**3GPP TSG RAN WG1 Meeting #105-e R1-2105978**

**e-Meeting, May 19 – 27, 2021**

**Source: Moderator (Intel Corporation)**

**Title: Summary #1 of email discussion on initial access aspects of NR extension up to 71 GHz**

**Agenda item: 8.2.1**

**Document for: Discussion**

# Introduction

This contribution summarizes discussions on initial access aspects of NR extension up to 71 GHz. The discussion of the initial access aspects has been approved for email discussion until May 27, 2021.

* [105-e-NR-52-71GHz-01] Email discussion/approval on initial access aspects with checkpoints for agreements on May-24, May-27 – Daewon (Intel)

# Summary of issues

## 2.1 SSB Aspects

### 2.1.1 Supported Numerology

* From [1] Futurewei:
	+ Support no more than one additional SCS for CD-SSB. If an additional SCS is supported, the support should be mandatory for CD-SSB.
	+ Support only the CD-SSB SCSs in for CORESET#0, SIB1, PRACH CBRA.
* From [2] Huawei, HiSilicon:
	+ Following the agreement in RAN1 #104-e, no further discussion on supported SSB SCSs is required. Continue discussions on other aspects of initial access design based on the current agreements regarding the supported SSB SCSs.
* From [3] vivo:
	+ Support 480/960 kHz SCS for both initial BWP and SSB
	+ Support ALT1 and ALT4 as the solution for SSB and initial/non-initial BWP design, and prefer ALT4.
		- ALT 1)
			* Support SSB with 240/480/960 kHz for initial and non-initial access with support of CORESET0/Type0-PDCCH configuration in the MIB.
			* It is assumed that RAN4 supports a channelization design which results in the total number of synchronization raster entries in the 57 – 71 GHz band no larger than 400 (Note: the total number of synchronization raster entries in FR2 for band n259 is 344). If the assumption cannot be satisfied, it’s up to RAN4 to decide which of 240/480/960 kHz SCS are supported for initial access of such band.
			* RAN1 prioritizes time-domain multiplex of SSB and CORESET0 to minimize the number of needed synchronization raster entries.
			* Supporting 480 kHz SCS and 960 kHz SCS for SSB are UE capabilities:
				+ UE is not expected to support 480 kHz SCS for SSB if it doesn’t support 480 kHz SCS for data/control channels.
				+ UE is not expected to support 960 kHz SCS for SSB if it doesn’t support 960 kHz SCS for data/control channels.
			* Send an LS to RAN2 and RAN4.
		- ALT 4)
			* Support SSB with 240 and one of 480 or 960 kHz for initial and non-initial access with support of CORESET0/Type0-PDCCH configuration in the MIB.
				+ [SSB time domain candidate resource pattern (within a slot or pair of slots) for 480 and 960kHz SSB are identical]
				+ [only 1 CORESTE#0/Type0-PDCCH SCS supported for each SSB SCS]
			* It is assumed that RAN4 supports a channelization design which results in the total number of synchronization raster entries in the 57 – 71 GHz band no larger than 400 (Note: the total number of synchronization raster entries in FR2 for band n259 is 344). per band. If the assumption cannot be satisfied, it’s up to RAN4 to decide which of 240/480/960 kHz SCS are supported for initial access of such band.
			* RAN1 prioritizes time-domain multiplex of SSB and CORESET0 to minimize the number of needed synchronization raster entries.
			* Supporting 480 kHz SCS and 960 kHz SCS for SSB are UE capabilities:
				+ UE is not expected to support 480 kHz SCS for SSB if it doesn’t support 480 kHz SCS for data/control channels.
				+ UE is not expected to support 960 kHz SCS for SSB if it doesn’t support 960 kHz SCS for data/control channels.
* From [4] Spreadtrum:
	+ SSB with 240kHz SCS can be down-prioritized.
	+ SSB with 480/960kHz SCS can be supported for the case where SSB is configured with Type0-PDCCH.
	+ SSB with 480/960kHz SCS can be supported for the case where SSB is used for initial cell selection, if the following conditions are satisfied:
		- The sync raster for 480/960kHz SSB is sparse enough;
		- Initial cell selection with 480/960kHz SSB is an optional UE capability, and to allow UE only supporting initial cell selection with 120kHz SSB to access a cell gNB should guarantee 120kHz SSB is deployed in the cell.
* From [5] Nokia, NSB:
	+ Confirm that PSCell and SCell operation with 480kHz and 960kHz SSB is supported from RAN1 perspective.
	+ Consider support for “initial access” (initial cell selection) for 480kHz and 960kHz kHz SCS SSB and mitigate the UE complexity via properly defining SS-raster.
	+ Support 240 kHz SCS for the SSB transmission in NR bands ranging between 52.6 GHz to 71 GHz
* From [6] CATT:
	+ Support of 480 KHz and/or 960 KHz SCS for initial access can be considered after RAN4’s confirmation for channelization design with acceptable synchronization raster entries.
* From [8] Qualcomm:
	+ RAN1 can continue to discuss other options for the SSB SCS support, but prioritize design on the already agreed choices (120 kHz SCS for initial access and 480 kHz and 960 kHz for non-initial access case where SSB location and SCS are explicitly provided to the UE and SSB does not configure Type-0 PDCCH)
* From [9] OPPO:
	+ For above 52.6GHz, adopt single numerology for initial access, where the numerology candidates are 120kHz, 480kHz and 960kHz.
	+ For above 52.6GHz, 240kHz SSB SCS is not supported.
* From [10] ZTE, Sanechips:
	+ SSB with 480/960kHz SCS should be supported in both initial and non-initial access cases.
* From [11] Intel:
	+ Support 480 kHz and 960 kHz SCS for SSB for initial access cases.
		- Note: support of 480kHz and/or 960kHz SCS for SSB is optional.
* From [14] Sony:
	+ 480 kHz and 960 kHz SCS for SSB for initial access should be supported for NR above 52.6 GHz.
		- If neither 480 kHz nor 960 kHz SCS is supported for SSB for initial access, 240 kHz SCS for SSB for initial access should be supported.
	+ 480 kHz and 960 kHz SCS for initial access related signals and channels should be supported for NR above 52.6 GHz regardless of supporting SCS SSB.
* From [16] Samsung:
	+ Support 480 kHz and 960 kHz SCS for SS/PBCH block in initial access case.
* From [18] LGE:
	+ Support 240 kHz SCS for SS/PBCH block in frequency range from 52.6 GHz to 71 GHz.
	+ At most one of 480 and 960 kHz SCSs can be additionally supported for SS/PBCH block with initial access.
* From [19] Lenovo, Motorola Mobility:
	+ For supporting NR from 52.6 GHz to 71 GHz in Rel. 17, support the same numerologies of data channel for SSB including 480kHz and 960kHz for both initial access and non-initial access cases
	+ For supporting NR from 52.6 GHz to 71 GHz in Rel. 17, if higher subcarrier spacings (numerologies) are adopted for initial access, coverage enhancement of channels and signals used for initial access should be considered for NR beyond 52.6 GHz.
* From [20] Xiaomi:
	+ Beyond 120k Hz SCS, at least one of 240/480/960 kHz SCSs should be configured for cell defined SSB.
	+ SSB and CORESET0 multiplexing configuration tables can be reused for 120kHz SCS SSB, but may need update if additional SCS for SSB is agreed for initial access.
* From [21] Interdigital:
	+ Further study necessity of SSBs and initial access related signals/channels for additional SCSs in Rel-17.
* From [22] Convida:
	+ The support of non-initial SSB design for higher SCS 480 KHz and 960 KHz can be based on Rel-15/16 SSB design as baseline to minimize the specification impact.
* From [23] NTT Docomo:
	+ For SSB SCS, in addition to 120 kHz:
		- 480 and/or 960 kHz SCS should be supported for initial access case.
		- The support of 480 and/or 960 kHz SCS for SSB can be optional as well as for the other signals/channels.
	+ For SCS used for CORESET#0 PDCCH and SIB1 PDSCH, in addition to 120 kHz:
		- Both 480 and 960 kHz SCS should be supported.

#### Summary of Discussions

* Various views on SSB SCS
	+ No need to discuss further:
		- Huawei, HiSilicon
	+ Support 240kHz SSB
		- LGE, Nokia, NSB,
	+ No more than 1 additional SCS for cell defining SSB
		- Futurewei
	+ Support at least one of 120, 480, or 960kHz SSB for initial access
		- Xiaomi
	+ Support one of 480 and 960kHz SSB for initial access
		- Vivo, LGE
	+ Support 480 and 960kHz SSB for initial access (with conditions: e.g. optional UE capability, sparse SS raster)
		- Spreadtrum, Nokia, NSB, CATT
	+ Support 480 and 960kHz SSB for initial access
		- OPPO, ZTE, Sanechip, Intel, Sony, Samsung, Lenovo, Motorola Mobility, Docomo
	+ Continue discussions
		- Qualcomm (prioritize current agreed choices in design), Interdigital
* Moderator suggestions:
	+ any companies have discussed this issue, continue discussion over email along with other issues.
	+ Given the limited TU and agreement from last RAN1 meeting, moderator suggests to only bring this issue up in GTW if there is close to consensus on a proposal.
		- Proposals described by vivo or Samsung might be good starting point for discussions.

#### **1st Round Discussion:**

Discussion on support of CORESET#0/Type0-PDCCH configuration in MIB can be discussed in Section 2.1.2 and 2.1.5. Please provide further comments on 240/480/960kHz SSB and clarification on optionality.

* Further discussion on 240/480/960kHz SSB
	+ Alt 1) Supporting 240, 480, and 960 kHz SSB for initial & non-initial access with support of CORESET0/Type0-PDCCH configuration in the MIB with constraints.
	+ Alt 2) Supporting 240 kHz and one of 480 or 960 kHz SSB for initial & non-initial access with support of CORESET0/Type0-PDCCH configuration in the MIB with constraints.
	+ Alt 3) Supporting one of 240, 480, or 960 kHz SSB for initial & non-initial access with support of CORESET0/Type0-PDCCH configuration in the MIB with constraints.
	+ Alt 4) Supporting 480 and 960 kHz for initial & non-initial access with support of CORESET0/Type0-PDCCH configuration in the MIB with constraints.
	+ Alt 5) Supporting one of 480 or 960 kHz SSB for initial & non-initial access with support of CORESET0/Type0-PDCCH configuration in the MIB with constraints.
	+ Alt 6) conclude no support of 240, 480, and 960kHz SSB for initial access.
	+ Additional constraints:
		- Limited sync raster entry numbers (details can be sorted out if generally acceptable)
		- only 1 CORESTE#0/Type0-PDCCH SCS supported for each SSB SCS
		- SSB time domain candidate resource pattern (within a slot or pair of slots) for 480 and 960kHz SSB are identical
* Clarification on optionality of 480/960kHz SCS.
	+ Supporting 480 kHz SCS and 960 kHz SCS for SSB are UE capabilities:
		- UE is not expected to support 480 kHz SCS for SSB if it doesn’t support 480 kHz SCS for data/control channels.
		- UE is not expected to support 960 kHz SCS for SSB if it doesn’t support 960 kHz SCS for data/control channels
	+ Optionally Supporting 480/960kHz SSB is:
		- Alt A) same capability as supporting 480/960kHz SCS, respectively (e.g. single capability per SCS, UE indicates support of 480kHz SCS mean support 480kHz SSB and 480kHz data/control/RS)
		- Alt B-1) separate capability from supporting 480/960kHz SCS for data/control/RS, respectively, and same capability for supporting initial access (if this case is supported) & non-initial access (2 different capability for each SCS)
		- Alt B-2) separate capability from supporting 480/960kHz SCS for data/control/RS, respectively, and seperate capability for supporting initial access (if this case is supported) & non-initial access (3 different capability for each SCS)

