**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** |
| Nokia | We would prefer to support also Case A. We understand that companies do not prefer to support Case B due to complexity concerns.  We would also prefer support Case C in addition. |
| OPPO | We support Case A and Case B. And we don’t support Case C. |
| Samsung | We support Case A and Case B. If there are companies having strong demand to support Case C for the same implementation as FR2, we are open to it. Also to clarify, if 240 kHz SCS is supported for initial access case, it should also be supported for non-initial access case (it’s strange that we support any numerology for initial access case only).  For the SSB SCS issue with Case A, we have some further comments and clarifications: For the case that UE is explicitly provided with center frequency and SCS of SSB and the UE is required to read MIB to determine the configuration of CORESET#0/Type0-PDCCH in Rel-15/16 (e.g. ANR purpose), we think there could be three alternative solutions for 52.6 to 71 GHz based on current status, and would like to ask clarification from other companies on which alternative is their thinking:   * Alt 1: Don’t support 480 kHz or 960 kHz SCS SSB for this case, and only support 120 kHz SCS SSB for this case; * Alt 2: Support 480 kHz and 960 kHz SCS SSB for this case, and the configuration of CORESET#0/Type0-PDCCH is provided by the MIB of the corresponding SSB; * Alt 3: Support 480 kHz and 960 kHz SCS SSB for this case, and the configuration of CORESET#0/Type0-PDCCH is provided in an alternative method other than the SSB.   Our understanding and comments of the alternatives are:   * We cannot accept Alt 1, since this case is a subset of non-initial access case, and the system still cannot implement in a single numerology if we support Alt 1. For example, considering a LAA scenario, where the SCell is operated on the 60 GHz unlicensed band (which we believe is a very typical scenario in real implementation for 60 GHz unlicensed band), without supporting Alt 2 or Alt 3, the SCell still cannot be implemented in a single numerology of 480 kHz or 960 kHz, since the ANR use case is essentially required for an unlicensed band. Also, we want to point out ANR is just one special use case under measurement (just one type of report), and we didn’t see it’s reasonable that a SSB can be operated with all the other functionalities but only not for ANR purpose. Lastly, Alt 1 may have RAN2 spec impact (e.g. at least adding some restriction on the configuration of SSB SCS when the report type is for ANR, and there could be more up to RAN2 like whether a UE needs to handle the case that it completes a regular RRM procedure but cannot proceed with ANR for such SSB). * Alt 2 is our preference, and we didn’t see any issue with it actually (e.g. same as Rel-15/16). If Alt 2 is supported, at least RAN1 spec impact is expected (e.g. CORESET#0/Type0-PDCCH configuration in MIB), and if Case B is supported, this spec impact is needed anyway (no extra work to support Alt 2 if Case B is supported). * We are open to discuss Alt 3 if the proposed alternative method is valid. If Alt 3 is supported, at least RAN2 spec impact is expected (e.g. the procedure for ANR doesn’t require reading MIB to acquire the configuration of CORESET#0/Type0-PDCCH), and whether RAN1 spec impact is needed depends on the detail of the alternative method.   So we would like to clarify with companies not supporting 480 and 960 kHz SSB for Case A, which of Alt 1 and Alt 3 is their thinking, and if possible, we can try to exclude Alt 1. |
| Intel | We support Case A and Case B, and we do not prefer Case C.  Case B is important for truly providing the single numerology operation, i.e., the same SCS for data, for control and for initial access. Case A is needed to provide ANR and CGI reporting. Here one scenario of our interest is on premises deployments in unlicensed spectrum where the ANR and CGI reporting could be an invaluable source of information for network optimization, e.g., using machine-learning or other AI-based techniques.  As for the concerns on support of these cases, we don’t really understand them since 480kHz and 960kHz are optional features to support. Support of these features will not cause issues to vendors and operators that do not need to support them. However, the cases are critical to enable support for specific deployments (managed networks) and enable robust network operations in unlicensed bands, which are key differentiator compared to existing NR. |
| Qualcomm | We support cases A and C.  We are not very supportive for case B due to higher UE complexity for initial search. Also, since 480/960 kHz for control/data are optional, not very clear on how to optionally support 480/960 kHz for SSB for initial access. |
