion in AI 9.3.1, moderator suggests to defer the discussion on this issue.

## Issue#2-3: Additional enhancements to support RA in IDLE/INACTIVE mode

### Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| **Tejas Networks** | **Proposal 17: Separate PRACH power control parameters are required for RACH operation in SBFD symbols.****Proposal 18: RACH parameters on Preamble Received Target Power, Maximum Preamble Transmission and Power Ramping Step can have different configuration values in SBFD symbols from that of non SBFD RACH configurations.**  |
| **LG Electronics** | **Proposal 22: RAN1 to support the RACH configuration relevant signal via SIB1 to enable PRACH transmission in SBFD symbols for both a SBFD aware UE in RRC\_IDLE/INACTIVE mode and a SBFD aware UE in RRC\_CONNECTED mode.**  |
| **Ericsson** | 1. The selected PRACH RO (SBFD or legacy) determines whether the UE follows the legacy or an SBFD-specific RACH procedure for Msg2, 3, 4.
 |
| **ZTE** | **Proposal 21: In RRC\_IDLE/INACTIVE mode, if the UL subband overlaps with some frequency domain resources of the initial DL BWP, puncturing based solution is supported for DL transmission to minimize the impact on the legacy UEs.** |
| **InterDigital** | **Proposal 11. Support early indication for SBFD-aware UE in RRC-Idle/Inactive modes to indicate UE’s support of SBFD operation as part of random-access, for example, via*** **SBFD-specific preamble selection, or**
* **PRACH transmission in SBFD ROs, or**
* **Indication as part of Msg3.**

**Proposal 13. In cell selection or initial access, support indicating cells’ support on SBFD operation (e.g., in SIB1) to be used for cell ranking by SBFD-aware UEs.** **Proposal 14. Support prioritization rules for selecting the cells that support SBFD operation based on RSRP or potential CLI, during initial access or cell selection procedures for SBFD-aware UEs in RRC-IDLE/INACTIVE modes.**  |
| **Samsung** | Proposal 19: For SBFD-aware UEs in RRC\_IDLE mode, support an Early Indication mechanism.Proposal 20: For Early Indication by SBFD-aware UEs in RRC\_IDLE mode, further consider the following 2 options:Option 1: L1-based Early Indication is supported.Option 2: L3-based Early Indication is supported. |
| **ETRI** | **Proposal 13: SIB1 can be enhanced to deliver RACH configurations and SBFD patterns.****Proposal 14: Additional feature combination preamble set can be introduced for SBFD operations.****Proposal 15: Introduce distinct parameter sets for ROs on SBFD symbols at least including power control parameters.****Proposal 16: At least msg2/3/4 in SBFD symbols are supported for non-connected UEs.** |
| **Qualcomm** | **Proposal 22: RAN1 to discuss SBFD-awareness indication for RRC Idle/Inactive UE by preamble partitioning and/or SBFD-dedicated ROs.** **Proposal 20: To reduce the impact of inter-UE CLI during SBFD random access operation, if any, RAN1 to discuss the following solutions:** * **Limitation on the maximum Tx power of PRACH/PUSCH in SBFD symbols.**
* **Introducing a RSRP threshold of the measured SSB RSRS.**
* **Mechanisms for the SBFD-aware UE to derive/measure the CLI impact in SBFD ROs before uplink transmission.**
 |
| **CATT** | **Proposal 14: Do not support early identification for SBFD aware UEs on legacy ROs configured by legacy RACH configurations.** |
| **Panasonic** | **Proposal 4: Separate RO can be used for the early indication if option 2 of two separate RACH configurations is agreed. Separate preamble in shared RO for early indication would not be required in this case.** |
| **CMCC** | **Proposal 5: For RACH configuration Option 1 with Alt 1-1 and for legacy-ROs (including the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by tdd-UL-DL-ConfigurationCommon), further study whether separate preambles can be allocated to SBFD aware UEs and non-SBFD aware UEs for early identification of SBFD-aware UEs.** |
| **Panasonic** | **Proposal 4: Separate RO can be used for the early indication if option 2 of two separate RACH configurations is agreed. Separate preamble in shared RO for early indication would not be required in this case.** |
| **NTT DOCOMO** | **Proposal 17: For CBRA, gNB can identify SBFD awareness of UE during random access.*** **The identification of SBFD awareness is realized by PRACH detection on valid RO in SBFD symbols.**