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| **Company** | **Comment** |
| DOCOMO | For the 1st bullet, our best preference is Alt 1. Second preference is Alt 4 or Alt 5. Not prefer Alt 2 nor Alt 3, but we can live with them also if it gets clear majority. Not support Alt 6. For additional constraints, we are ok with the captured three sub-sub-bullets but it should depend on the exact alternative we will take in our view. For the 2nd bullet, while we prefer to discuss about anything related to optionality, our preference is to associate it with the optionality on the support of 480/960k SCS for data/control, i.e. the 2nd sub-sub-bullet in the 1st sub-bullet and Alt A.  |
| LG Electronics | Our first preference is to support 240 for initial & non-initial access with support of CORESET0/Type0-PDCCH configuration in the MIB with constraints. So, please add * Alt 7) Supporting 240 for initial & non-initial access with support of CORESET0/Type0-PDCCH configuration in the MIB with constraints

As a compromise, we can accept Alt 2.Regarding UE capabilities on 480/960 kHz SCS, we prefer Alt A. By the way, Alt B can be updated as follows.* + - Alt B-1) separate capability from supporting 480/960kHz SCS for SSB and data/control/RS, respectively, and same capability for supporting initial access (if this case is supported) & non-initial access (2 different capability for each SCS)
		- Alt B-2) separate capability from supporting 480/960kHz SCS for SSB and data/control/RS, respectively, and separate capability for supporting initial access (if this case is supported) & non-initial access (3 different capability for each SCS)
 |
| Samsung | Our first preference is Alt 5), and can compromise to Alt 1) or 4). 2) and 3) seem need to be modified, since we already agreed to support 480 and 960 for non-initial access case, and if our understanding is correct, the “one of 480 or 960” only applies to initial access case. With such clarification, we are also ok with Alt 2) as a compromise. For the UE capability discussion, we already provide our understanding in the tdoc, and we are also with defining the same UE capability for SSB and data/control/RS for each SCS.  |

#### **1st Round Discussion Summary:**

* TDB

### 2.1.2 ANR and CGI Reporting

* From [2] Huawei, HiSilicon:
	+ Support CGI report on cells that broadcast 120 kHz SSB in 52.6 GHz to 71 GHz spectrum as in Rel-15/16.
	+ RAN1 further discuss whether and how to support inter-operator PCI collision for 480/960 kHz SSBs whose SSB location and SCS are explicitly provided to the UE (non-initial access) and SSB does not configure Type-0 PDCCH.
* From [3] vivo:
	+ ANR should be supported for 480/960KHz SSB by indicating Type-0 PDCCH in the SSB.
* From [7] CATT:
	+ The agreement of supporting 480 KHz and 960 KHz SCS for non-initial access should be extended to include the feature to address ANR issue.
* From [10] ZTE, Sanechips:
	+ In non-initial access cases, SSB with 480/960kHz SCS should be allowed to configure Type0-PDCCH in the MIB for supporting ANR function and CGI reporting.
* From [16] Samsung:
	+ Support ANR and inter-operator PCI confusion resolution for all supported SS/PBCH block subcarrier spacings, and the CORESET#0/Type0-PDCCH configuration is provided by the MIB of the SS/PBCH block.
* From [17] Mediatek:
	+ Solution to enable ANR use case can be discussed after LBT bandwidth and the number of synchronization raster within a LBT bandwidth are decided.
* From [18] LGE:
	+ Further discuss whether/how to support ANR functionality for SS/PBCH block with a SCS when SS/PBCH block with the SCS does not configure CORESET#0 and type0-PDCCH CSS set.
* From [28] AT&T, NTT DOCOMO, INC., T-Mobile USA:
	+ RAN1 shall provide solutions to support ANR and inter-operator PCI confusion resolution for all supported SSB subcarrier spacings in 52.6 GHz and beyond

#### Summary of Discussions

* Discussion further on how to support inter-operator PCI confusion resolution for 480/960kHz SSB case
	+ Huawei, HiSilicon, LGE, MEdiatek
* Support ANR by supporting CORESET#0/Type0-PDCCH configuration in 480/960kHz SSB
	+ vivo, Intel, ZTE, Sanechips, Samsung, [CATT]
* RAN1 to conclude provide support for ANR and inter-operator PCI confusion resolution for all supported SSB SCS
	+ AT&T, NTT DOCOMO, INC., T-Mobile USA
* Moderator suggestions:
	+ Most companies seems to hint ANR and PCI confusion resolution issues are something worth while to resolve, and moderator suggests to further discuss over email.
	+ Given the many company support, moderator suggests to further discuss (as starting point) based on following proposal:
		- Support ANR by supporting CORESET#0/Type0-PDCCH configuration in 480/960kHz SSB

#### **1st Round Discussion:**

Moderator suggest discussing on the following proposal. Moderator would like to encourage companies who prefer Alt 2 of Proposal 1.2-1 to describe the method.

##### **Proposal 1.2-1)**

* To support ANR and PCI confusion resolution,
	+ Alt 1) Support CORESET#0/Type0-PDCCH configuration in MIB of 480 and 960kHz SSB
	+ Alt 2) [alternative method] to enable support to obtain neighbor cell PCI and SIB1 contents related to CGI reporting

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| **Company** | **Comment** |
| DOCOMO | We prefer to support Alt 1 regardless of the support of Alt 2 since Alt 1 could be simpler solution which is something already supported in the previous releases in NR.  |
| LG Electronics | Alt 2 is preferred. One possible way could be that MIB (e.g., with 960 kHz SCS) indicates frequency domain location of SS/PBCH (e.g., with 120 kHz SCS) being able to configure CORESET#0 and type0-PDCCH CSS set. |
| Samsung | We believe there is no confusion on how to support the ANR purpose for 120 kHz (current spec already supports so), so in this sense, Alt 2 should be also for 480 and 960kHz SSB only, or more straightforward to restrict the discussion for 480 and 960kHz SSB in the main bullet. * To support ANR and PCI confusion resolution for 480 and 960 kHz SSB,

As explained in the contribution, we don’t know how dedicated signalling can work for resolving PCI confusion for inter-operator case. If Alt 2 refers to the dedicated signalling approach, please clarify; if not, please provide the details of such alternative method.  |

#### **1st Round Discussion Summary:**

* TDB

### 2.1.3 DRS Related Aspects

* From [1] Futurewei:
	+ Support DBTW at least for SSB with 120 kHz SCS with the following requirements:
		- PBCH payload size is no greater than that for FR2
		- Duration of DBTW is no greater than 5 ms
		- Number of PBCH DMRS sequences is the same as for FR2
	+ Support mechanisms to indicate or inform UEs that DBTW is enabled/disabled for both IDLE and CONNECTED mode UEs
	+ Support signaling to indicate that LBT is disabled or enabled for the RACH procedure for UE in IDLE and CONNECTED modes
	+ Consider using CSI-RS presence in the discovery burst for possible ways to do beam refinement during the initial channel access.
	+ Consider selection of multiple SS/PBCH blocks at UE to perform transmissions of multiple RACH preambles (MSG1/MSG A) during initial channel access.
	+ When RACH exchange may be considered as short control/management frames that can be exempt from LBT, gNB should signal to UEs if RACH exchange is LBT exempt.
* From [2] Huawei, HiSilicon:
	+ Configure DBTW length in SIB1 for operations with shared spectrum in 52.6GHz to 71GHz with the following values:
		- 120 kHz SCS: {40, 32, 24, 20, 16, 10, 4} slots
		- 480 kHz SCS: {72, 32, 26, 20, 16, 14, 8, 4} slots
		- 960 kHz SCS: {64, 32, 26, 20, 16, 14, 8, 4} slots
	+ To indicate for operation with shared spectrum in 52.6GHz to 71GHz, three bits are used from MIB payload as follows:
	+ For SSB with 120 kHz, one bit from subCarrierSpacingCommon, one bit from ssb-SubcarrierOffset, and one bit from searchSpaceZero in pdcch-ConfigSIB1.
	+ For SSB with 480 kHz or 960 kHz, one of the following alternatives can be selected:
		- Alt 1) one bit from subCarrierSpacingCommon, one bit from ssb-SubcarrierOffset, and one bit from pdcch-ConfigSIB1.
		- Alt 2) one bit from subCarrierSpacingCommon, two bits from pdcch-ConfigSIB1.
		- Alt 3) three bits from pdcch-ConfigSIB1.
* From [3] vivo:
	+ Support DBTW in un-licensed band from 52.6 GHz to 71 GHz, no matter which SSB SCS.
	+ The following methods could be considered to determine whether there is DBTW:
		- Alt. 1: Frequency band (licensed or un-licensed);
		- Alt. 2: The indicator in PBCH;
		- Alt. 3: The design of SSB sequence (PSS, SSS and DMRS).
	+ The following methods could be considered to indicate the value of Q:
		- Alt. 1: Specify the value of Q for each SCS;
		- Alt. 2: Utilize the bits in PBCH;
	+ With the increase value of Q and the introduction of DBTW, the ssbPositionsInBurst in SIB1 should be clarified.
* From [4] Spreadtrum:
	+ DBTW can be supported.
* From [5] Nokia, NSB:
	+ Support operation with and without DBTW for initial access.
	+ If the DBTW assumption is to be provided to the UE, it would need to be available from the start to be useful.
	+ If DBTW assumption can be changed, it should be available to the UE starting from initial cell selection.
	+ It is possible to apply SCSe to one part of actually transmitted SSBs and LBT procedure for other/rest of the SSBs.
	+ Consider semi-static or predetermined mechanism to determine which SSBs are under SCSe and which under LBT in certain time windows.
* From [6] Ericsson:
	+ RAN1 needs to conclude on how to indicate LBT on/off (especially addressing the issue of DCI 1\_0 size during SIB1 reading) before any decision on supporting a DBTW is made.
	+ Conclude that a DBTW is not supported for shared spectrum in the 52.6 – 71 GHz band.
* From [7] CATT:
	+ For NR operation in 60 GHz unlicensed spectrum, the discovery burst transmission window (DBTW) shall be supported for 120 KHz SSB when gNB configures more than 56 SSBs transmission.
	+ DBTW is not needed for SSB with 480 KHz/960 KHz SCS since the duty cycle is less than 10% over the 100 ms observation window for the short control signaling transmissions.
	+ For indicating the DBTW enabling/disabling, following options can be further studied.
		- Option 1：1bit indication in MIB/PBCH, e.g. subCarrierSpacingCommon can be used if Type0-PDCH SCS can be implicitly indicated from SSB SCS.
		- Option 2：1 bit information indicated by SIB-1.
		- Option 3：If 1 bit is not available in PBCH/MIB, PBCH/MIB and SIB1 can be used jointly to indicate DBTW enabling/disabling.
	+ If the actual number of SSB configured is up to 64, the scheme that DBTW is performed only for a sub-set SSB can be considered.
* From [8] Qualcomm:
	+ for an unlicensed band that requires LBT, do not support discovery burst transmission window (DBTW) for SSB for all SCSs
	+ for an unlicensed band that requires LBT, if DBTW for SSB is adopted for 120KHz SSB:
		- Minimize the number of bits needed to signal Q (1 or 2 bits) and thus the values (2 or 4 values)
		- Enabling/disabling DBTW can be implicit in the Q value
		- Based on other agreements/designs, consider getting the bits needed from one or more of the following: controlResourceSetZero, searchSpaceZero, ssb-SubcarrierOffset, subCarrierSpacingCommon (in case 120 kHz SSB and 480/960 kHz CORESET0 is not adopted)
		- Do not introduce new candidate SSB positions outside the FR2 Case D pattern, and the QCL relationship is introduced among the existing 64 candidate SSB positions
		- Consider having a subset of the SSBs (< 64) transmitted under the short control signal assumption while another subset can be best effort or have multiple positions per beam (have a Q factor within the subset)
* From [9] OPPO:
	+ For above 52.6GH unlicensed spectrum, the DBTW within which additional SSB candidate positions may be configured is supported.
	+ Reuse NRU mechanism to determine QCL relationship between SSB candidate indexes.
* From [10] ZTE, Sanechips:
	+ Discovery burst transmission window (DBTW) should be supported for 120 kHz SSB SCS and other SSB SCSs.
	+ For LBT exempt operation and overlapping licensed/unlicensed bands, it is not necessary to enable/disable the DBTW by explicit signaling. The impacts on LBT exempt operation brought by DBTW can be eliminated by configuration implementation.
* From [11] Intel:
	+ At least for SSB SCS 120 kHz:
		- Support DBTW
		- Support signaling of enable/disable of DB and DBTW
		- Consider supporting Option 1 and/or 2 for DB and DBTW for 120kHz SSB:
			* Option 1:
				+ Increase the number of candidate SSB indices up to 80, i.e., ;
				+ Support additional values of n, such as 4, 9, 14, 19, in the equation defining the first symbols of candidate SS/PBCH blocks
				+ For QCL relationship indication across SSBs, reuse Rel-16 NR-U mechanism by introducing parameter

FFS: or ;

* + - * + No changes to MIB payload size. Further discuss and consider reinterpreting bits from some bit fields within MIB to extend candidate SSB index and information.
			* Option 2:
				+ Support floating DBTW, where the time (or slot) offset for DBTW can be smaller than 5msec.

