**3GPP TSG RAN WG1 Meeting #104-bis-e R1-2103802**

**e-Meeting, April 12 – 20, 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 April 20, 2021.

* [104b-e-NR-52-71GHz-01] Email discussion/approval on initial access aspects with checkpoints for agreements on Apr-15, Apr-20 – Daewon (Intel)

# Summary of issues

## 2.1 SSB Aspects

### 2.1.1 Supported Numerology

* From [1] Huawei, HiSilicon:
  + SCSs other than 120 kHz are not supported for SSB.
  + Reuse SSB pattern case D for 120 kHz SCS for both operations with and without shared spectrum channel access.
* From [2] 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 [3] Spreadtrum:
  + SSB with 480/960kHz SCS can be supported for connected mode UE.
* From [4] vivo:
  + Support SCS 120KHz, 480KHz and 960KHz for initial DL BWP in NR operation from 52.6-71GHz.
  + Support the following SCS pairs for SSB and initial DL BWP in NR operation from 52.6-71GHz：(120K, 120K) + (960K, 480K) + (960K, 960K)
  + The design of SSB and PRACH should be consistent for initial access and non-initial access.
* From [5] Nokia, Nokia Shanghai Bell:
  + Support of 480kHz and 960kHz kHz SCS for the SSB transmission in NR bands ranging between 52.6 GHz to 71 GHz.
  + Support of 480kHz and 960kHz kHz SCS SSB transmission in NR bands ranging between 52.6 GHz to 71 GHz at least for “non-intial access” scenarios, covering both CONNECTED mode and IDLE/Inactive mode. Consider support for “intial access” (initial cell selection) case as well if UE complexity can be mitigated.
  + Support 240 kHz SCS for the SSB transmission in NR bands ranging between 52.6 GHz to 71 GHz.
* From [6] CATT:
  + Support 480kHz and 960kHz SSB SCS for non-initial access cases
  + Further study is needed before RAN1 conclude to support 480 kHz and 960 kHz for initial access.
* From [7] MediaTek:
  + The SCS of SSB and initial BWP should be both 120 kHz to prevent the timing error from mixed numerology in idle mode.
* From [8] Fujitsu:
  + In addition to 120kHz, support 480 kHz and 960 kHz for SSB for initial access and other cases.
* From [9] Futurewei:
  + Support only 120kHz SCS for initial channel access dedicated SSB (i.e. SSB with MIB that indicates that the CORESET for Type0-PDCCH CSS set is present). Support adding higher SCS (480 kHz and 960 kHz) for non-initial access SSBs.
* From [10] Ericsson:
  + For cases other than initial access (e.g. for an SCell / PSCell), support 480 and 960 kHz SCS for SS/PBCH block.
  + Like for FR2 in Rel-15/16, for initial access (PCell), support the following SCS combination in an initial BWP: 240 kHz SCS for SS/PBCH block + 120 kHz SCS for initial access related signals/channels.
* From [11] Xiaomi:
  + At least for SSB after initial access, 480 kHz and 960 kHz SCS should be supported.
  + Beyond 120k Hz SCS，at least one of 240/480/960 kHz SCSs can be configured for cell defined SSB.
* From [12] Lenovo, Motorola Mobility:
  + For supporting NR from 52.6 GHz to 71 GHz in Rel. 17, support the same numerology of data channel for SSB including 480kHz and 960kHz for both initial access and non-initial access cases.
* From [13] Intel:
  + Support 480 kHz and 960 kHz SCS for SSB and initial BWP.
  + Support Type0-PDCCH configuration indication in MIB of SSB for all supported SSB SCS.
* From [14] Apple:
  + If additional SCS is supported for initial access, only consider 480kHz SCS.
* From [15] Qualcomm:
  + For the SSB for NR operation in the frequency between 52.6GHz and 71GHz:
    - Use SCS = 120 kHz and 240 kHz for SA mode (initial access)
    - Use SCS = 120 kHz, 240 kHz, 480 kHz, and 960 kHz for NSA mode (non-initial access where timing and frequency are known)
* From [16] Samsung:
  + Support 480 kHz and 960 kHz SCS for SS/PBCH block in both initial access and non-initial access cases.
* From [17] Sony:
  + 480 kHz and 960 kHz SCS for SSB should be supported for NR above 52.6 GHz.
* From [18] LGE:
  + Support 240 kHz SCS for SS/PBCH block in frequency range from 52.6 GHz to 71 GHz.
  + For SS/PBCH block with 480 and/or 960 kHz SCS, the following three alternatives can be taken into account and Alt 3 is preferred considering no specification impact and CSI-RS as an alternative of SS/PBCH block in most use cases.
    - Alt 1: Support SS/PBCH block with 480 and/or 960 kHz SCS for all cases, if supported, reuse one of legacy SS/PBCH block patterns (e.g., SS/PBCH block Case D)
    - Alt 2: Support SS/PBCH block with 480 and/or 960 kHz SCS for cases other than initial access, if supported, reuse one of legacy SS/PBCH block patterns (e.g., SS/PBCH block Case D)
    - Alt 3: Do not support SS/PBCH block with 480 and/or 960 kHz SCS for any case
* From [19] Convida Wireless:
  + The support of SSB and SSB burst design for higher SCS like 480 KHz and above should be considered for NR operation from 52.6 to 71 GHz.
* From [20] AT&T:
  + Specify one additional SCS (either 480kHz or 960kHz) for initial access related signals and channels in the initial BWP.
  + The same subcarrier spacings are specified for initial access related signals and channels in the initial BWP and cases other than initial access.
* From [21] Interdigital:
  + Further study necessity of SSBs and initial access related signals/channels for additional SCSs in Rel-17.
* From [22] Sharp:
  + Support 480 kHz and/or 960 kHz at least for SSB of non-initial access case.
* From [23] ZTE, Sanechip:
  + The following options can be considered for determining SCSs of SSB and other initial access signals/channels in initial BWP, wherein Option 1 is preferred.
    - Option 1: both SSB and other initial access signals/channels support SCS (120kHz, 480kHz, 960kHz)
    - Option 2: SSB supports SCS (120kHz, 240kHz); Other initial access signals/channels support SCS (120kHz)
  + Regardless of SSB SCSs 480/960 kHz are supported only in non-initial access case or in both initial and non-initial access cases, the SSB design should not impact on supporting ANR function and CGI reporting.
* From [25] NTT Docomo:
  + For SSB SCS, in addition to 120 kHz:
    - 480 and/or 960 kHz SCS should be supported for initial access case.
    - 480 and 960 kHz SCS should be supported for non-initial access cases.
    - 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 which SCS should be supported for SSB (in addition to 120 kHz)
  + No other SCS:
    - Huawei, HiSilicon, MediaTek, Futurewei
  + 240 kHz:
    - LGE, Qualcomm (in addition to 480/960kHz), ZTE(2nd preference), Sanechip (2nd preference)
  + 480kHz:
    - Apple, Convida
  + Either 480kHz or 960kHz:
    - AT&T, Sharp, NTT Docomo (for initial access)
  + Both 480 kHz/960kHz:
    - OPPO, Spreadtrum (connected mode), vivo, Nokia, Nokia Shanghai Bell, CATT (non-initial access), Fujitsu, Ericsson (non-initial access), Xiaomi, Lenovo, Motorola Mobility, Qualcomm (non-initial access), Samsung, Sony, [Convida?], Sharp, ZTE, Sanechip, NTT Docomo (non-initial access)
* It was last RAN1 meeting to conclude on this issue, therefore moderator suggest to try to conclude on this issue first during the first week of RAN1 meeting. There are several other issues that are dependent on this decision.