| Charter Communications | We support case A and case B. There is nothing preventing a gNB from transmitting both 120 kHz SCS and 480 kHz SCS SSBs in a TDM manner to accommodate both UEs with and without capability of the optional SCSs (if desired to do so). Furthermore, a NPN operating at 480 kHz SCS can utilize case B without being concerned about compatibility for UEs that do not support 480 kHz SCS.  The addition of 240 kHz SCS SSB does not provide any performance advantage and only increases the initial access PSS/SSS blind detection complexity (assuming Case B is supported). |
| Futurewei | We can support case C to move forward, and we are open to discuss whether A is necessary or not for ANR purposes.  We do not support case B. We have a similar opinion with other companies that UE complexity is not justified for adding the optional 480/960 kHz SCS for the initial access. |
| InterDigital | We support Case A and Case B. We are open to support Case C. |
| LG Electronics | Our first preference is to support only Case C which is already supported for FR2.  For ANR support of 480/960 kHz SCS SSB, we don’t see the strong motivation since 480/960 kHz SCS is optional (so we cannot assume all neighbor cells are operated with 480/960 kHz SCS). If it can be guaranteed that all neighbor cells are operated with 480 or 960 kHz SCS (same as the serving cell), then the main use case would be for private or managed network. In such deployment scenarios, PCI collision must not be an issue. We strongly disagree with supporting Case A just for the purpose of ANR. |
| CATT | We support Case A and Case C. Beside complexity issue case B may also have coverage issue. |
| Ericsson | We support Case C to have commonality with the FR2 initial access framework, both from a specifications and implementation point of view. As pointed out by Samsung, when supporting 240 kHz for initial access use case, it should also be supported for the non-initial access use case to allow same SSB numerology across all serving cells. We agree, it would be strange to support any SSB numerology that would be valid for initial access case only. Therefore, we think Case C should be reformulated as follows to be consistent with FR2   * + Case C) Support SSB with 240 kHz SCS for both initial access and non-initial access case. For initial access, it is assumed the SSB with 240Hz SCS will support Type0-PDCCH configuration in the MIB.   Regarding Case A, we don't see a strong need to support it given that we are not a supporter of Case B. There doesn't seem to be a compelling need for ANR for SCells only. We also observe that the mechanism introduced in Rel-16 NR-U to configure an off-sync raster SSB will not work for this band since the single-sync raster point per channel cannot be guaranteed. For Rel-15 ANR (on sync-raster SSB), if a critical need in the 52.6 – 71 GHz band is identified, it can be further discussed how to provide a CORESET0/Type-0 PDCCH configuration by dedicated signaling (this is generally known for cells of the same operator by the overlaid O&M system). This would correspond to Samsung's Alt-3. |
| ZTE, Sanechips | We support Case A and Case B. Case A is beneficial for supporting ANR function and CGI reporting in non-initial access case. For Case B, larger SCS 480/960 kHz has a higher tolerance on frequency offset and it can bring benefit to single numerology operation. Thus we think SSB SCS 480/960 kHz should be supported in both non-initial access and initial access cases. |
| Huawei/HiSilicon | We do not support any of the cases.  We believe that the agreement we reached in the last GTW meeting satisfies the main concerns related synchronization accuracy and RRM measurement in operations with 480/960 kHz SCSs.  Case A results in an additional specification work at least for 1) CORESET#0 design including number of supported RBs and symbols for 480(960) kHz; 2) Supported {SSB, CORESET#0} multiplexing patterns and CORESET#0 RB offsets for 480(960) kHz; 3) Search Space design for each CORESET#0 multiplexing pattern for 480(960) kHz without tangible benefits.  Case B results in even more specification work than Case A as the support for 480/960 kHz SSB for initial access would require the design of synch raster and also, most likely, entails the support of 480/960 kHz PRACH in initial access for both shared and non-shared spectrum. Additionally, Case B results in additional blind search complexity during initial access and may result in fragmentation (two set of networks one support 120 kHz only and the other supports 960 kHz only) which neither is acceptable for us. We have explained these issues and other issues relevant to the support of 480/960 kHz SSB for initial access in details in R1-2102327.  