FFS: smallest supported DBTW offset (i.e. granularity of the floating DBTW)

* + - * If neither Option 1 nor 2 is supported, RAN1 to support mechanism to balance out SSB DTX (among all SSB beams) from LBT failure.
* From [13] Apple:
	+ If DBTW is introduced for above 52.6GHz frequency band, support enabling/disabling the DBTW by scrambling CRC bits of PBCH payload.
	+ If DBTW is introduced, for above 52.6GHz frequency band, consider re-purposing the 1-bit 'subCarrierSpacingCommon' and 1-bit MSB of controlResourceSetZero to signal the Q value.
* From [14] Sony:
	+ Discovery Burst Transmission Window should be supported.
	+ If Discovery Burst Transmission Window is supported for 120 kHz SSB, additional n values (4, 9, 14, 19) should be supported.
* From [15] NEC:
	+ DBTW should be supported at least for SSB transmission with 120 kHz SCS.
	+ The long term sensing could be considered as an approach to mechanism for enabling/disabling DBTW.
	+ The application of DBTW for SSB transmission could be indicated per SSB/beam.
	+ The indication of Q value in NR-U should be reused to indicate DBTW enabling/disabling and Q value jointly at least for 120 kHz SSB SCS.
	+ Additional discovery burst transmission window in the adjacent frame could be considered as a method of cycling SSB transmission.
	+ With concurrent spatial multiplexing DBTWs, all SSBs could be transmitted in a cycling transmission fashion.
* From [16] Samsung:
	+ Support discovery burst transmission window for 60 GHz unlicensed band.
		- The indication of Q can be in MIB for a best effort, and if not possible, in SIB1;
		- The indication of DBTW disabling can be joint coded with the indication of Q;
		- Support more than 64 candidate SS/PBCH block locations within a half frame;
			* Current PBCH payload can support timing indication of up to 128 candidate SS/PBCH block candidate locations;
			* For example, for 120 kHz SCS, support 80 candidate SS/PBCH block locations within a half frame;
		- For initial access, different synchronization raster entries are applied for licensed and unlicensed operations; for non-initial access, support an explicit indication of licensed or licensed operation when configuring a cell.
* From [17] MediaTek:
	+ Do not support DBTW for SSB.
* From [18] LGE:
	+ Consider the following methods to indicate enabled/disabled DBTW for idle and/or connected mode UEs.
		- Separate two sets of GSCN values where one set corresponds to the case of disabled DBTW while the other set corresponds to the case of enabled DBTW
		- Signalling via system information (e.g., measObject)
		- UE-specific RRC signaling (e.g., for SCell addition)
	+ Consider all or some of the following bits to indicate candidate values.
		- subCarrierSpacingCommon
		- LSB(s) of ssb-SubcarrierOffset
		- dmrs-TypeA-Position
	+ Discuss how to signal actually transmitted SSBs via ssb-PositionsInBurst when can be indicated to be less than 64 in MIB.
* From [19] Lenovo, Motorola Mobility:
	+ For NR operation in unlicensed bands between 52.6 GHz and 71 GHz, potential enhancements related to periodic transmission of DRS such as SSB/PBCH/CORESET#0 are needed including:
		- performing directional LBT prior to the transmission of SSB according to the ssb-PositionsInBurst
		- directional LBT on multiple beams at the same time at the beginning of the DRS window
		- Cat 2 LBT (depending on the gap) before actual transmission
* From [20] Xiaomi:
	+ Indication of DBTW information for initial access should be supported and could be carried in the PBCH.
* From [21] Interdigital:
	+ Enhance the initial access operation to support Discovery Burst (DB) and Discovery Burst Transmission Window (DBTW) in unlicensed spectrum operations that require LBT in beyond 52.6GHz spectrum.
	+ Consider the enhancements to indicate the enabling/disabling of the DBTW in initial access operations for the support of DBTW in shared spectrum in beyond 52.6GHz.
	+ Support the enhancements on the reference tables in indication of the Q parameter for up to 64 SSB beams in initial access operations for unlicensed spectrum in beyond 52.6GHz, e.g., subsamples of the Q parameter.
* From [23] Sharp:
	+ Adopt DBTW for SSB with 120 kHz SCS in above 52.6GHz.
* From [26] Charter:
	+ DBTW is supported for 120 kHz, 480 kHz, and 960 kHz SCS SSB even in the non-initial access case.
* From [27] WILUS:
	+ It seems beneficial to introduce discovery burst transmission window (DBTW) which makes it possible to define candidate SSB positions within the DBTW with support of DB which was already agreed.
	+ It should be further considered that the additional candidate SS/PBCH block locations within a DBTW can be set to the closest slot locations after LBT failure at candidate SS/PBCH blocks locations as defined in FR2.

#### Summary of Discussions

* Companies have provided several detailed proposals. Most of the proposals are suggestions and answers to several sub-issues. Moderator suggest to continue discussion with the following question list, and try to resolve each question during the RAN1 meeting.
	+ Whether or not to support DBTW for 120/480/960kHz SSB
	+ Mechanisms to support enabling/disabling LBT & DBTW, including DCI 1\_0 size issue and where to signal enable/disable (if supported)
	+ Additional information needed to be included in MIB to support DBTW, including which bits to re-purpose for the additional information
	+ Supported DBTW lengths
	+ Supported values
	+ Whether to support floating DBTW
	+ Whether to support mechanism to balance out SSB DTX (from LBT failure)
	+ Number of candidate SSB positions (not number of Tx SSBs)

#### **1st Round Discussion:**

Companies are encouraged to provide inputs on the following questions

* Q1) Whether of not to support DBTW for 120/480/960kHz SSB
* Q2) Mechanisms to support enabling/disabling LBT & DBTW, including DCI 1\_0 size issue and where to signal enable/disable (if supported)
* Q3) Additional information needed to be included in MIB to support DBTW, including which bits to re-purpose for the additional information
* Q4) Supported DBTW lengths
* Q5) Supported values
* Q6) Whether to support floating DBTW
* Q7) Whether to support mechanism to balance out SSB DTX (from LBT failure)
* Q8) Number of candidate SSB positions (not number of Tx SSBs)

If there are other aspects that require discussion, please comment them and moderator will update the list accordingly.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| DOCOMO | Q1) we support to introduce DBTW for all the supported SCSs in 52.6 – 71 GHz. As LBT can be mandatory for any SCS, the operation with DBTW should be possible with any SCS. Q2) It can be associated with LBT on/off switching and/or whether LBT needs to be performed for the associated DB transmissions. Q3) We prefer not to have any additional information in MIB for DBTW purpose. Q4) We prefer to keep it as Rel-16 NR-U to avoid increasing UE implementation burden. Q5) If only SSB and CORESET#0 multiplexing with the same numerology is supported, same as Rel-16 NR-U should be supported. Q6) We do not prefer it from SSB detection complexity perspective at UE. Q7) we do not see the necessity to support any other functionality than DBTW. Q8) Ok with further study about this, but it should be realized under the same overhead as Rel-16 NR-U in our view.  |
| LG Electronics | * Q1) Whether of not to support DBTW for 120/480/960kHz SSB
	+ Prefer to support DBTW for all of 120/480/960 kHz SSB
* Q2) Mechanisms to support enabling/disabling LBT & DBTW, including DCI 1\_0 size issue and where to signal enable/disable (if supported)
	+ Three methods can be used for different purposes. The first method is to separate two sets of GSCN values where one set corresponds to the case of disabled DBTW while the other set corresponds to the case of enabled DBTW, which is for initial access. The second methods is to indicate LBT & DBTW is enabled/disabled via system information, which is at least for neighbor cell measurement. The third methods is to indicate LBT & DBTW is enabled/disabled via UE-specific RRC signaling, which is at least for SCell addition.
* Q3) Additional information needed to be included in MIB to support DBTW, including which bits to re-purpose for the additional information
	+ values need to be included in MIB and {*subCarrierSpacingCommon,* LSB(s) of *ssb-SubcarrierOffset, dmrs-TypeA-Position*}can be used for indicating values.
* Q4) Supported DBTW lengths
	+ The same values (i.e., 0.5/1/2/3/4/5 ms) with R16 can be the starting point.
* Q5) Supported values
	+ {8, 16, 32, 64} values are preferred.
* Q6) Whether to support floating DBTW
	+ The motivation to introduce floating DBTW is unclear.
* Q7) Whether to support mechanism to balance out SSB DTX (from LBT failure)
	+ Not sure whether any specific mechanism other than DBTW is needed.
* Q8) Number of candidate SSB positions (not number of Tx SSBs)
	+ 64 candidate SSB positions might be enough, but open to discuss whether to define more candidate positions, which depends on the availability of MIB to indicate the increased number of candidate SSB positions.
 |
| Samsung | 1) We support DBTW for 120/480/960kHz SSB2) Enabling/Disabling LBT & DBTW can be jointly coded with the indication of Q, since Q is only applicable to LBT & DBTW enabled. The indication can be in MIB if the number of bits are enough, and in SIB1 otherwise. We didn’t see there is an impact on the DCI 1\_0 size. 3) Indicate 4th LSB of SFN in MIB, and reinterpret the 4th LSB of SFN in PHY bits as the 7th LSB of the candidate SSB index. 4) Within 5 ms, and the maximum number of SSB candidate locations for each SCS can be further discussed, based on the indication capacity without increasing PBCH payload size. 5) {1, 2, 4, 8, 16, 32, 64} as the starting point for discussion, and can remove some small values to save the number of bits. 6) “Floating DBTW” needs extra intra indication on the timing offset. Better to clarify its purpose first before discussing other details. 7) Didn’t quite get the intention of the question. We thought supporting DBTW is already a way to balance out SSB DTX (from LBT failure), and no other method is needed.8) 80 candidate SSB locations for 120 kHz, and up to 128 candidate SSB locations for 480/960 kHz.  |