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

In the Tuesday GTW session, the following was agreed.

Agreement:

* For the case where SSB location and SCS are explicitly provided to the UE (non-initial access) and SSB does not configure Type-0 PDCCH, support 480 kHz and 960 kHz numerologies for the SSB
  + Note: Strive to minimize specification impact due to the new SCS for SSB

Based on the discussions during GTW, RAN1 should try to conclude on the rest of the cases that is not covered by the agreement in the GTW session during this meeting. As such, moderator asks companies to comment on the following:

* Whether or not following case(s) are supported:
  + Case A) For non-initial access case, a SSB with 480 kHz and 960kHz SCS and Type0-PDCCH configuration in the MIB.
  + Case B) Support SSB with 480 kHz and 960 kHz SCS for initial access case (where UE is not explicitly provided with center frequency and SCS of SSB). In this case, it is assumed initial access SSB with 480kHz and 960kHz SCS will support Type0-PDCCH configuration in the MIB.
  + Case C) Support SSB with 240 kHz SCS for initial access case (where UE is not explicitly provided with center frequency and SCS of SSB). In this case, it is assumed initial access SSB with 240Hz SCS will support Type0-PDCCH configuration in the MIB.

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| **Company** | **Comment** |
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#### **1st Round Discussion Summary:**

The following is a summary of 1st round discussion by the moderator.

* TBD

### 2.1.2 DRS Related Aspects (including potential use of Short Signal Exemption for SSB)

* From [1] Huawei, HiSilicon:
  + Support discovery burst and discovery burst transmission window for operations in shared spectrum in 52.6GHz to 71GHz. Discovery burst includes SSB, CORESET#0, PDSCH carrying RMSI and non-zero power CSI-RS.
  + Use the following method to implicitly indicate that DBTW is enabled/disabled for both IDLE and CONNECTED mode UEs:
    - If DBTW length is equal to or smaller than the time duration from the beginning of the half frame to the end of the slot containing the candidate SSB index N\_SSB^QCL-1, DBTW is disabled.
    - If DBTW length is larger than the time duration from the beginning of the half frame to the end of the slot containing the candidate SSB index N\_SSB^QCL -1, DBTW is enabled.
  + Three bits are used to indicate in shared spectrum in 52.6GHz to 71GHz: One bit from subCarrierSpacingCommon in MIB, One bit from ssb-SubcarrierOffset in MIB, and one bit from searchSpaceZero in pdcch-ConfigSIB1 in MIB.
  + DBTW with values {0.5ms, 1ms, 2ms, 2.5ms, 3ms, 4ms, 5ms} is supported in shared spectrum in 52.6GHz to 71GHz and is configured in ServingCellConfigCommonSIB.
* From [2] 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.
  + DB is not supported.
* From [3] Spreadtrum:
  + If Cat-2 LBT is supported, DB can be supported.
  + DBTW can be supported.
* From [4] vivo:
  + Type0-PDCCH, SIB1 and CSI-RS should be included in DB other than SSB for NR operation from 52.6 GHz to 71 GHz.
  + 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 [5] Nokia, Nokia Shanghai Bell
  + Support operation with and without DBTW for initial access.
  + Apply Short Control Signal exemption (SCSe) at least for SSB.
  + Consider SCSe limitation in DBTW procedure to enable fair transmission opportunities for all SSBs.
  + If DBTW assumption can be changed, it should be available to the UE starting from initial cell selection.
* From [6] CATT:
  + For NR operation in unlicensed spectrum in 52.6-71 GHz, the discovery burst (DB) and 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 480KHz/960KHz SCS since the duty cycle is less than 6% over 100 ms observation window of the short control signaling transmissions constraint.
  + 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 additional bit(s) for the extension of SSB candidate index need to be further study.
  + How to perform DBTW shall be further studied if the actual number of SSB transmissions is more than 56 with the potential extension to have maximum number of candidate SSB position up to 80.
* From [7] MediaTek:
  + Candidate positions of SSB should not be increased if additional bits are required.
* From [9] Futurewei:
  + Support DBTW for 60 GHz unlicensed spectrum. The DBTW may be disabled or enabled by the gNB.
  + Signaling to UEs to indicate that DBTW is enabled and disabled should be supported.
  + Use the NR-U DBTW design as basis for DBWT in 60 GHz design.
  + Consider using CSI-RS presence in the discovery burst for possible ways to do beam refinement during the initial channel access.
* From [10] Ericsson:
  + Reuse the definition of the Rel-16 discovery burst (DB) also for the 52.6-71 GHz frequency range.
* From [11] Xiaomi:
  + Discovery burst transmission window should be supported similarly as in Rel\_16.
* From [12] 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 [13] Intel:
  + At least for SSB SCS 120 kHz, support SS burst as DRS (discovery burst):
  + Increase the number of candidate SSB indices up to 80, i.e., ;
  + 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.
* From [14] 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 [15] Qualcomm:
  + for an unlicensed band that requires LBT, do not support discovery burst (DB) or discovery burst transmission window (DBTW) for SSB
  + 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
* From [16] Samsung:
  + Support discovery burst transmission window for 60 GHz unlicensed band.
    - The content of discover burst at least include the same components as Rel-16 NR-U;
    - 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;
    - Current PBCH payload can support timing indication of up to 128 candidate SS/PBCH block candidate locations;
    - 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] Sony:
  + Discovery burst and discovery burst transmission window should be supported at least for 120 kHz SSB SCS.
  + Up to 80 candidate SSB position should be supported for 120 kHz SSB SCS.
    - Lower value of QCL relations (e.g. 1, 2, 4) is not necessary to introduce for 60 GHz unlicensed operation.
    - When {SS/PBCH Block, CORESET#0 for Type0-PDCCH} SCS equal to {120, 120} kHz, reserved state could be utilized for indication of candidate SSB indices and QCL relation.
    - If 480 kHz and 960 kHz SSB SCS is supported for initial access case, subCarrierSpacingCommon could be utilized for indication of candidate SSB indices and QCL relation.
* 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 of ssb-SubcarrierOffset
    - dmrs-TypeA-Position
  + Discuss how to signal actually transmitted SSBs via ssb-PositionsInBurst when less than 64 can be indicated in MIB.
* From [19] Convida Wireless:
  + Increasing the number of SSB candidate positions to above 64 to increase transmission opportunities to cope with LBT failure should be considered.
* 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.
  + 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] ZTE, Sanechip:
  + Discovery burst (DB) and discovery burst transmission window (DBTW) should be supported for 120 kHz SSB SCS and other SSB SCSs if they are agreed to be supported.
  + A discovery burst (DB) in Rel-17 NR above 52.6 GHz includes at least an SSB and may also include RMSI-CORESET, RMSI-PDSCH and/or NZP CSI-RS.
  + 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 limited to 128 or kept unchanged (maintain 64) for 240/480/960 kHz SSB SCS.
  + 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 [24] NEC:
  + DBTW should be supported at least for 120 kHz SSB SCS in mmWave unlicensed band that requires LBT.
  + Discovery burst (DB) in mmWave operation should include CORESET#0 for PDCCH scheduling PDSCH with SIB1, PDSCH carrying SIB1 and/or non-zero power CSI-RS at least.
  + 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.
  + 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.
* From [26] WILUS:
  + It seems beneficial to introduce discovery burst (DB) and discovery burst transmission window (DBTW) by defining candidate SSB positions within the DBTW.
  + To maintain commonality and minimum of specification impacts for NR operation in both licensed band and an unlicensed band of 60GHz, we propose not to change the first symbol indexes for candidate SS/PBCH blocks as defined in FR2 and not to change SSB pattern with 120kHz SCS within a slot.
  + 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**