**If UE transmits PRACH transmission on valid RO in SBFD symbols, gNB can identify that the UE is aware of SBFD and the UE can use SBFD symbols for Msg 3 repetitions. Otherwise, UE should determine Msg 3 PUSCH repetition slots same as legacy since gNB cannot identify UE’s SBFD awareness.** |

### Summary

Companies propose some enhancements to support random access in SBFD symbols for RRC IDLE/INATCIVE UEs, mainly about early Indication/RACH partition. Considering whether or not support RRC IDLE/INATIVE mode is under discussion, moderator suggests to defer the discussion on this issue.

## Issue#2-4: Others

* + 1. Submitted proposal

|  |  |
| --- | --- |
| **Company** | **Proposals** |
| **New H3C** | **Proposal 14: UE is scheduled to transmit SDT PUSCH in SBFD time-frequency resource in inactive mode.** |
| **TCL** | **Proposal 16: RAN1 to study Paging in the SBFD symbols.** |
| **NEC** | **Proposal 14:*** **The aspects below should be considered for SDT enhancements on SBFD symbols:**
	+ **PUSCH allocation/configuration in the UL subband of SBFD symbols**
	+ **Valid PO determination on SBFD symbols**
	+ **The PO mapping relationship with SSB for PO in SBFD symbols**
 |
| **Google** | 1. **Study enhancement for paging in SBFD symbols.**
 |

# Agreements in this meeting

# Contact person

Please provide/update the information of the contact person in the following table to facilitate the discussions.

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
| New H3C | Lei Zhou | Zhou.leih@h3c.com |
| Sony | Shin Horng Wong | shinhorng.wong@sony.cm |
| ETRI | Cheulsoon Kim | cs.kim@etri.re.kr |
| IDC | Jonghyun Park | jonghyun.park@interdigital.com |
| TCL | Shahid Jan | shahid.jan@tcl.com  |
| Google | Abdellatif SalahKaopeng Chou | asalah@google.comnevillechou@google.com |
| SK Telecom | Doohee Kim | doohee.kim@sk.com |
| CATT | Yanping Xing | xingyanping@catt.cn  |
| Ericsson | Magnus Åström | magnus.astrom@ericsson.com |
| Ericsson | Ratheesh Kumar Mungara | ratheesh.kumar.mungara@ericsson.com  |
| Ericsson | Narendar Madhavan | narendar.madhavan@ericsson.com  |
| NEC | Frank ZhangPravjyot Deogun | Zhang\_bohang@nec.cnPravjyot.Deogun@EMEA.NEC.COM |
| Qualcomm | Muhammad | mabdelgh@qti.qualcomm.com  |
| Fujitsu | Taewoo LEE | lee.taewoo@fujitsu.com  |
| Panasonic | Tomoya Nunome | nunome.tomoya@jp.panasonic.com |
| Panasonic | Hidetoshi Suzuki | suzuki.hidetoshi@jp.panasonic.com |
| Spreadtrum | Huan Zhou | Huan.zhou@unisoc.com |
| ZTE | Xianghui Han | han.xianghui@zte.com.cn  |
| Tejas Networks | Abhijith B G | abhijithb@tejasnetworks.com |
| Sharp | Tomoki Yoshimura | yoshimurat@sharplabs.com |
| Nokia | Karim kasan | karim.kasan@nokia.com |
| DOCOMO | Qiping Pi | piqp@docomolabs-beijing.com.cn |
| DOCOMO | Hiroki Harada | hiroki.harada.sv@nttdocomo.com |
| Samsung | Marian Rudolf | m.rudolf@samsung.com |
| Lenovo | Yuantao Zhang | zhangyt18@lenovo.com |
| LG | Minwoo song | Minwoo1.song@lge.com |
| LG | Yujin Noh | Yujin.noh@lge.com |
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37. R1-2405153 SBFD Random Access Operation Qualcomm Incorporated
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39. R1-2405281 Discussion on SBFD random access operation WILUS Inc.