#### **1st Round Discussion Summary:**

* TDB

### 2.1.4 SSB Resource Pattern

* From [2] Huawei, HiSilicon:
	+ Other than the agreed values of n corresponding to Cased D SSB pattern, do not support any additional values of n for SSB with 120kHz SCS in operation with shared or without shared spectrum.
	+ Support following patterns for SSB with 480 kHz and 960 kHz SCS:
		- For operations without shared spectrum:
			* {2,8}+14n, (n=0,1,2,…,31) for both 480 kHz and 960 kHz SCS
		- For operations with shared spectrum:
			* {2,8}+14n, (n=0,1,2,…,31,40,…,71) for 480 kHz SCS;
			* {2,8}+14n, (n=0,1,2,…,63) for 960 kHz SCS.
* From [3] vivo:
	+ Support of additional n values to support of DBTW, and the value of n can be 4, 9, 14, 19.
	+ Support to reuse case D as the baseline for designing the SCS 480 kHz and 960 kHz time domain pattern.
	+ The following alternatives could be considered to solve beam switching problem for contiguous candidate SSBs:
		- Alt. 1: New SSB pattern introducing gaps between contiguous candidate SSBs;
		- Alt. 2: The same QCL assumptions for contiguous candidate SSBs;
* From [4] Spreadtrum:
	+ If the symbol gap between SSB positions is agreed to be supported, the SSB pattern of Case A/C for SSB with 15/30kHz SCS can be considered for SSB with 480/960kHz SCS.
* From [5] Nokia, NSB:
	+ Define additional SSB locations for the purpose of SSB retransmissions
	+ Group additional SSB locations and associate each group to set of regular SSB positions, e.g. after each block of 16 regular SSB positions there is associated group of up to four additional positions that can be used to retransmit any of the associated actual SSBs.
	+ For carrier frequencies within 52.6 GHz to 71GHz, at 120kHz SSB, introduce additional candidate locations for SSB transmission support for 𝑛 = 4, 9, 14, 19.
		- The first symbols of the additional candidate SS/PBCH blocks have indexes {4, 8,16, 20} + 28×n.
	+ For carrier frequencies within 52.6 GHz to 71GHz, at 240kHz SSB, introduce additional candidate locations for SSB transmission support for 𝑛 = 10, 11, 12, 13, 15, 16, 17, 18.
		- The first symbols of the candidate SS/PBCH blocks have indexes {8, 12, 16, 20, 32, 36, 40, 44} + 56×n.
* From [6] Ericsson:
	+ For SS/PBCH block with 120 kHz SCS, support Case D pattern as defined in Rel-15. No new values of n are supported.
	+ Pending decision from RAN4 on beam switching times, if beam switching can be performed within the cyclic prefix, support the FR2 Case D pattern for time domain pattern for SSB transmissions with 480 kHz and 960 kHz SCS.
* From [7] CATT:
	+ More than 64 SSB transmission opportunities shall be defined within a 5ms SSB burst set to support up to 64 beams for SSB beam sweeping in case of occasional LBT failure. The issue of supporting additional bit(s) for the extension of SSB candidate index needs further study.
	+ Additional n value such as #4, #9, #14, and #19 can be used for new SSB candidates if LBT/DBTW is needed for SSB transmission.
* From [8] Qualcomm:
	+ for the SSB for NR operation in the frequency between 52.6GHz and 71GHz and SCS = 480 kHz and 960 kHz, consider defining an SSB pattern consisting of multiple “SSB slots” where SSB symbols for one or more beams are contained in the “SSB slot”
		- A beam switching gap of 1 symbol is inserted between SSBs within the “SSB slot”
		- Additional control symbols may be defined in the SSB slots with beam switching gaps between control and SSB symbols of different beams
		- Additional “gap slots” may be inserted between “SSB slots” to account for URLLC and UL traffic
		- Consider the option of aligning the higher SCS SSBs with the corresponding beams for the lower SCS SSB
* From [9] OPPO:
	+ Wait for RAN4 response before further discuss beam switching gap issue.
* From [10] ZTE, Sanechips:
	+ For designing SSB patterns with different SCSs for NR operation above 52.6 GHz, it is proposed to reuse the existing design (i.e. Case A/C, Case B/D and Case E) as much as possible, and take different impacts in single/mixed numerology operation into account.
	+ The following options can be considered for supporting beam switching for SSB with SCS 480 kHz and 960 kHz if the CPs can not used to support beam switching and other functions simultaneously.
		- Option 1: In a half-frame, any two candidate SSBs are discontinuous in the time domain
		- Option 1-1: SSB pattern with SCS 480/960 kHz can adopt the existing pattern of Case A and Case C in one or two slots defined in Rel-15 NR
		- Option 1-2: SSB pattern with SCS 480/960 kHz should be re-designed to reserve at least one symbol between any two candidate SSBs, e.g. only defining one candidate SSB per slot, or shift the existing SSB by one or more symbols
		- Option 2: Multiple adjacent candidate SSBs are defined to have a same SSB index or QCL assumption
	+ In order to reduce the impact of standardization caused by indicating candidate SSB indices, the maximum number of candidate SSB defined in the half-frame can be kept unchanged (maintain 64) or limited to 128 for 240/480/960 kHz SSB SCS.
* From [11] Intel:
	+ Consider SSB pattern in a slot with 3 SSB containing slots, each slot with 2 SSB position, followed by 1 non-SSB carrying slot for 480 kHz and 6 SSB carrying slots followed by 2 non-SSB carrying slots for 960kHz, to accommodate Rx-Tx switching gap.
		- For 480kHz and 960kHz SCS based SSB, first symbols of the candidate SSB have indexes {2,9} + 14×n, where index 0 corresponds to the first symbol of the first slot in a half-frame.
		- For 480kHz, n = 0,1,2, 4,5,6, 8,9,10, 12,13,14, 16,17,18, 20,21,22, 24,25,26, 28,29,30, 32,33,34, 36,37,38, 40,41.
		- For 960kHz, n = 0,1,2,3,4,5, 8,9,10,11,12,13, 16,17,18,19,20,21, 24,25,26,27,28,29, 32,33,34,35,36,37, 40, 41.
* From [13] Apple:
	+ Support to introduce a unified SSB Pattern for 480kHz SCS and 960kHz SCS (if supported):
		- The first symbol of candidate SSB have indexes {2,9,16,23} within each SSB burst.
		- Reserve 2 slots for DL/UL and UL/DL switching to allow for fast UL transmission between two SSB bursts.
* From [15] NEC:
	+ Additional n values of 4, 9, 14 and 19 should be supported to indicate additional candidate SSBs in DBTW at least for 120 kHz SCS SSB pattern.
	+ The indication of additional candidate SSBs based on additional n values should be investigated.
* From [16] Samsung:
	+ Support the same SS/PBCH block pattern for 480 kHz and 960 kHz SCSs.
		- At least one symbol should be reserved between neighboring SS/PBCH block for beam sweeping delay.
		- Symbols should be reserved for CORESET and HARQ with SCS same as the SS/PBCH block.
		- For SS/PBCH block candidate locations in a slot, Case A or Case C can be reused.
* From [18] LGE:
	+ Reuse existing SS/PBCH Case D (which is applied for 120 kHz SCS) for SS/PBCH block with 480/960 kHz SCS, if RAN4 confirms that no explicit switching gap is needed between successive SS/PBCH blocks.
	+ Support of additional n values for the time domain pattern of SS/PBCH block with 120 kHz SCS can be considered to increase SS/PBCH block’s transmission opportunities, only if PBCH payload is sufficient to indicate the increased number of candidate SS/PBCH block indexes.
* From [19] Lenovo, Motorola Mobility:
	+ For supporting NR from 52.6 GHz to 71 GHz in Rel. 17, if higher subcarrier spacings (numerologies) are adopted for SSB, then to allow the beam switching between contiguous SSBs, a gap (for example a symbol gap or post prefix) should be supported before beam switching.
* From [21] Interdigital:
	+ Introduce the enhancements on SS/PBCH block transmission patterns to deliberately include the CORESET#0 and SIB1 in fixed time locations along with the corresponding SS/PBCH block to ensure the channel occupancy as much as possible, in the initial access operations for unlicensed spectrum in beyond 52.6GHz.
* From [22] Convida:
	+ Increasing the number of SSB candidate positions to above 64 to increase transmission opportunities to cope with LBT failure should be considered.
* From [23] Sharp:
	+ Based on SSB resource pattern Case D of FR2, other values of n (e.g., 4, 9, 14, 19) should be added for the SSB with 120kHz SCS in above 52.6GHz.
* From [25] NTT Docomo:
	+ When new SCSs are supported for SSB, the two alternatives below can be considered for SSB mapping in time domain:
		- Two SSBs per slot, with guard period of at least 1 symbol between the SSBs
		- One SSB per slot
* From [27] WILUS:
	+ At least one symbol gap in time domain between SS/PBCH blocks with different SSB indices should be considered for higher subcarrier spacing (e.g., 960kHz) by taking a beam switching gap into account due to a RF interruption time of Tx/Rx beams and/or LBT gap in unlicensed spectrum.

#### Summary of Discussions

* Several companies stated that RAN1 should wait for RAN4 reply LS on beam switching before deciding the exact SSB patterns.
* If exact SSB position within a slot(s) is difficult to conclude due to lack of information from RAN4, moderator suggests to discuss and conclude on other aspects of SSB pattern that do not require feedback from RAN4. For example:
	+ number of SSB candidates per slot
	+ slots that may contain candidate SSB(s) (including maximum number of candidate SSB in half-radio frame)

#### **1st Round Discussion:**

Based on input Moderator has put together possible options for SSB resource pattern.

* For 120kHz SSB:
	+ Whether or not to add n = 4, 9, 14, 19 for the SSB candidate position
* For 480kHz SSB:
	+ SSB candidate position defined over
		- Option 1-1) 1 slot (e.g. start position defined as {X,Y} + 14\*n)
		- Option 1-2) 2 consecutive slots (e.g. start position defined as {W,X,Y,Z} + 28\*n)
	+ Assuming {X,Y} + 14×n, SSB candidate position, support
		- Option 2-1) n = 0,1,2,…,31
		- Option 2-2) n=0,1,2,…,31,40,…,71 (applicable only for unlicensed cases)
		- Option 2-3) n = 0,1,2, 4,5,6, 8,9,10, 12,13,14, 16,17,18, 20,21,22, 24,25,26, 28,29,30, 32,33,34, 36,37,38, 40,41.
* For 960kHz SSB:
	+ SSB candidate position defined over
		- Option 3-1) 1 slot (e.g. start position defined as {X,Y} + 14\*n)
		- Option 3-2) 2 consecutive slots (e.g. start position defined as {W,X,Y,Z} + 28\*n)
	+ Assuming {X,Y} + 14×n, SSB candidate position, support
		- Option 4-1) n = 0,1,2,…,31
		- Option 4-2) n=0,1,2,…,63 (applicable only for unlicensed cases)
		- Option 4-3) n = 0,1,2,3,4,5, 8,9,10,11,12,13, 16,17,18,19,20,21, 24,25,26,27,28,29, 32,33,34,35,36,37, 40, 41.

Given that there are many options, moderator suggest starting out by answering some fundamental questions (as suggested by few companies)

* For 120kHz:
	+ Q1) Whether or not to add n = 4, 9, 14, 19 for the SSB candidate position for unlicensed operation
* For 480 and 960 kHz:
	+ Q2) same SSB resource pattern within pair of consecutive slots?
	+ Q3) 1 SSB per slot or 2 SSB per slot
	+ Q4) same number of candidates depending on mode of operation (e.g. licensed and unlicensed or depending on LBT on or off)?
	+ Q5) if different number of SSB candidates depending on mode of operation, SSB resource pattern for licensed/no LBT case a complete subset of the other case (i.e. value of n for one mode all included in the other mode)?
	+ Q6) should there be non-SSB slots every few SSB containing slots (i.e. non-consecutive values of n) to support intermittent UL or other transmissions than SSB?