* Discovery burst (DB) and discovery burst transmission window (DBTW) for SSB
  + Do not support DB or DBTW
    - CATT (for 480/960kHz), Qualcomm
  + Support DB or DBW
    - Huawei, HiSilicon, OPPO, Spreadtrum, vivo, Nokia, Nokia Shanghai Bell, CATT (only for 120kHz SSB), Ericsson, Xiaomi, Lenovo, Motorola Mobility, Intel, Apple, Samsung, Sony, LGE, Interdigital, ZTE(120kHz), Sanechip (120kHz), NEC (at least for 120kHz), WILUS
* Configuration of DB/DBTW
  + Enable configuration: OPPO, Huawei HiSilicon, Futurewei, Samsung, LGE
    - Method of configuration: implicit, explicit

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

Companies are asked to revise and update the company preferences, now that RAN1 has agreed to support 480kHz and 960kHz SCS SSB for non-initial access cases with Type0-PDCCH not configured in MIB.

Please also clarify whether **support of DB of DBTW** is **specific to specific SSB SCS.**

* Discovery burst (DB) and discovery burst transmission window (DBTW) for SSB
  + Do not support DB or DBTW
    - *CATT (for 480/960kHz), Qualcomm*
  + Support DB or DBW
    - *Huawei, HiSilicon, OPPO, Spreadtrum, vivo, Nokia, Nokia Shanghai Bell, CATT (only for 120kHz SSB), Ericsson, Xiaomi, Lenovo, Motorola Mobility, Intel, Apple, Samsung, Sony, LGE, Interdigital, ZTE(120kHz), Sanechip (120kHz), NEC (at least for 120kHz), WILUS*
* Configuration of DB/DBTW
  + Enable configuration of DB/DBTW (either using implicit or explicit methods):
    - *OPPO, Huawei HiSilicon, Futurewei, Samsung, LGE*
  + Do not enable configuration of DB/DBTW (always support):
    - *??*

*Moderator will provide a suggested proposal based on feedback by UTC 03:00am April 14.*

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| **Company** | **Comment** |
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#### **1st Round Discussion Summary:**

The following is a summary of 1st round discussion by the moderator.

* TBD

### 2.1.3 SSB Resource Pattern

* From [2] OPPO:
  + Wait for RAN4 response before further discuss beam switching gap issue.
* From [3] Spreadtrum:
  + The legacy pattern for SSB with 120kHz SCS, i.e. Case D, can be considered.
  + The new pattern for SSB with 120kHz SCS, e.g. Case A/C for SSB with 15/30kHz SCS, can be also considered.
  + 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.
* From [4] vivo:
  + 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;
    - Alt. 3: Hopping transmission for contiguous candidate SSBs.
* From [5] Nokia, Nokia Shanghai Bell:
  + Keep the SS/PBCH block design unchanged for all sub-carrier spacings.
  + One-shot LBT within COT is not required before gNB beam switch between SSBs.
* From [10] Ericsson:
  + Use the FR2 Case D pattern for time domain pattern for SSB transmissions with 480 kHz and 960 kHz SCS.
* From [12] Lenvo, 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 [13] Intel:
  + Consider SSB pattern in a slot with 3 SSB containing slots 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.
  + Consider 480 kHz and 960kHz SCS based SSB positions in a slot with SSB symbols 2, 3, 4, 5 and 9, 10, 11, 12 in a slot.
    - Note: symbols numbers are enumerated from 0.
* From [14] 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] 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 [16] Samsung:
  + Support new SS/PBCH block patterns 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 same SCS as SS/PBCH block.
    - SS/PBCH block candidate locations in a slot for Case A can be reused.
* From [23] ZTE, Sanechip:
  + 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
* 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 [26] 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**

* For the not yet specified SSB SCS (i.e. 480 and 960 kHz), several companies provided proposals on which OFDM symbols and slots the SSB should be mapped on.
* For 120 kHz SSB SCS, few companies suggested to update the SSB pattern (OFDM symbols and slots SSB is defined for).
* Suggest discussing first supported SSB numerology.