# Previous agreements

## RAN1#116

**Working assumption:**

For SBFD aware UEs in RRC CONNECTED state, support CBRA and CFRA in SBFD symbols.

**Conclusion**

No new PRACH format is introduced in Rel-19 duplex WI.

**Agreement**

For random access operation for SBFD-aware UEs in RRC CONNECTED state, at least consider the following options:

* Option 1: Use one single RACH configuration with possible enhancement
	+ The ROs within UL subband in SBFD symbols can be valid for SBFD-aware UE
	+ FFS: Further details
* Option 2: Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration
	+ The ROs within UL subband in SBFD symbols configured by the additional RACH configuration can be valid for SBFD-aware UE
	+ FFS: Further details

**Agreement**

For SBFD aware UEs in RRC CONNECTED state, support Type-1 random access procedure (4-step RACH) in SBFD symbols.

* FFS Type-2 random access procedure (2-step RACH)

**Conclusion**

If PRACH is allowed in SBFD symbols for SBFD-aware UEs in RRC\_IDLE/INACTIVE mode, RAN1 observed the following:

* The benefits include at least one or more of the following:
	+ reduced random access latency
	+ reduced PRACH collision probability or allowing more contiguous frequency resources for PUSCH in UL slots
	+ improved coverage of PRACH with sparse UL resources
	+ increased cell range of PRACH with sparse UL resources
* PRACH transmissions in UL subband in SBFD symbols may cause UE-to-UE CLI (similar to the case of RRC connected mode UEs) for some deployment scenarios. Initial studies based on two companies’ evaluation results, the DL performance degradation due to UE-to-UE CLI caused by PRACH transmission in SBFD symbols is not significant for indoor office scenario and Urban Macro scenario.

**Agreement**

For SBFD aware UEs in RRC CONNECTED state, at least PRACH without repetition is supported in SBFD symbols.

* FFS PRACH repetition in SBFD symbols.
* FFS PRACH repetition across SBFD symbols and non-SBFDs symbols.

**Agreement**

For SBFD-aware UEs in RRC CONNECTED state, further study the following two options:

* Option 1: a valid RO can only be on SBFD symbols or on non-SBFD symbols
	+ a configured RO across SBFD and non-SBFD symbols in the same slot or across slots is invalid
* Option 2: a valid RO can be across SBFD and non-SBFD symbols in the same slot or across slots

RAN1 to leverage the study in Rel-18 as baseline.

**Agreement**

For SBFD-aware UEs in RRC CONNECTED state, at least further study whether/how to enable Msg2, Msg3 and Msg4 related transmission/reception in SBFD symbols taking into account the following aspects:

* Msg2[/Msg4 PDSCH] reception in DL subband(s)
* Msg3 PUSCH[/Msg4 HARQ-ACK PUCCH] frequency resource allocation and frequency hopping
* Msg3 repetition
* Msg3 PUSCH[/Msg4 HARQ-ACK PUCCH] power control
* FFS whether/how gNB to identify whether a UE is SBFD aware UE or non-SBFD aware UE

Note: Strive to make progress in accordance to the discussion in AI 9.3.1.

## RAN1#116-bis

**Agreement**

Confirm the working assumption:

**Working assumption:**

For SBFD aware UEs in RRC CONNECTED state, support CBRA and CFRA in SBFD symbols.

**Agreement**

For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, consider the following alternatives to derive the time and frequency resources of the configured ROs in SBFD symbols.

* Alt 1-1: only based on the existing parameters of the single RACH configuration (e.g., *prach-ConfigurationIndex*, *msg1-FDM* and *msg1-FrequencyStart* in *rach-ConfigCommon*).
	+ FFS the details
* FFS: Alt 1-2: based on the existing parameters of the single RACH configuration (e.g., *prach-ConfigurationIndex*, *msg1-FDM* and *msg1-FrequencyStart* in *rach-ConfigCommon*) and newly introduced parameter(s).

**Agreement**

For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, no separate *prach-ConfigurationIndex* to be configured in this option.