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| **Company** | **Comment** |
| DOCOMO | Q1) It seems related to DBTW, so should be discussed there. Q2) Q3) We support 1 SSB per slot since it has some benefits, e.g., relaxing beam sweeping overhead and resource utilization efficiency. 1 SSB per slot can achieve more resources available for other transmissions with the same beam within the slot. Also, the time required to complete beam sweeping will not be a significant issue since slot length is shortened with larger SCS. Q4) It may depend on if DBTW is supported, but we basically think the same number of SSB candidates would be sufficient. Q5) Yes. Q6) We support to consider non-SSB slots. Its periodicity would need to be discussed further.  |
| LG Electronics | For 120 kHz, we prefer not to add n = 4, 9, 14, 19 for the SSB candidate position for unlicensed operation. But adding n = 4, 9, 14, 19 can be considered if we can find bit location to indicate the increased SSB candidate position.For 480/960 kHz, we have NOTE (Strive to minimize specification impact due to the new SCS for SSB) in the previous agreement. In that sense, we suggest legacy pattern (e.g., Case D) as the starting point. |
| Samsung | 1) Yes, if DBTW is supported for 120 kHz SSB. 2) Yes. 3) 2 SSB per slot4) No, the number of candidate SSB locations for unlicensed band can be larger. 5) Yes, the candidate SSB locations for licensed band can be a subset of the ones for unlicensed band. 6) Yes, for licensed band.  |

#### **1st Round Discussion Summary:**

* TDB

### 2.1.5 CORESET#0 Configuration

* From [2] Huawei, HiSilicon:
	+ Support only {SS/PBCH Block, CORESET#0 for Type0-PDCCH} SCS equal to {120, 120} kHz in 52.6GHz to 71GHz spectrum.
	+ CORESET#0 with 96 PRB can be configured to make full use of allowed transmit power at least for operation with shared spectrum.
	+ Support the following CORESET#0 RB offsets values for {SSB, CORESET#0} SCS={120, 120} kHz:
		- 24 RB and 48 RB CORESET#0: the same as supported values in Table 13-8 of 38.213
		- 96 RB CORESET#0: 0, 38, 76 RBs for multiplexing pattern 1 and -20 (-21) RBs when for multiplexing pattern 3.
* From [3] vivo:
	+ The following SSB-Coreset 0 multiplexing patterns are supported for each SCS pair:
		- (120K, 120K): Pattern 1, Pattern 3
		- (480K, 480K): Pattern 1, Pattern 3
		- (960K, 960K): Pattern 1, Pattern 3
		- (960K, 480K): Pattern 1, Pattern 2
	+ To save more bits, the CORESET design of un-licensed band operation from 52.6GHz to 71GHz can re-use the design criterion in NR-U, which occupies as much bandwidth as possible in the frequency domain.
* From [5] Nokia, NSB:
	+ Support providing CORESET#0/Type0-PDCCH configuration for 480kHz and 960kHz kHz SCS SSB transmission in NR bands ranging between 52.6 GHz to 71 GHz.
	+ Consider supporting at least SSB and CORESET multiplexing pattern 1 for {480, 480} case. Pending on the UE minimum BW capability, consider also SSB and CORESET multiplexing pattern 2 or 3.
	+ Consider supporting at least SSB and CORESET multiplexing pattern 1 for {960, 960} case.
	+ Consider supporting pattern 1 and pattern 2 for {240,120} case.
	+ For CORESET#0 with 120kHz sub-carrier spacing, consider supporting also N\_{RB}^{CORESET}={96}. In case SSB and Type0 CORESET multiplexing pattern 1 removing option of N\_{RB}^{CORESET}={24} could be considered.
	+ For SSB and CORESET#0 with 480kHz sub-carrier spacing, support following options:
		- For multiplexing pattern1
		- For multiplexing pattern2 or 3 (if supported)
	+ For CORESET#0 with 480kHz sub-carrier spacing, support
	+ For SSB and CORESET#0 with 960kHz sub-carrier spacing, support for multiplexing pattern 1
	+ For CORESET#0 with 960kHz sub-carrier spacing, support
	+ For SSB with 240kHz sub-carrier spacing and CORESET#0 with 120kHz sub-carrier spacing, support following options:
* From [7] CATT:
	+ Multiplexing pattern 2 or 3 can be used for further multiplexing SSB/CORSET#0 with periodic CSI-RS/paging PDCCH&PDSCH in frequency.
	+ For SSB and CORESET#0/Type0-PDCCH with 120 KHz SCS, support the following combinations of SSB/CORESET multiplexing pattern, number of RB and symbols for CORESET.
		- {mux pattern 1, 48 PRB CORESET, 1 symbol CORESET}
		- {mux pattern 1, 48 PRB CORESET, 2 symbol CORESET}
		- {mux pattern 3, 48 PRB CORESET, 2 symbol CORESET}
* From [8] Qualcomm:
	+ For non-initial access where SSB does configure Type-0 PDCCH and timing of the SSB is known to the UE (within limits defined in Table 7.6.4-2 of TS 38.133): support SCS = 480/960 kHz
	+ consider the following SSB and CORESET0 SCS combinations:
		- SSB SCS = 120 kHz, CORESET0 SCS = 120, 480, 960 kHz
		- If SSB SCS = 240 kHz is supported, support CORESET0 SCS = 120, 480, 960 kHz
		- If SSB SCS = 480/960 kHz is supported for non-initial access where SSB does configure Type-0 PDCCH and timing of the SSB is known to the UE, support CORESET0 SCS = SSB SCS
	+ consider ways to have 2 bits (1 extra bit compared to FR2) to indicate the common SCS in the SSB structure or contents in case more than 2 values for the common SCS are allowed
	+ NR Rel-16 SSB/CORESET0 multiplexing pattern 1 design may be reused with possibly some changes to the table (e.g., the need for < 2.5 ms options for the start of the CORESET0 wrt frame boundary) which depends on the outcome of the SSB pattern design
	+ SSB/CORESET0 multiplexing pattern 2:
		- For the 240 kHz + 120 kHz combination (if supported): reuse the same design as in NR Rel-16
		- For the 120 kHz + 480/960 kHz combination (if supported): the CORESET0 symbols may be placed in the gap symbols between the SSBs (similar to the existing NR Rel-16 design)
	+ NR Rel-16 SSB/CORESET0 multiplexing pattern 3 design may be reused for the valid combinations of 120 + 120 kHz, 480 + 480 kHz, and 960 + 960 kHz
	+ consider introducing an SSB/CORESET0 multiplexing pattern for higher SCS SSB (480 and 960 kHz), where a time domain fixed location for the CORESET0 and SIB1 is considered
	+ consider introducing an SSB/CORESET0 multiplexing pattern for higher SCS SSB (480 and 960 kHz), where TDM grouping of the SSB and the corresponding CORESET0/SIB1 is considered
* From [10] ZTE, Sanechips:
	+ The following multiplexing patterns for three approved SCS combinations of SSB and Type0-PDCCH can be considered for Rel-17 NR above 52.6 GHz. Other SCS combinations could be precluded.
		- (SSB, Type0-PDCCH): SCS (120 kHz, 120 kHz) Multiplexing patterns: 1, 3
		- (SSB, Type0-PDCCH): SCS (480 kHz, 480 kHz) Multiplexing patterns: 1, 3
		- (SSB, Type0-PDCCH): SCS (960 kHz, 960 kHz) Multiplexing patterns: 1, 3
	+ For {SSB, CORESET#0 for Type0-PDCCH} SCS = {120, 120} kHz, even though RAN4 has agreed the minimum CBW is increased to 100 MHz, at least SSB and CORESET#0 multiplexing patterns, number of RBs for CORESET#0, number of symbols (duration of CORESET#0) that are supported in Rel-15/16 should still be supported.
* From [11] Intel:
	+ Support CORESET#0/Type0-PDCCH configuration indication in MIB of SSB for all supported SSB SCS.
	+ Consider only same SCS for SSB and CORESET#0 (configured by MIB) for 480 and 960 kHz SCS.
* From [16] Samsung:
	+ For CORESET#0
		- Support SSB with 240/480/960 kHz for initial and non-initial access with support of CORESET0/Type0-PDCCH configuration in the MIB.
			* SSB time domain candidate resource pattern (within a slot or pair of slots) for 480 and 960kHz SSB are identical
			* only 1 CORESTE#0/Type0-PDCCH SCS supported for each SSB SCS
		- It is assumed that RAN4 supports a channelization design which results in the total number of synchronization raster entries in the 57 – 71 GHz band no larger than [400] (Note: the total number of synchronization raster entries in FR2 for band n259 is 344). If the assumption cannot be satisfied, it’s up to RAN4 to decide which of 240/480/960 kHz SCS are supported for initial access of such band.
		- RAN1 prioritizes time-domain multiplex of SSB and CORESET0 to minimize the number of needed synchronization raster entries.
		- Supporting 480 kHz SCS and 960 kHz SCS for SSB are UE capabilities:
			* UE is not expected to support 480 kHz SCS for SSB if it doesn’t support 480 kHz SCS for data/control channels.
			* UE is not expected to support 960 kHz SCS for SSB if it doesn’t support 960 kHz SCS for data/control channels.
		- Send an LS to RAN2 and RAN4.
	+ For SS/PBCH block with 120 kHz SCS,
		- only support CORESET#0 SCS as 120 kHz;
		- additional CORESET#0 RB offsets are needed;
		- support 96 RB as the number of RBs for CORESET#0.
	+ For SS/PBCH block with 480 kHz SCS and 960 kHz,
		- only support CORESET#0 SCS same as SS/PBCH block SCS;
		- support at least the same SS/PBCH block and CORESET#0 multiplexing patterns, number of RBs for CORESET#0, and number of symbols as in 120 kHz SCS;
		- support 96 RB as the number of RBs for CORESET#0;
		- Further study the RB offset based on RAN4 design of channel and synchronization rasters.
* From [17] MediaTek:
	+ CORESET#0 should have the same SCS as SSB in initial access.
* From [21] Interdigital:
	+ Consider other means to convey the CORESET#0 and Type0-PDCCH to UE to avoid BWP and SCS switching.
	+ Consider introducing the parameters for the CORESET#0 and Type0-PDCCH, where the time and frequency allocations and the multiplexing patterns are (pre)configured in fixed settings
* From [23] Sharp:
	+ Regarding {SSB, CORESET#0/Type0-PDCCH} SCS combination of {120, 120} kHz, in principle reuse the CORESET#0 configuration table of FR2. The motivations of removing/adding/modifying row(s) should be justified.
* From [25] NTT Docomo:
	+ When new SCS(s) is supported for SSB and a single numerology is used for both SSB and CORESET#0/SIB1, at least TDM between SSB and CORESET#0/SIB1 can be supported.
	+ In case of TDM between SSB and CORESET#0 PDCCH/SIB1 PDSCH, support different structure(s) of TDM than the ones supported in Rel-15/-16 NR.
		- E.g., a group of SSB/CORESET#0 PDCCH/SIB1 PDSCH, which are associated with the same QCL, is allocated within a slot
	+ When the supported SCS for SSB in initial access case is limited compared to non-initial access cases, mixed numerology between SSB and CORESET#0/SIB1 should be supported.
	+ When lower SCS is used for SSB compared with that used for CORESET#0/SIB1, FDM between SSB and SIB1 PDSCH such as in pattern 2 can be considered.
* From [26] Charter:
	+ For the case where SSB location and SCS are explicitly provided to the UE (non-initial access) and SSB configures Type-0 PDCCH, support 480 kHz and 960 kHz numerologies for the SSB.
* From [27] WILUS:
	+ Regarding the multiplexing between SSB and CORESET#0/RMSI-PDSCH, after agreeing new SCSs for SSB above all, it should be decided which combinations and multiplexing patterns are supported for NR operation from 52.6GHz to 71GHz.
	+ We propose that SS/PBCH block and CORESET#0/RMSI can be multiplexed in TDM/FDM within a slot considering multi-beam operation and it can be closely located without the gap between SSB and CORESET#0/RMSI for not allowing any in-between channel access operation in the unlicensed band.