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

Moderator would like to receive comments on SSB resource pattern aspects, based on latest RAN1 agreement on support of SSB with 480kHz and 960kHz SCS (at least) for non-initial access without Type0-PDCCH configuration in MIB.

More specifically, please provide further feedback on the following:

* Whether any change is needed to SSB resource pattern (symbol positions, and slots positions in time domain) for 120kHz SCS.
* SSB resource pattern for 480kHz.
* SSB resource pattern for 960kHz.

*Moderator will provide a suggested proposal based on feedback by UTC 03:00am April 14.*

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| **Company** | **Comment** |
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#### **1st Round Discussion Summary:**

The following is a summary of 1st round discussion by the moderator.

* TBD

### 2.1.4 CORESET#0 Configuration

* From [1] 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 operations in 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 k\_SSB=0 (k\_SSB>0) for multiplexing pattern 3.
* From [4] vivo:
  + The following SSB-Coreset 0 multiplexing patterns are supported for each SCS pair:
    - (120K, 120K): 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 is occupy as much bandwidth as possible in the frequency domain.
* From [5] Nokia, Nokia Shanghai Bell:
  + 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 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 N\_{RB}^{CORESET}={96} in addition to N\_{RB}^{CORESET}={24, 48}.
  + For SSB and CORESET#0 with 480kHz sub-carrier spacing, support following options:
    - For multiplexing pattern1 N\_{symb}^{CORESET}={[1],2, 3}
    - For multiplexing pattern3 N\_{symb}^{CORESET}={1, 2}
  + For CORESET#0 with 480kHz sub-carrier spacing, support N\_RB^CORESET={24, 48}.
  + For SSB and CORESET#0 with 960kHz sub-carrier spacing, support for multiplexing pattern 1 N\_{symb}^{CORESET}={2, 3}.
  + For CORESET#0 with 960kHz sub-carrier spacing, support N\_RB^CORESET={24}.
  + For SSB with 240kHz sub-carrier spacing and CORESET#0 with 120kHz sub-carrier spacing, support following options:
    - N\_symb^CORESET={1, 2}
    - N\_RB^CORESET={24, 48}
* From [6] CATT:
  + While 480 kHz and 960 kHz SCS are introduced, the 1bit indication in MIB provides the information of Type0-PDCCH SCS along with the detected SSB SCS in a given band in 52.7 -71 GHz ,
  + Proposal 8: Patterns 2 and 3 of SSB and CORESET for Type0-PDCCH can multiplex with periodic CSI-RS/paging PDCCH&PDSCH in frequency.
* From [9] Futurewei:
  + Support SSB and CORESET#0 multiplexing pattern 1 (different slots), and pattern 3 (same slots).
* From [10] Ericsson:
  + For the case when {SS/PBCH block, PDCCH} SCS is {120, 120} kHz, Table 13.8 in 38.213 can be used for operation in 57 – 71 GHz.
  + For the case when {SS/PBCH, PDCCH} SCS is {240, 120} kHz, Table 13-10 in 38.13 can be used for operation in 57 – 71 GHz.
* From [11] Xiaomi:
  + SSB and CORESET0 multiplexing cconfiguration tables need update to support additional SCS for NR from 52.6GHz to 71 GHz.
* From [13] Intel:
  + Support Type0-PDCCH configuration indication in MIB of SSB for all supported SSB SCS.
  + Consider only SSB and CORESET#0 multiplexing pattern 1 for 480 and 960 kHz SCS.
  + Consider only same SCS for SSB and CORESET#0 (configured by MIB) for 480 and 960 kHz SCS.
  + Type0-PDCCH CSS may utilize symbols {0,1} and {7,8} that correspond to SSB in the first half and second half of the slot.
* From [15] Qualcomm:
  + Consider the following SSB and CORESET0 SCS combinations:
    - SSB SCS = 120 kHz, CORESET0 SCS = 120, 480, 960 kHz
    - SSB SCS = 240 kHz, CORESET0 SCS = 120, 480, 960 kHz
    - SSB SCS = 480/960 kHz, CORESET0 SCS = SSB SCS
  + 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: reuse the same design as in NR Rel-16
    - For the 120 kHz + 480/960 kHz combination: 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 [16] Samsung:
  + For COREST#0,
    - if synchronization raster interval is larger than FR2, additional CORESET#0 RB offsets are needed for 120 kHz SS/PBCH block SCS;
    - if 480 kHz and/or 960 kHz SS/PBCH block SCS is supported, at least CORESET#0 configuration table with same SCS as SS/PBCH block should be supported;
    - if there are reserved configurations, both multiplexing Pattern 2 and Pattern 3 can be supported in a CORESET#0 configuration table;
    - if CORESET#0 bandwidth can be increased, 96 RB can be added to the CORESET#0 configuration table for 120 kHz SS/PBCH block SCS.
* From [21] Interdigital:
  + Introduce the enhancements on SS/PBCH block transmission patterns to deliberately include the CORESET#0 and sib1 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 [23] ZTE, Sanechip:
  + 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
* 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 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] 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**

* Supported SCS for Type0-PDCCH/CORESET#0 indicated by MIB
  + With 120kHz SSB:
    - 120kHz SCS for Type0-PDCCH: Intel, ZTE, Sanechip, Huawei, vivo, Ericsson
    - 120kHz, 480kHz, 960kHz SCS for Type0-PDCCH: Qualcomm
  + With 240kHz SSB (if agreed):
    - 120kHz SCS for Type0-PDCCH:
    - 120kHz, 480kHz, 960kHz SCS for Type0-PDCCH: Qualcomm
  + With 480 kHz SSB (if agreed):
    - 480kHz SCS for Type0-PDCCH: Qualcomm, Intel, Nokia, Nokia Shanghai Bell, Samsung, ZTE, Sanechip
  + With 960 kHz SSB (if agreed):
    - 960kHz SCS for Type0-PDCCH: Qualcomm, Intel, Nokia, Nokia Shanghai Bell, Samsung, ZTE, Sanechip
    - 480kHz and 960 kHz SCS for Type0-PDCCH: vivo
* For the specific {SSB, Type0-PDCCH} SCS pair, supported CORESET#0 PRB size, and supported SSB/CORESET#0 multiplexing pattern
  + Further discussion needed based on supported SCS pair(s).