**Agreement**

For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, use existing random access configurations tables for unpaired spectrum (i.e., Table 6.3.3.2-3 for FR1 and Table 6.3.3.2-4 for FR2 in TS38.211).

**Working Assumption**

For SBFD-aware UEs in RRC CONNECTED state, both RACH configuration Option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration) and RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) are supported. Enabling both options at the same time for a UE is not supported.

* For Option 1 with Alt 1-1, FFS whether/how to reinterpret *msg1-FrequencyStart* in *rach-ConfigCommon,* RO validation rules and SSB-RO mapping rules, etc.
* For Option 2, FFS the RO validation rules, SSB-RO mapping rules, whether all the parameters currently in *rach-ConfigCommon* are necessary to be included in the additional RACH configuration, etc.

UE is not required to support both options.

**Agreement**

For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, down-select (in RAN1#117) from the following alternatives:

* Alt 2-3:
	+ The additional-ROs in non-SBFD symbols configured by additional RACH configuration are invalid for SBFD-aware UEs.
	+ FFS: The case where the additional-ROs partially overlap with non-SBFD symbols
* Alt 2-4:
	+ The additional-ROs in non-SBFD symbols configured by additional RACH configuration can be valid for SBFD-aware UEs.

For the legacy-ROs configured by legacy RACH configuration, the legacy RO validation rules and the legacy SSB-RO mapping rules are followed for SBFD aware UEs.

**Agreement**

For SBFD-aware UEs in RRC CONNECTED state, and for RACH configuration Option 1 with Alt 1-1 (i.e., use one single RACH configuration, and only based on the existing parameters of the single RACH configuration),

* For the legacy-ROs, including the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by *tdd-UL-DL-ConfigurationCommon* (if any), the legacy SSB-RO mapping is followed.
* For the ROs in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon*, separate SSB-RO mapping will be used

**Agreement**

For RACH configuration Option 2 (i.e., Use two separate RACH configurations, including one legacy RACH configuration and one additional RACH configuration) to support random access operation for SBFD-aware UEs in RRC CONNECTED state, and for interpretation of the parameter *prach-ConfigurationIndex* provided by the additional RACH configuration,

* For FR2, consider from the following alternatives:
	+ Alt 1: use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211)
		- FFS whether to introduce new parameter(s) to determine the slot number for ROs in SBFD symbols.
	+ Alt 3: Introduce new entries on top of existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-4 in TS38.211)
* For FR1, consider from the following alternatives:
	+ Alt 1: Use existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211)
		- FFS whether to introduce new parameter(s) to determine the subframe number for ROs in SBFD symbols.
	+ Alt 2: Use existing random access configurations table for paired spectrum/supplementary uplink (i.e., Table 6.3.3.2-2 in TS38.211)
	+ Alt 3: Introduce new entries on top of existing random access configurations table for unpaired spectrum (i.e., Table 6.3.3.2-3 in TS38.211)

**Agreement**

For Option 1 (i.e., use one single RACH configuration with possible enhancement) to support random access operation for SBFD-aware UEs in RRC CONNECTED state,

* no enhancements for the RO validation rule for the ROs in non-SBFD symbols and the ROs in SBFD symbols configured as flexible by *tdd-UL-DL-ConfigurationCommon* (if any).
	+ FFS: the ROs in non-SBFD symbols that are valid for non-SBFD aware UEs are also valid for SBFD aware UEs.
	+ FFS: It’s up to network configuration to ensure the ROs in SBFD symbols configured asflexible by *tdd-UL-DL-ConfigurationCommon,* which are valid for non-SBFD aware UEs based on legacy RO validation rule, are also valid for SBFD aware UEs (i.e., the configured ROs in SBFD symbols, if configured as flexible by *tdd-UL-DL-ConfigurationCommon*, are within the UL usable PRBs)
* the RO in SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon* is valid if at least:
	+ Time and frequency resource of the RO are fully within UL usable PRBs, and not overlapped with SSB
	+ FFS: Other condition.

Note: For the case that all the SBFD symbols configured as downlink by *tdd-UL-DL-ConfigurationCommon,* there is no restriction that all the configured ROs in SBFD symbols should be within the UL usable PRBs.