#### Summary of Discussions

* Only support same SCS between SSB and CORESET#0/Type-PDCCH
	+ Huawei/Hilicon (for 120kHz SSB which is the only currently agreed SSB for initial access), Intel, ZTE, Sanechip, Samsung (for 480/960kHz), Mediatek, Docomo (for new SCS)
* Support only 1 SCS for CORESET#0/Type0-PDCCH for each SSB SCS
	+ Samsung
* Support CORESET#0/Type0-PDCCH configuration for 480/960kHz SSB
	+ vivo, Nokia, NSB, Intel, Qualcomm, Samsung, Charter
* Moderator suggest to discuss further on following issues:
	+ Whether or not support CORESET#0/Type0-PDCCH configuration for 480/960kHz SSB
	+ Any updates/changes to existing CORESET#0/Type0-PDCCH configuration for 120kHz SSB (if needed)
	+ Supported multiplexing patterns and CORESET#0/Type-PDCCH parameters for 480/960kHz (if supported)

#### **1st Round Discussion:**

Moderator asks companies to provide input on the following:

* Q1) Any updates/changes to existing CORESET#0/Type0-PDCCH configuration for 120kHz SSB? If so what are some of the aspects that need consideration for the update/changes
* Q2) Whether Support CORESET#0/Type0-PDCCH configuration for 480/960kHz SSB
* Q3) if supported in Q1, supported multiplexing patterns and CORESET#0/Type-PDCCH parameters for 480/960kHz
* Q4) Support only 1 SCS for CORESET#0/Type0-PDCCH for each SSB SCS agreeable?

|  |  |
| --- | --- |
| **Company** | **Comment** |
| DOCOMO | Q1) If 480/960 kHz SCS is not supported for SSB during initial access, we prefer to support 480 and/or 960 kHz CORESET#0/Type0-PDCCH configuration in addition to 120 kHz SCS for SSB with 120 kHz SCS. Q2) We strongly support it as it achieves ANR/CGI reporting which is essential from operator’s perspective. Q3) TDM should be baseline. FDM can be considered but it needs to be carefully considered in terms of coverage of CORESET#0/SIB1. Q4) it highly depend on other aspects.  |
| LG Electronics | * Q1) Any updates/changes to existing CORESET#0/Type0-PDCCH configuration for 120kHz SSB? If so what are some of the aspects that need consideration for the update/changes
	+ Existing configuration seems sufficient. However, if additional configuration is required, then that configuration can be just added with current configurations kept.
* Q2 & Q3
	+ They depend on the decision in proposals from Sections 2.1.1 and 2.1.2.
* Q4) Support only 1 SCS for CORESET#0/Type0-PDCCH for each SSB SCS agreeable?
	+ We agree to support only 120 kHz CORESET#0/Type0-PDCCH for 120 kHz SSB SCS.
 |
| Samsung | 1) Yes. * The number of RBs for CORESET#0 can consider 96 RBs, since the carrier bandwidth is much larger than FR2.
* The RB offset for CORESET#0 needs to be reconsidered (after RAN4 finalizes the channel and sync raster design), since the minimum channel bandwidth is increased from FR2.

2) Yes. 3) * Other than the RB offsets, the other parameters for CORESET#0 configuration for 480 and 960 kHz can reuse 120 kHz SSB.
* Other than the offset O, the other parameters for Type0-PDCCH configuration for 480 and 960 kHz can reuse 120 kHz SSB.

4) Yes.  |

#### **1st Round Discussion Summary:**

* TDB

### 2.1.5 Various other aspects on SSB Design

* From [2] Huawei, HiSilicon:
	+ For operation with shared spectrum and for 480 kHz and 960 kHz SSBs, indicate the 7th bit of the candidate SSB index by borrowing the 4th LSB of SFN in the PBCH payload. Indicate the 4th LSB of SFB in MIB payload.
* From [3] vivo:
	+ For initial cell search in 52.6-71GHz, a UE may assume that half frames with SSB occur with smaller period than FR2 (e.g. 5ms), or lower RAN4 requirement for the cell search time.
* From [4] Spreadtrum:
	+ The SSB-based TRS/CSI-RS validation can be supported.
* From [8] Qualcomm:
	+ For initial access, in cases where the SSB SCS is smaller than other channels’ SCS (e.g., PDCCH/PDSCH), consider WB DMRS or cell-specific TRS for further timing error corrections
		- For cell-specific TRS, consider studying the FD density needed
* From [21] Interdigital:
	+ Consider the enhancements to indicate the license regime in initial access operations for licensed/unlicensed overlapping spectrum in beyond 52.6GHz.
* From [22] Convida:
	+ SSB coverage enhancement should be studied for higher SCS.

#### Summary of Discussions

* Companies have provided discussion on considerations for SSB design.
	+ For operation with shared spectrum and for 480 kHz and 960 kHz SSBs, indicate the 7th bit of the candidate SSB index by borrowing the 4th LSB of SFN in the PBCH payload. Indicate the 4th LSB of SFB in MIB payload.
	+ For initial cell search in 52.6-71GHz, a UE may assume that half frames with SSB occur with smaller period than FR2 (e.g. 5ms), or lower RAN4 requirement for the cell search time.
	+ The SSB-based TRS/CSI-RS validation can be supported.
	+ For initial access, in cases where the SSB SCS is smaller than other channels’ SCS (e.g., PDCCH/PDSCH), consider WB DMRS or cell-specific TRS for further timing error corrections
		- For cell-specific TRS, consider studying the FD density needed
	+ Consider the enhancements to indicate the license regime in initial access operations for licensed/unlicensed overlapping spectrum in beyond 52.6GHz.
	+ SSB coverage enhancement should be studied for higher SCS.
* Moderator suggests discussing above listed issues further.

#### **1st Round Discussion:**

Moderator asks companies to provide input on the following issues:

* Support wideband DMRS or cell-specific TRS to aide timing error correction (for 120kHz SSB with 480 or 960kHz control/data transmission)
* Any changes to the default SSB periodicity to be assumed by the UE
* Methods to indicated licensed or unlicensed operation
	+ This may need to be discussed under channel access agenda

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| **Company** | **Comment** |
| Samsung | * Is it for IDLE mode only? Seems more discussion is needed for this topic.
* If DBTW is supported, the initial access performance may not be an issue. More discussion towards this seems needed.
* Different sync raster can be assigned for licensed and unlicensed band for initial access purpose, and network can explicit configure this information after initial access.
 |

#### **1st Round Discussion Summary:**

* TDB

## 2.2 PRACH Aspects

### 2.2.1 Supported PRACH Numerology

* From [1] Futurwei:
	+ For initial access and non-initial access use cases, support 120kHz PRACH SCS with sequence length L=571, 1151 (in addition to L=139) for PRACH Formats A1~A3, B1~B4, C0, and C2.
		- For non-initial access use cases, support 480 and 960 kHz PRACH SCS with sequence length L=139 for PRACH Formats A1~A3, B1~B4, C0, and C2, respectively.
* From [2] Huawei, HiSilicon:
	+ When UE is in RRC\_IDLE or RRC\_INACTIVE state, support only 120 kHz SCS for PRACH preamble and Msg.3 transmission in 52.6GHz to 71GHz spectrum. This includes all following cases:
		- Initial access from RRC\_IDLE,
		- Transition from RRC\_INACTIVE to RRC\_CONNECTED,
		- Request for OSI in RRC\_IDLE or RRC\_INACTIVE state.
		- Note: When UE is in RRC\_IDLE or RRC\_INACTIVE state, RACH configuration is provided in the configuration of initial UL BWP for PCell in SIB1.
	+ When UE is in RRC\_CONNECTED state, in addition to 120 kHz SCS, support 480 kHz and 960 kHz SCS for PRACH preamble and Msg.3 transmission in 52.6GHz to 71GHz spectrum.
* From [3] vivo:
	+ Support 120KHz, 480KHz and 960KHz as candidate SCS of initial UL BWP.
	+ Support 960KHz SCS in addition to 120KHz SCS for PRACH format (A, B, C).
* From [5] Nokia, NSB:
	+ Support 480kHz and/or 960 kHz SCS for PRACH in non-initial access use cases.
	+ Support 480kHz and/or 960 kHz SCS for PRACH in initial access use case when UE’s SSB search complexity can be mitigated
* From [10] ZTE, Sanechips:
	+ Support additional SCSs (480kHz and/or 960kHz) for PRACH and SSB if single subcarrier spacing is supported.
* From [11] Intel:
	+ Support 480 kHz and 960 kHz SCS for PRACH in NR extension up to 71 GHz.
		- Note: no need to distinguish whether the PRACH is for initial access or non-initial access, as such distinction does not exist for RAN1 specification.
* From [12] Fujitsu:
	+ In addition to 120kHz, support 480kHz and 960kHz for PRACH SCS for all cases.
* From [13] Apple:
	+ If 480kHz and 960kHz SCS are used for PRACH transmission, support L=139 only.
* From [18] LGE:
	+ If 480 and/or 960 kHz SCS SSB is not supported for the initial access use case, support only the 480 and/or 960 kHz SCS PRACH with the sequence length L=139 for the cases other than initial access (e.g., for SCell).
* From [19] Lenovo, Motorola Mobility:
	+ For supporting NR from 52.6 GHz to 71 GHz in Rel. 17, support both the numerologies of 480kHz and 960kHz for PRACH transmission
* From [21] Interdigital:
	+ Further study necessity of PRACH for additional SCSs in Rel-17.
* From [25] NTT Docomo:
	+ For PRACH SCS, as well as SSB, 480 and 960 kHz SCS should be supported at least for non-initial access cases.

#### Summary of Discussions

* Support 120kHz PRACH in all cases, support 480/960kHz RACH for connected mode
	+ Huawei, HiSilicon
* Support 120kHz PRACH in all cases, support 480/960kHz RACH for (at least) non-initial access cases
	+ Futurewei, Docomo
* Support 480 and 960kHz PRACH (in addition to 120kHz PRACH)
	+ vivo, ZTE, Sanechips, Intel, Fujitsu, Apple (only L=139), LGE (only L=139), Lenovo, Motorola Mobility,
* Moderator understands that most (if not all) companies have similar proposal to support 480/960kHz in RAN1 specification. There are some discussion around limiting use of specific PRACH SCS in different use cases, but from moderator’s understanding such distinction will not be present in RAN1 specification. Moderator suggest further discussion as companies seems to be close to alignment.

#### **1st Round Discussion:**

From modertor’s understanding the physical layer does not distinguish initial access and non-initial access for PRACH as all the random access behaviors is described in RAN2. In order to make further discussion and progress on RACH, moderator suggest to first see we can agree to support which SCS for PRACH, and further discuss how and whether to limit the SCS usage for specific scenarios. This way some further discussion on RO and PRACH sequence and format could be made.

Please comment further on the following proposal.