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

Given that discussion on whether Type0-PDCCH configuration will be supported for SSB with 480kHz and 960kHz SCS is under discussion and discussion on whether 240kHz will be supported is also under discussion, moderator suggest to first focus on Type0-PDCCH configuration for SSB with 120kHz SCS.

Please provide inputs on the following:

* For SSB with 120kHz,
  + SCS for CORESET#0
    - Alt 1) Only support 120kHz Type0-PDCCH (current specification)
    - Alt 2) support 120kHz, 480kHz, and 960kHz Type0-PDCCH
  + Any changes to Type0-PDCCH configuration (other than Offset RB)
    - Alt 1) support all existing combinations of SSB/COREST multiplexing pattern, and number of RB and symbols for CORESET.
      * {mux pattern 1, 24 PRB CORESET, 2 symbol CORESET}
      * {mux pattern 1, 48 PRB CORESET, 1 symbol CORESET}
      * {mux pattern 1, 48 PRB CORESET, 2 symbol CORESET}
      * {mux pattern 3, 24 PRB CORESET, 2 symbol CORESET}
      * {mux pattern 3, 48 PRB CORESET, 2 symbol CORESET}
    - Alt 2) other options {companies to provide details}
    - Alt 3) …

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| **Company** | **Comment** |
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#### **1st Round Discussion Summary:**

The following is a summary of 1st round discussion by the moderator.

* TBD

### 2.1.5 Various other aspects on SSB Design

* From [3] Spreadtrum:
  + The SSB-based TRS/CSI-RS validation can be considered to be supported.
* From [4] 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 [9] Futurewei
  + The UE LBT channel access operation in 60 GHz unlicensed spectrum may be disabled by the gNB when LBT operation is not mandated by the spectrum regulations.
* From [10] Ericsson:
  + Consistent with EN 302 567, when operating in LBT mode a node can access the channel without LBT for control signal/channel transmissions, the total duration of which shall not exceed 10ms within an observation period of 100ms. The following signals/channels shall be classified as Short control signaling transmissions:
    - a. Discovery burst (as defined in Rel-16)
    - b. msg1 and msg3 for the 4 step RACH and MsgA for the 2-step RACH
    - c. FFS: Other control transmissions not multiplexed with user data (subject to gNB configuration)
* From [13] Intel:
  + While SSB may be considered as a candidate for short control signal exemption, RAN1 specification shall support operations of SSB transmission with LBT (at the gNB) and discovery burst (DS) at least for 120 kHz SSB.
    - For SSB with larger SCS, consider further supporting operations of SSB transmission with LBT (at the gNB) for commonality with 120 kHz SSB.
  + Send LS to RAN4 asking them to clarify sync raster and channel raster relationship for NR extension from 52.6 GHz up to 71 GHz.
* From [15] 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 [19] Convida Wireless:
  + SSB coverage enhancement should be studied for higher SCS if it is supported.

**Summary of Discussions**

* Companies have provided discussion on considerations for SSB design. The discussion includes, support of 5 msec SSB periodicity as default value, LBT operation control, application of short signal exemption for DB, TRS availability for time error correction, and SSB coverage enhancements.
* Suggest discussing these issues further.

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

Please provide suggestions on proposal(s) companies would like to discuss on SSB that is not covered by other discussions. Once the proposals are provided, moderator will copy the proposal and present in the discussion document to further request input/feedback from companies.

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| **Company** | **Comment** |
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#### **1st Round Discussion Summary:**

The following is a summary of 1st round discussion by the moderator.

* TBD

## 2.2 PRACH Aspects

### 2.2.1 Supported PRACH Numerology

* From [1] Huawei, HiSilicon:
  + For PRACH and Msg3 in initial UL BWP, only 120 kHz should be used in 52.6GHz to 71GHz spectrum.
* From [4] vivo:
  + Support 120KHz, 480KHz and 960KHz as candidate SCS of initial UL BWP.
  + The design of SSB and PRACH should be consistent for initial access and non-initial access.
* From [5] Nokia, Nokia Shanghai Bell:
  + 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 [8] Fujitsu:
  + In addition to 120kHz PRACH SCS with sequence length L=139, 571 and 1151, support at least 480kHz and 960kHz for PRACH SCS with sequence length L=139 for initial access and other cases.
* From [10] Ericsson:
  + Proposal 8 For cases other than initial access (e.g. for a SCell or PSCell), if SS/PBCH block with 480 and 960 kHz SCS is supported, support PRACH with the same SCS as the UL BWP.
* From [13] Intel:
  + Support 480 kHz and 960 kHz SCS for PRACH in NR extension up to 71 GHz.
* From [14] Apple:
  + If 480kHz and 960kHz SCS are used for PRACH transmission, support L=139 only.
* From [15] Qualcomm:
  + consider only using PRACH sequence length = 139 for SCS = 480 kHz and 960 kHz
* From [18] LGE:
  + If 480 and/or 960 kHz SCS PRACH is supported, support only the sequence length L=139 for the cases other than initial access (e.g., for SCell).
* From [21] Interditigal:
  + Further study necessity of PRACH for additional SCSs in Rel-17.
* From [22] Sharp:
  + Support 480 kHz and/or 960 kHz SCS for PRACH.
* From [23] ZTE, Sanechip:
  + Support additional SCSs (480kHz and/or 960kHz) for PRACH and SSB if single subcarrier spacing is supported.