##### **Proposal 2.1-1)**

* Support 480kHz and 960kHz PRACH in physical layer specifications
	+ RAN1 to send LS to RAN2 to inform any specific PRACH SCS are to be excluded from certain modes of operation from RAN1 perspective (if any)
* RAN1 to discuss further on restriction of specific PRACH SCS for specific scenarios

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| **Company** | **Comment** |
| DOCOMO | Support the Proposal 2.1-1. Since 480/960 kHz SCS for SSB are supported at least for non-initial access, 480/960 kHz PRACH should be supported in PHY specifications. Ok with sending LS to RAN2 on use case restrictions and discussing about it further in RAN1.  |
| Samsung | We support the proposal. We have a clarification question regarding the comment in the GTW. In our understanding, initial BWP configured in SIB1 can take a SCS of 480 kHz and 960 kHz, for both downlink and uplink cases, since the agreement of supporting 480 kHz and 960 kHz for data/control/RS didn’t specify its use cases. Then it would be straightforward to allow PRACH to use the same SCS as well.  |
| LG | Support the Proposal 2.1-1. Since 480/960 kHz SCS for SSB are supported at least for non-initial access, it is better to send LS to RAN2 in order to make further discussion and progress on RACH. |

#### **1st Round Discussion Summary:**

* TDB

### 2.2.2 PRACH Sequence and Format

* From [5] Nokia, NSB:
	+ Support L=139 for PRACH with 480kHz and 960kHz at above 52.6 GHz.
* From [6] Ericsson:
	+ Conclude that for PRACH with 480/960 kHz SCS, only L = 139 is supported, i.e., L = 571 and 1151 are not supported.
* From [7] CATT:
	+ Consider supporting increasing symbols in time domain to enhance PRACH coverage.
	+ Consider repeating and concatenating the PRACH preamble sequence to enhance PRACH coverage for unlicensed spectrum operation
* From [8] Qualcomm:
	+ consider only using PRACH sequence length = 139 for SCS = 480 kHz and 960 kHz
* From [9] OPPO:
	+ Sequence length L=571 and 1151 for PRACH when the SCS is 480kHz/960kHz are not needed.
* From [11] Intel:
	+ Optional support of PRACH formats A1~A3, B1~B4, C0, C2 for and with SCS 480 kHz and 960 kHz, i.e., .
* From [16] Samsung:
	+ Support short PRACH format for all PRACH sequence lengths and all SCSs , and don’t support long PRACH format.
* From [18] LGE:
	+ The 120 kHz PRACH SCS with sequence lengths L=571 and L=1151 are not required for the licensed spectrum where the regulatory requirements are not defined on PSD limit.
* From [21] Interdigital:
	+ For 52.6 – 71 GHz, the existing PRACH sequences with the existing PRACH sequence lengths 571 and 1151 should be reused.
* From [23] Sharp:
	+ Only support L = 139 for PRACH with 480kHz and 960 kHz SSB SCS.
* From [25] NTT Docomo:
	+ For PRACH sequence with 480/960 kHz SCS, at least L=139 should be supported.
		- Whether to support additional length (e.g., L=571 and/or 1151) should be discussed after receiving an LS reply from RAN4 on UE EIRP and conducted power in 52.6 – 71 GHz

#### Summary of Discussions

* Supported sequence lengths
	+ For 480/960kHz SCS PRACH (if agreed):
		- L=139: Ericsson, LGE, Nokia, NSB, OPPO, Qualcomm, Docomo (other lengths FFS)
		- L=139, 571, 1151: Intel, Samsung, Interdigital
* Supported PRACH formats:
	+ For 480/960kHz SCS PRACH (if agreed) support all existing formats, A1~A3, B1 ~B4, C0, C2:
		- Intel
* One company commented that PRACH length decision may need to wait for RAN4 reply LS on EIRP and max conducted power.
* Moderator suggest discussing further based on following proposal (as starting point):
	+ For 480/960kHz SCS PRACH (if agreed), only support L=139

#### **1st Round Discussion:**

Moderator suggest discussing on the following:

##### **Proposal 2.2-1)**

* For 480/960kHz SCS PRACH (if agreed), support all existing PRACH formats (A1~A3, B1 ~B4, C0, C2) with sequence length L = 139
	+ FFS: support for sequence length L = 571, and 1151

|  |  |
| --- | --- |
| **Company** | **Comment** |
| DOCOMO | We support the Proposal 2.2-1.  |
| Samsung | We are ok with the proposal.  |
| LG | We support the Proposal 2.2-1. |

#### **1st Round Discussion Summary:**

* TDB

### 2.2.3 RACH Occasion Resources

* From [1] Huawei, HiSilicon:
	+ Support maximum of 40 ms for ra-ResponseWindow for operation with shared spectrum and msgB-ResponseWindow for both operations with and without shared spectrum. Support indicating two LSBs of SFN at which gNB has received msg1 (msgA) in DCI format 1\_0 with CRC scrambled by RA-RNTI (msgB-RNTI).
	+ For operations with shared channel access in 52.6GHz to 71GHz spectrum, a gap symbol between consecutive ROs within the PRACH slot should be supported to avoid a LBT failure at the UE due to a PRACH transmission from another UE in the previous RO.
* From [3] vivo:
	+ For RO configuration for PRACH with 480/960kHz SCS:
	+ Reuse the exiting FR2 RACH configuration table and the location of duration containing PRACH slot pattern within 10ms is same as FR2.
	+ How to determine the RACH slot index:
		- Alt.1: Reuse the same reference slot as FR2 and maintain the same number of PRACH slots per reference slot.
		- Alt.2: Reuse the same reference slot as FR2 and increase the number of PRACH slots to more than 2 per reference slot.
		- Alt.3: Define a new reference slot and maintain the same number of PRACH slots per reference slot.
		- Alt.4: Define a new reference slot and increase the number of PRACH slots to more than 2 per reference slot.
		- Alt.5: Define different reference slot for different PRACH SCS and the number of PRACH slots within a reference slot is the same as FR2.
* From [5] Nokia, NSB:
	+ Reuse the existing FR2 RACH configuration table and PRACH slot(s) for 480 and 960 kHz are allocated with the following principles where the reference SCS is 60 kHz:
		- If “Number of PRACH slots within a 60 kHz slot” is 1, then there is one PRACH slot with 480 or 960 kHz SCS among the slots defined by the 60 kHz reference slot
		- If “Number of PRACH slots within a 120 kHz slot” is 2, then there are two PRACHs slot with 480 or 960 kHz SCS among the slots defined by the 60 kHz reference slot.
* From [6] Ericsson:
	+ For 480/960 kHz PRACH, support PRACH configurations that allow maintaining the same PRACH processing load (operations/unit time) as for 120 kHz PRACH configurations.
		- support configuration of PRACH occasion(s) in only 1 or 2 480/960 kHz slots within a 60 kHz reference slot.
	+ For 480/960 kHz PRACH, reuse the current PRACH configuration table in 38.211 for FR2 "as is." Specify rule for which 1 or 2 480/960 kHz slots within a 60 kHz reference slot are used depending on the value in the existing column "Number of PRACH slots within a 60 kHz slot" in the current PRACH configuration table. The rule should be common for all PRACH configurations in the table.
* From [7] CATT:
	+ For RO configuration support of 480/960 KHz, 120 KHz configuration can be reused for each 8/16 slots within the 60 KHz slot time.
* From [8] Qualcomm:
	+ a maximum of 4 and 2 FD multiplexed ROs for SCS = 120 kHz and sequence length = 571 and 1151, respectively
	+ for SCS = 120 kHz, if the maximum number of FD ROs are reduced, consider ways to increase the TD ROs (to maintain the same capacity) with minimal specification impact
	+ for higher RACH SCS (480 and 960 kHz), consider including a symbol-level gap between ROs to allow for gNB beam switching delay
	+ for higher RACH SCS (480 and 960 kHz), consider ways to support more than 2 RACH slots per RACH reference slot
* From [9] OPPO:
	+ Set the reference SCS for RACH slot determination as 120kHz.
	+ RAN1 should design a unified RO configuration for both licensed and unlicensed spectrums.
	+ On top of RO configuration, a mask can be further added for unlicensed spectrum to switch off certain RO from being selected.
* From [10] ZTE, Sanechips:
	+ Support the same RO configuration table as in Rel-15/16 with the same RO density as in PRACH SCS equals to 120KHz.
	+ Support 60kHz for reference slot as in FR2 with the less spec effort in beyond 52.6G.
* From [11] Intel:
	+ Regarding PRACH RO configurations for SCS 480 kHz and 960 kHz:
	+ The numerology for reference slot counting within a system frame remains corresponding to SCS 60 kHz;
	+ The max number of starting positions for PRACH slots within a reference slot (which has SCS 60 kHz) is equal to 2;
	+ Fix the starting position(s) of PRACH slots within the reference slot by properly setting the values of parameter n\_{slot}^{RA} (TS 38.211, Section 5.3.2).
		- The starting position(s) should be aligned with the SSB slot patterns in order to avoid systematic overlapping between SSBs and ROs.
	+ Reuse PRACH RO configurations listed in Table 6.3.3.2-4 from TS 38.211.
	+ For PRACH SCS 480 kHz and 960 kHz, introduce optional time gaps between consecutive ROs;
	+ Modify equation defining the first OFDM symbol of PRACH RO given Section 5.3.2 from TS 38.211 as follows:
		- ,
		- where is the gap duration (number of OFDM symbols) and for no gap.
* From [12] Fujitsu:
	+ Support RO configuration for non-consecutive ROs in time domain.
* From [13] Apple:
	+ Maximum 4 PRACH ROs can be configured for 120kHz SCS with L=571.
	+ Maximum 2 PRACH ROs can be configured for 120kHz SCS with L=1151.
	+ Reuse the existing FR2 PRACH configuration Table to indicate the time-domain PRACH slot location.
	+ Support to keep the same PRACH capacity as Rel-16 FR2 for 480kHz and 960kHz SCS to minimize the signaling overhead.
	+ The configured PRACH slots should be distributed over the 60kHz reference slot.
* From [16] Samsung:
	+ Using the RO pattern for SCS = 120 kHz derived from the PRACH configuration table as the reference for larger SCS cases.
	+ For RO configuration, both direction 1 (indication on which one(s) of the 8 eighty-slots or which one(s) of the eight 960 kHz ROs within a 120 kHz RO) and direction 2 (keep 80 slots in total but redesign the RACH period and RACH duration location) can be considered.
	+ Support non-consecutive RO configuration to alleviate the RACH LBT failure.
* From [18] LGE:
	+ If the reference slot SCS is kept as 60 kHz and the density of PRACH occasion is the same as in 120 kHz in the time-domain (e.g., 2 slots out of 8 slots for 480 kHz), the PRACH slot index for 480 and 960 kHz SCS can be determined based on the selected two values of with the pre-configured rule or based on the configured/indicated value(s) of by the gNB.
	+ If the reference slot SCS is kept as 60 kHz and the density of PRACH occasion is increased compared to 120 kHz in the time-domain, the additional PRACH slots for 480 and 960 kHz SCS can be indicated/configured by the parameter X to allocate the consecutive X slots before the last slot ( for 480 and 960 kHz SCS, respectively).
	+ When LBT is used to transmit the PRACH preamble, consider to insert CCA gap between adjacent RACH occasions in time domain (e.g. X usec or Y symbol) to avoid inter-UE LBT blocking due to the propagation delay of PRACH transmitted in an earlier RO.
* From [20] Xioami:
	+ Inconsecutive RO time domain configuration should be supported.
* From [21] Interdigital:
	+ For 52.6 – 71 GHz, supporting non-consecutive RACH occasions is not preferred.
* From [23] Sharp:
	+ Regarding PRACH configuration design for 480/960kHz SCS, reuse Table 6.3.3.2-4 (Random access configurations for FR2 and unpaired spectrum) in Rel-16 38.211 as much as possible. 60kHz reference slot should be also inherited.
	+ Regarding PRACH configuration design for 480/960kHz SCS, keep the same RO density and the same relative locations as PRACH configuration in Rel-16.
* From [25] NTT Docomo:
	+ For RO configuration for PRACH with 480/960 kHz SCS,
		- Support to specify only 480/960 kHz PRACH slot within a 120 kHz referenced slot in addition to the existing RO configuration in FR2.
			* The 120 kHz referenced slot should be determined based on the existing RO configuration specified in FR2
			* Only one 480/960 kHz PRACH slot within the 120 kHz referenced slot is sufficient.
		- No need to enhance RA-RNTI calculation for NR operation in 52.6 – 71 GHz