**Summary of Discussions**

* Companies provided proposals on supported SCS for PRACH.
  + Support only 120kHz
    - Huawei, HiSilicon
  + Support 120, 480, 960 kHz
    - vivo, Nokia, Nokia Shanghai Bell, Fujitsu, Ericsson, Intel, Qualcomm, Apple, ZTE, Sanechip
* Some companies mentioned the SCS selection for PRACH should be aligned with SCS selection for SSB.

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

Companies are asked to revise and update the company preferences, now that RAN1 has agreed to support 480kHz and 960kHz SCS SSB for non-initial access cases with Type0-PDCCH not configured in MIB.

* Support only 120kHz
  + *Huawei, HiSilicon*
* Support 120, 480, 960 kHz
  + *vivo, Nokia, Nokia Shanghai Bell, Fujitsu, Ericsson, Intel, Qualcomm, Apple, ZTE, Sanechip*

*Moderator will provide a suggested proposal based on feedback by UTC 03:00am April 14.*

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| **Company** | **Comment** |
| LG | We added the related proposal in our contribution to above and since the 480 and 960 kHz SCS SSB has agreed only for non-initial access cases, 480 and 960 kHz SCS PRACH can be supported only for the cases other than initial access (e.g., for SCell). |

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

The following is a summary of 1st round discussion by the moderator.

* TBD

### 2.2.2 PRACH Sequence and Format

* From [2] OPPO:
  + Sequence length L=571 and 1151 for PRACH when the SCS is 480kHz/960kHz are not needed.
* From [4] vivo:
  + The PRACH sequence lengths 571 and 1151 can be supported for 480/960KHz SCS.
  + Format 0-3 with special SCS is not supported
  + Support 960KHz SCS for PRACH format (A, B, C) in addition to 120KHz SCS for initial access use cases.
  + With the usage of higher SCS, the issue of preamble sequence generation needs to be considered to match the certain coverage area.
* From [5] Nokia, Nokia Shanghai Bell:
  + Support L=571 and L=1151 for PRACH only with 120 kHz SCS at above 52.6 GHz.
* From [6] CATT:
  + Consider supporting the increasing of symbols in time domain to enhance coverage and the extending of frequency domain by repeating and concatenating the RACH preamble sequence in the unlicensed spectrum.
* From [9] Futurewei:
  + 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,
    - if 480kHz and/or 960 kHz SSB SCS is agreed to be supported, support 480 and/or 960 kHz PRACH SCS with sequence length L=139 for PRACH Formats A1~A3, B1~B4, C0, and C2, respectively.
* From [10] Ericsson:
  + Specify support for all sequence lengths (139/571/1151) for 120 kHz PRACH. For 480/960 kHz PRACH, specify support for only L = 139.
* From [13] Intel:
  + Support PRACH formats A1~A3, B1~B4, C0, C2 for L\_{RA}= 571 with SCS 480 kHz and 960 kHz, i.e., \mu\in{5,\ 6}, in addition to the formats for L\_{RA}= 139.
  + Optional support of PRACH formats A1~A3, B1~B4, C0, C2 for L\_{RA}= 1151 with SCS 480 kHz and 960 kHz, i.e., \mu {5, 6}.
* 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.
  + If 480 and/or 960 kHz SCS PRACH is supported, support only the sequence length L=139 for the cases other than initial access (e.g., for SCell).
* 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 [22] Sharp:
  + For 480kHz and/or 960 kHz PRACH SCS if supported, it is not needed to introduce preamble sequence lengths of 571 and 1151.
* From [23] ZTE, Sanechip:
  + Support sequence length 571 and 1151 for PRACH in non-initial use cases.

**Summary of Discussions**

* Supported sequence lengths
  + For 120kHz SCS PRACH:
    - L=139, 571, 1151: OPPO, vivo, Nokia, NSB, Ericsson, Intel, Samsung, LGE, Interdigital
  + For 480/960kHz SCS PRACH (if agreed):
    - L=139: Ericsson, LGE
    - L=139, 571, 1151: Intel, Futurewei, Samsung, [Interdigital], Sharp, ZTE (non-initial access), Sanechip (non-initial access)
* Supported PRACH formats:
  + For 480/960kHz SCS PRACH (if agreed):
    - Support format A1~A3, B1 ~B4, C0, C2: Futurewei, Intel

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

Agreement from RAN1 #104-e:

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| Agreement:   * 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,   + if 480kHz and/or 960 kHz SSB SCS is agreed to be supported, support 480 and/or 960 kHz PRACH SCS with sequence length L=139 for PRACH Formats A1~A3, B1~B4, C0, and C2, respectively.     - FFS: support of sequence length L = 571, 1151 * FFS: Support of 480 and/or 960 kHz PRACH SCS for initial access use cases, if 480 and/or 960 kHz SSB SCS is agreed to be supported for initial access |

Moderator suggest resolving the FFS aspects. Please provide further comments on the following proposal on PRACH sequence format.

* Whether or not the FFS can be agreed
  + For non-initial access use cases, if 480kHz and/or 960 kHz SSB SCS is agreed to be supported,
    - support 480 and/or 960 kHz PRACH SCS with sequence length L=571, 1151 for PRACH Formats A1~A3, B1~B4, C0, and C2, respectively.
  + For initial access use cases, if 480kHz and/or 960 kHz SSB SCS is agreed to be supported,
    - support 480 and/or 960 kHz PRACH SCS with sequence length L for PRACH Formats A1~A3, B1~B4, C0, and C2, respectively.
      * Alt 1) L = 139
      * Alt 2) L = 139, 571, 1151

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| **Company** | **Comment** |
| LG | For PRACH formats and the sequence length, we would like to clarify that 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. Besides, as mentioned in 2.2.1, since the 480 and 960 kHz SCS SSB has agreed only for non-initial access cases, 480 and 960 kHz SCS PRACH with the sequence length L=139 is only supported for the cases other than initial access (e.g., for SCell) for PRACH Formats A1~A3, B1~B4, C0, and C2, respectively. |

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

The following is a summary of 1st round discussion by the moderator.