#### Summary of Discussions

* Companies have provided several detailed proposals. Most of the proposals are suggestions and answers to several sub-issues. Moderator suggest to continue discussion with the following question list, and try to resolve each question during the RAN1 meeting.
	+ RA response window size
	+ For 120kHz RO, whether (and how) to support gap for LBT (if needed)
	+ For 480/960kHz RO (if agreed), whether (and how) to support gap for LBT (if needed)
	+ For 480/960kHz RO (if agreed), whether (and how) to support gap for beam switching (if needed)
	+ How to determine the RACH slot index for 480/960kHz
	+ Supported RO density for 480/960kHz PRACH per reference slot
	+ SCS for reference slot for 480/960kHz PRACH RO
	+ Any changes/updates to starting symbol positions of PRACH slots within reference slot

#### **1st Round Discussion:**

* Companies are encouraged to provide inputs on the following questions
	+ Q1) RA response window size (e.g. 10msec, 20msec, etc)?
	+ Q2) For 120kHz RO, whether (and how) to support gap for LBT (if needed)
	+ Q3) For 480/960kHz RO (if agreed), whether (and how) to support gap for LBT (if needed)
	+ Q4) For 480/960kHz RO (if agreed), whether (and how) to support gap for beam switching (if needed)
	+ Q5) How to determine the RACH slot index for 480/960kHz
	+ Q6) Supported RO density for 480/960kHz PRACH per reference slot
	+ Q7) SCS for reference slot for 480/960kHz PRACH RO
	+ Q8) Any changes/updates to starting symbol positions of PRACH slots within reference slot

Moderator will try to formulate proposal based on inputs from the companies.

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| **Company** | **Comment** |
| DOCOMO | Q1) Same as FR2 would be sufficient. Q2 and Q3) Since Rel-16 NR-U did not introduce gap for LBT, we do not see the necessity for 60 GHz either. Q4) Depending on RAN4 LS reply. Q5) It should correspond to 120 kHz PRACH slot determined by FR2 RO configuration/ Q6) It should be the same as the one for 120 kHz PRACH RO per reference slot in FR2. Q7) either 60 kHz or 120 kHz. Slightly prefer 120 kHz SCS.Q8) we do not see the necessity to change anything on symbol position within reference slots.  |
| Samsung  | 1) configured by gNB, the value range can use the one from NRU Rel16 as starting point2) support, by indicating the RO to be used in one RACH slot, e.g., even or odd RO;3) and 4). Similar way as Q2;5) down select from two ways: one is scaling 10ms-120khz PRACH pattern to fit the 2.5ms-480khz/1.25ms-960khz and find which 2.5ms/1.25ms location in 10ms; the other is indicating the 480khz/960khz RO within a 120khz RO;6). keep it same as 120khz at least, FFS others7). 120khz8). FFS. It may be impacted by decision on above questions and we think it may not need discussion from reference slot level, we can discuss from RO with reference SCS.  |
| LG | Q1) We prefer to keep the RAR window size as 10ms.Q2 and Q3) The gap between the consecutive RO should be supported for 120/480/960 kHz SCS to avoid the inter-UE LBT blocking due to the propagation delay of PRACH transmitted in an earlier RO. The gap between the adjacent RACH occasions can be the fixed duration (e.g., X usec or Y symbol).Q4) It would be better to defer the related discussion until RAN4 respond to RAN1’s LS.Q5) If the reference slot SCS is kept as 60 kHz and the density of PRACH occasion is the same as in 120 kHz in the time-domain (e.g., 2 slots out of 8 slots for 480 kHz), the PRACH slot index for 480 and 960 kHz SCS can be determined based on the selected two values of with the pre-configured rule or based on the configured/indicated value(s) of by the gNB.Q6) The density of PRACH occasion can be the same as in 120 kHz (e.g., 2 slots out of 8 slots for 480 kHz) or can be increased compared to 120 kHz.Q7) Prefer 60 kHz and we would like to ask what is meaning of 120 kHz SCS reference slot to the proponent companies (i.e., what is the differences from 60 kHz SCS reference slot?).Q8) We do not see the necessity. |

#### **1st Round Discussion Summary:**

* TDB

### 2.2.4 RA Preamble ID calculation

* From [3] vivo:
	+ For larger PRACH SCS (480KHz/960KHz), the following options can be considered for RA-RNTI calculation:
		- Alt.1: Modify the RA-RNTI formula as following and introduce some contention resolution mechanism to resolve the conflict.
			* RA-RNTI = (1+s\_id+14×t\_id+14×X×f\_id +14×X×8×ul\_carrier\_id) mod A
		- Alt.2: Reuse the current RA-RNTI formula while introducing additional indicator field to indicate the time-frequency resource together with RA-RNTI.
		- Alt.3: Depending on the RO configuration pattern, reuse the RA-RNTI formula and express the slot indexes t\_id based on a new specific subcarrier spacing.
* From [5] Nokia, NSB:
	+ Reuse RA-RNTI formula defined for 120 kHz SCS also for the cases PRACH is configured with 480 or 960 kHz SCS where
		- s\_{id} assumes 480/960 kHz SCS
		- t\_{id} assumes 120 kHz SCS
* From [6] Ericsson:
	+ For 480/960 kHz PRACH, reuse the RA-RNTI expressions from Rel-15/16, with the additional statement that for 480/960 kHz PRACH, t\_id should be determined based on a subcarrier spacing of 120 kHz.
* From [7] CATT:
	+ For supporting Msg1 transmission with 480 KHz/960 KHz SCS, RA-RNTI is divided into two parts. One part of RA-RNTI is carried by DCI, and the remaining 16-bit of RA-RNTI could be used to scramble CRC of the DCI1. Two possible options are:
	+ Option A:
		- s\_id is the index of the first OFDM symbol of the PRACH occasion (0 ≤ s\_id < 14)
		- t\_id is the index of the first slot of the PRACH occasion in a system frame (0 ≤ t\_id < 640)
	+ Option B:
		- s\_id is the index of the first OFDM symbol of the PRACH occasion (0 ≤ s\_id < 14)
		- t\_id is the index of the first slot of the PRACH occasion in a system frame (0 ≤ t\_id < 640)
* From [10] ZTE, Sanechips:
	+ For higher PRACH SCS (480 and/or 960 kHz), consider the following options for RA-RNTI enhancements:
		- Option 1: Modification of t\_id, change the equation of RA-RNTI calculation, without additional signalling overhead
		- Option 3: Multiple RO blocks (segmented RO blocks) with indication. Reuse the same RA-RNTI equation in NR Rel-16, divide the system frame into N segments (each segment is 80 slots using the used SCS), and signal the segment index that transmit the preamble in the DCI.
* From [11] Intel:
	+ RA-RNTI computation equation should be adjusted to avoid overflow in case of PRACH SCS 480 kHz and 960 kHz;
	+ Support the following modified equation for RA-RNTI computation:
		- RA-RNTI = 1 + s\_id + 14 × floor(t\_id / ) + 14 × 80 × f\_id + 14 × 80 × 8 × ul\_carrier\_id,
		- where t\_id is based on the value of specified in clause 5.3.2 of TS 38.211.
* From [12] Fujitsu:
	+ If 480kHz/960kHz PRACH SCS is supported, the following should be considered to uniquely identify a RO:
		- When calculating RA-RNTI, t\_id is determined in a way that more than one slot can have the same t\_id; and
		- DCI scheduling RAR indicates the local index among the slots having the same t\_id.
* From [13] Apple:
	+ modifying the existing calculation equation to solve the RA-RNTI overflowing problem:
* From [18] LGE:
	+ If the reference slot SCS remains as 60 kHz and the density of PRACH occasion is the same as in 120 kHz in the time-domain (e.g., 2 slots out of 8 slots for 480 kHz), the existing RA-RNTI/MSGB-RNTI equation can be reused for 480 and 960 kHz SCS by reinterpreting the slot indexes t\_id based on a new specific subcarrier spacing as the slot indexes of 120 kHz SCS (e.g., floor(t\_id/n) where n=4 for 480 kHz SCS and n=8 for 960 kHz).
	+ If the reference slot SCS remains as 60 kHz and the density of PRACH occasion is increased compared to 120 kHz in the time-domain, to calculate RA-RNTI/MSGB-RNTI associated with the PRACH occasion for 480 and 960 kHz SCS using the existing RA-RNTI equation, the following options can be considered:
		- Option 1: Divide the RAR window into N sub-periods (where each sub-period is 80 slots using the used SCS) + signal the sub-period index using the DCI that schedules the MSG2/MSGB.
		- Option 2: Divide the frequency index or the symbol index into M subset (if M=4, the subset index 0/1/2/3 can be configured to the frequency index {0, 1}, {2, 3}, {4, 5}, {6, 7}, respectively) + signal the subset index using the DCI that schedules the MSG2/MSGB
* From [23] Sharp:
	+ Assuming RO density per reference slot is unchanged, without modifying the formula and definition of s\_id. Modify the definition of t\_id as the slot index referring to 120kHz SCS.

#### Summary of Discussions

* In case 480/960 kHz SCS is supported for PRACH, it was identified existing RA-RNTI calculation will have overflow issue. One of more of the following options were considered by companies to resolve this issue.
	+ Option 1) Modify the RA-RNTI formula as following and introduce some contention resolution mechanism to resolve the conflict.
		- RA-RNTI = (1+s\_id+14×t\_id+14×X×f\_id +14×X×8×ul\_carrier\_id) mod A
	+ Option 2) multiple RO blocks (segmented RO blocks) with indication in RAR
	+ Option 3) update how t\_id, s\_id is determined (t\_id computed based on 120kHz, s\_id computed based on 480/960kHz)
	+ Option 4) modulous operation on whole RA-RNTI
	+ Option 5) modulous operation on t\_id
	+ Option 6) scaled and floored operation on t\_id (e.g. floor(t\_id / ))
* Moderator suggest if single solution is not agreeable, then to refine the different options (describe more precisely) and list all options for down-select in the future RAN1 meeting.

#### **1st Round Discussion:**

Moderator would like to ask companies to precisely list the solutions that companies are considering. Moderator will capture them as options for down-select in future RAN1 meeting.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| DOCOMO | Support Option 3.  |
| LG | We support the Option 3) and Option 6). |

#### **1st Round Discussion Summary:**

* TDB

### 2.2.5 Other aspects on PRACH

* From [5] Nokia, NSB:
	+ Support SCSe for PRACH transmissions and consider how gNB can control use of SCSe for PRACH transmissions so that the maximum limit for the SCSe transmissions can be kept
	+ If LBT gaps are needed between ROs, it would be better to define fixed LBT gap time between valid ROs that do not depend on the time domain allocation of the PRACH. In that case the LBT gap length would not depend on the used PRACH format.
* From [11] Intel:
	+ Consider applying short control signal exemption to PRACH transmission by the UE.

#### Summary of Discussions

* Companies have provided discussion on considerations for PRACH design. The discussion includes, application of short control signal exemption for PRACH, and enable/disable of LBT for PRACH.

#### **1st Round Discussion:**

Moderator suggest to discuss the application of short control signal exemption in channel access agenda. If there are any other issues related to PRACH that requires discussion, please provide suggestions and inputs below.

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

#### **1st Round Discussion Summary:**

* TDB

# Summary of Agreements/Conclusions in RAN1 #105-e

TBD

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