* TBD

### 2.2.3 RACH Occasion Resources

* From [1] Huawei, HiSilicon:
  + 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 [2] 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 [4] vivo:
  + Support non-consecutive RO in time domain to avoid LBT failure.
  + With the introduction of larger SCS in 52.6-71GHz, such as 480/960kHz, how to configure time domain ROs should be considered.
  + One approach is to reuse FR2 RO slot configuration rule but to define new reference slot and re-interpret RACH slot index for high PRACH SCS in 52.6-71GHz.
* From [5] Nokia, Nokia Shanghai Bell:
  + 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.
  + 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 [6] CATT:
  + When the specification supports SCS=/480/960 KHz, 120 KHz configuration is reused for each 8/16 slots within 60 KHz slot.
* From [8] Fujitsu:
  + Support RO configuration for non-consecutive ROs in time domain
* From [10] 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.
  + To fulfill Proposal 8, 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 [11] Xiaomi:
  + Inconsecutive RO time domain configuration need be discussed.
* From [13] 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).
  + 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 RO;
  + 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 [14] 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 [15] Qualcomm:
  + a maximum of 4 and 2 FD multiplexed ROs for SCS = 120 kHz and sequence length = 571 and 1151, respectively
  + 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 including a symbol-level gap between POs to allow for gNB beam switching delay
* 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 80slots 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, 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.
  + 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 [21] Interdigital:
  + For 52.6 – 71 GHz, supporting non-consecutive RACH occasions is not preferred.

**Summary of Discussions**

* Support of non-consecutive RO to account for LBT
  + Needed: Samsung, LGE, Fujitsu, vivo, Huawei, HiSilicon, [Nokia, NSB]
  + Not Needed: Interdigital, Intel, Ericsson
* Support of non-consecutive RO to account for beam switching
  + Needed (for larger SCS): Qualcomm, Intel
  + Not Needed: Ericsson
* RO configuration for 480/960kHz SCS (if agreed)
  + Several companies proposed to limit number of RO in a reference 60 (or 120kHz) PRACH slot. For example, 4 RO for 480kHz and 2 RO for 960kHz.

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

Companies are asked to revise and update the company preferences (below).

Companies are encouraged to also clarify which PRACH SCS the non-consecutive RO (if applied) would be needed for. Based on company inputs, moderator will try to provide suggested proposal(s).

Also, companies are encourage to provide suggestions on potential proposals that could be considered for agreement (that are not covered by below) regarding PRACH RO configuration.

* Support of non-consecutive RO to account for LBT
  + Needed: *Samsung, LGE, Fujitsu, vivo, Huawei, HiSilicon, [Nokia, NSB]*
  + Not Needed: *Interdigital, Intel, Ericsson*
* Support of non-consecutive RO to account for beam switching
  + Needed (for larger SCS): *Qualcomm, Intel*
  + Not Needed: *Ericsson*
* RO configuration for 480/960kHz SCS (if agreed)
  + FFS: details of how to limit of number of 480/960 kHz PRACH RO per [60 kHz] reference PRACH slot

*Moderator will provide a suggested proposal based on feedback by UTC 03:00am April 14.*

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| **Company** | **Comment** |
| LG | The CCA gap between adjacent RACH occasions in time domain (e.g. X usec or Y symbol) is required to avoid inter-UE LBT blocking due to the propagation delay of PRACH transmitted in an earlier RO. For the non-consecutive RO gap for RACH beam switching, it would be better to defer the related discussion until RAN4 respond to RAN1’s LS that is sent in the last RAN1 meeting. |

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

The following is a summary of 1st round discussion by the moderator.

* TBD

### 2.2.4 RA Preamble ID calculation

* From [9] 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, Nokia Shanghai Bell:
  + 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] CATT:
  + For supporting Msg1 transmission on SCS=480KHz/960KHz uplink, RA-RNTI is divided into two parts . One part of RA-RNTI is carried by DCI IE, and remaining RA-RNTI will be used to scramble the DCI as in R15/R16. Two possible options as following:
    - Option A:
    - RA-RNTI = (1 + s\_id + 14 × t\_id + 14 ×× f\_id + 14 × × 8 × ul\_carrier\_id) mod
    - inDCI\_bit = floor ((1 + s\_id + 14 × t\_id + 14 ×× f\_id + 14 × × 8 × ul\_carrier\_id) /
      * 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:
    - RA-RNTI = 1 + s\_id + 14 ×(t\_id mod 80) + 14 × 80 × f\_id + 14 × 80 × 8 × ul\_carrier\_id
    - inDCI\_bit =
      * 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 [8] 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 [9] Futurewei:
  + If 480 and/or 960 kHz PRACH SCS is supported, use Rel-16 solution as basis for extension of RA-RNTI formula for higher SCS.
* From [13] 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 × 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 [14] Apple:
  + modifying the existing calculation equation to solve the RA-RNTI overflowing problem:
* From [15] Qualcomm:
  + for higher RACH SCS (480 and 960 kHz), consider the following options for the RA-RNTI:
    - Option A: using the following equation for the RA-RNTI calculations (\mu\_{max} is the maximum \mu for the FR used) and defining rules in case RA-RNTI conflicts with pre-allocated RNTIs or in case multiple ROs have the same RA-RNTI
      * RA-RNTI
    - Option B: reuse the same RA-RNTI equation in NR Rel-16, divide the RAR window into N segments (each segment is 80 slots using the used SCS), and signal the segment index in the DCI that schedules the MSG2/B
* From [18] LGE:
  + To calculate RA-RNTI/MSGB-RNTI associated with the PRACH occasion for 480 and 960 kHz subcarrier spacing 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.
    - Option 3: Maintain the density of RACH occasion same as in 120 kHz in the time-domain (e.g., 2 slots out of 8 slots for 480 kHz) and calculate the RA-RNTI based on 120 kHz SCS for 480 and 960 kHz SCS.
* From [22] Sharp:
  + Modify the calculation of RA-RNTI to accommodate 480kHz and/or 960kHz PRACH SCS if supported.
  + At least the following alternatives on calculation of RA-RNTI to accommodate 480kHz and/or 960kHz PRACH SCS can be discussed:
    - Alt 1: Modify the equation considering new maximum PRACH SCS and available RNTI value range.
    - Alt 2: Reuse the Rel-16 equation and the additional information is indicated by DCI bits.
    - Alt 3: Exploit sparse nature of PRACH occasion allocations in time domain.
    - Alt 4: Constraint RO allocation period/positions.
* From [23] ZTE, Sanechip:
  + For higher PRACH SCS (480 and/or 960 kHz), consider the following options for RA-RNTI enhancements:
  + Option 1: Change the equation of RA-RNTI calculation, without additional signalling overhead
  + Option 2: 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.

**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) modification of t\_id
    - Intel, vivo (Alt 3), Nokia, Nokia, NSB, CATT (option B), Fujitsu, LGE (option 3)
  + Option 2) modulus of the whole RA-RNTI
    - vivo (alt 1), CATT (option A), Apple, Qualcomm (option A)
  + Option 3) multiple RO blocks (segmented RO blocks) with indication in RAR
    - CATT, Fujitsu, Qualcomm (option B), LGE (option 1), ZTE, Sanechip (option 2)

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

Companies have commented that RA-RNTI calculation issue should be concluded after further progress has been made for RO configuration. Therefore, moderator suggest continuing discussion on RA-RNTI once further progress have been made for RO configuration.

With this said, if companies think we can formulate some proposal that all companies would be ok with, please suggest a proposal for discussion. Once the proposal(s) are provided, moderator will copy the proposal and present in the discussion document to further request input/feedback from companies.

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| **Company** | **Comment** |
| LG | We share the same view with Moderator. Since RA-RNTI calculation issue is closely related to the RO configuration, it is better to discuss the RO configuration first and we can continue the discussion on RA-RNTI based on the conclusion of the RO configuration. |

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

The following is a summary of 1st round discussion by the moderator.

* TBD

### 2.2.5 Other aspects on PRACH

* From [5] Nokia, Nokia Shanghai Bell:
  + Support short control signal exemption (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.
* From [9] Futurewei:
  + Signaling to indicate that LBT is disabled or enabled for the RACH procedure may be provided to UE in IDLE mode via system information block or during random access procedure (for instance via RAR, or MSG 4).
  + Signaling to indicate that LBT is disabled or enabled for the RACH procedure may be provided to UEs in CONNECTED mode via RRC.
  + 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 is considered as short control/management frames that can be exempt from LBT, gNB should signal to UEs if RACH exchange is LBT exempt.
* From [10] Ericsson:
  + Consistent with EN 302 567, when operating in LBT mode a node can access the channel without LBT for control signal/channel transmissions, the total duration of which shall not exceed 10ms within an observation period of 100ms. The following signals/channels shall be classified as Short control signaling transmissions:
    - a. Discovery burst (as defined in Rel-16)
    - b. msg1 and msg3 for the 4 step RACH and MsgA for the 2-step RACH
    - c. FFS: Other control transmissions not multiplexed with user data (subject to gNB configuration)
* From [13] 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.
* Suggest discussing these issues further.

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

Please provide suggestions on proposal(s) companies would like to discuss on PRACH that is not covered by other discussions. Once the proposals are provided, moderator will copy the proposal and present in the discussion document to further request input/feedback from companies.

As for the short control signal exemption for PRACH, moderator assumed that this will be discussed under the channel access agenda item.

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| **Company** | **Comment** |
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#### **1st Round Discussion Summary:**

The following is a summary of 1st round discussion by the moderator.

* TBD

# Summary of Moderator Proposals and Conclusions

TBD

# Summary of Agreements/Conclusions in RAN1 #104bis-e

TBD

# Reference

1. R1-2102327, “Initial access signals and channels for 52-71GHz spectrum,” Huawei, HiSilicon
2. R1-2102385, “Discussion on initial access aspects,” OPPO
3. R1-2102448, “Discussion on initial access aspects for NR for 60GHz,” Spreadtrum Communications
4. R1-2102514, “Discussions on initial access aspects for NR operation from 52.6GHz to 71GHz,” vivo
5. R1-2102558, “Initial access aspects,” Nokia, Nokia Shanghai Bell
6. R1-2102621, “Initial access aspects for up to 71GHz operation,” CATT
7. R1-2102688, “Discussion on initial access of 52.6-71 GHz NR operation,” MediaTek Inc.
8. R1-2102715, “Considerations on initial access for NR from 52.6GHz to 71 GHz,” Fujitsu
9. R1-2102772, “Further considerations on initial access for additional SCS in Beyond 52.6GHz,” FUTUREWEI
10. R1-2102788, “Initial Access Aspects,” Ericsson
11. R1-2102977, “On initial access aspects for NR from 52.6GHz to 71GHz,” Xiaomi
12. R1-2102996, “Initial access aspects for NR from 52.6 GHz to 71GHz,” Lenovo, Motorola Mobility
13. R1-2103021, “Discussion on initial access aspects for extending NR up to 71 GHz,” Intel Corporation
14. R1-2103096, “Discussion on Initial access signals and channels,” Apple
15. R1-2103157, “Initial access aspects for NR in 52.6 to 71GHz band,” Qualcomm Incorporated
16. R1-2103229, “Initial access aspects for NR from 52.6 GHz to 71 GHz,” Samsung
17. R1-2103294, “Considerations on initial access aspects for NR from 52.6 GHz to 71 GHz,” Sony
18. R1-2103339, “Initial access aspects to support NR above 52.6 GHz,” LG Electronics
19. R1-2103411, “NR Initial Access from 52.6 GHz to 71 GHz,” Convida Wireless
20. R1-2103442, “Further Discussion of Initial Access Aspects,” AT&T
21. R1-2103448, “Discussions on initial access aspects,” InterDigital, Inc.
22. R1-2103472, “Initial access aspects,” Sharp
23. R1-2103487, “Discussion on the initial access aspects for 52.6 to 71GHz,” ZTE, Sanechips
24. R1-2103519, “Discussion on initial access aspects supporting NR from 52.6 to 71 GHz,” NEC
25. R1-2103567, “Initial access aspects for NR from 52.6 to 71 GHz,” NTT DOCOMO, INC.
26. R1-2103691, “Discussion on initial access aspects for NR beyond 52.6GHz,” WILUS Inc.