Regarding the ANR use case, we have the following comments/questions that would like to have clarifications about before discussing whether or how ANR should be supported:   1. We find ANR an optimization issue without which the network is functional (certainly RRM can work without ANR. CGI-InfoNR is a late addition to MeasResults). Please note that, based on proponents’ arguments so far, a main motivation of using 480/960 kHz SSB SCS is for private networks in controlled environments such as data centers. For such applications and other vertical industries in controlled environments, we wonder how useful and necessary the ANR application is. 2. To our understanding, with the current agreements (support 120 kHz SSB for all cases and 480/960 kHz SSB when explicit frequency/SCS is provided and CORESET#0 is not configured), all required information from a neighboring network can be provided by the UE to the serving network: UE can read SIB1 associated with 120 kHz SSB of the neighboring network and provide relevant neighbor network information to the serving network. UE can also detect 480/960 kHz SSB of the neighboring network and report “noSIB1” in the CGI-Report:   C:\Users\K00903651\AppData\Roaming\eSpace_Desktop\UserData\k00903651\imagefiles\E13D0259-96B6-492B-8ECA-F1CB648C1788.png  Note that as “noSIB1” includes the four bit “pdcch-ConfigSIB1”, depending on the value of “pdcch-ConfigSIB1”, the serving network would also be able to know the location of the first SSB with CORESET#0 from the neighboring network.   1. With the current agreement regarding 480/960 kHz SSBs (support 480/960 kHz SSB when explicit frequency/SCS is provided and CORESET#0 is not configured), 480/960 kHz SSBs will be associated only to Scells and a UE from another network cannot directly camp on and connect to them. So, in view of this and, further, the highly direction transmissions in B52 GHz spectrum, we would like to know what is exactly the possible danger of PCI collision? 2. Again, using current mechanisms, UE can report the presence of a 480/960 kHz SSB SCS of a neighbor network on a specific location on frequency domain and further can report that this SSB does not configure SIB1 (cannot be used for camping or PCell configuration). This information would be enough for the serving network that, if it deems necessary, moves away its configured cells from the detected location of the 480/960 kHz SSB SCS of a neighbor network to avoid possible inter-network interference. We don’t see what would be the problem with such a mechanism and why we need to additionally support Case A or Case B above? |
| AT&T | We support Case A and Case B. If no further progress can be made, RAN1 should at least agree that the agreement above from RAN1 #104bis-e is mandatory for UEs supporting 480 and or 960 kHz, i.e., SSB and PDSCH for 480 and 960 kHz are not separate capabilities. That at least partially addresses the concerns of companies supporting 480 and 960 kHz SSB also for initial access. |
| NTT DOCOMO | We support Case A. We would like to support RRM measurement for all use cases while supporting the operation with single numerology. For example, we don’t think it would be good to have the operation with different numerologies to achieve RRM measurement for ANR purpose ONLY. By having such restrictions in 52.6 – 71 GHz, larger SCSs may not be useful in practical.  We support Case B, but we are also ok with having a bit more restrictions, e.g., only either 480 or 960 kHz SCS is supported for SSB for initial access case to reduce the number of blind detection hypotheses at UE.  We are fine with Case C as the second preference. In case that Case B) is not supported at all, Case C) should be supported. In this case, just reusing FR2 has the very same issue as supporting only 120 kHz SCS. Supporting multiplexing between SSB with 240 kHz and CORESET#0 PDCCH with 480/960 kHz needs to be considered, which in our understanding requires the same (or even larger) amount of specification effort as Case B). |
| Mediatek | Support case A and open to discuss case C. For case B, we do not see strong need and it will cause high complexity for initial cell search. |
| Convida Wireless | We prefer to support Case A and Case B. |
| vivo | We support Case A and Case B.  The design target of B52.6GHz system is to make the Rel-15/16 function work. We don’t know why we remove ANR function as we already support 480/960KHz SSB for non-initial access case. So Case A should be supported.  For Case B, we don’t understand the concern on UE complexity if 480K/960K SCS is optional. Corresponding to Qualcomm’s question on how to optionally support 480/960K SCS for initial access, for private network, the personal operator such as factory, home or office could use the equipment which implement 480K/960K SSB SCS. If spec doesn’t support 480K/960K SSB SCS, at least two BWP with different SCS (one is 120KHz initial BWP and another is 960K operation BWP) in peak data rate case, which will introduce more complexity and overhead especially for private network case. The support of optional 480K/960K in spec will provide more choices to the market. |
| Lenovo, Motorola Mobility | We support Case A and Case B to provide the single numerology operation |
| Xiaomi | We support cases A and Case C, open for Case B |
| Spreadtrum | We support Case A. CGI reporting is an important use case for NR-U, and led to a design of “off-raster” SSB in R16. CGI reporting is beneficial to the multi-operator network for R16 NR-U and above 52/6GHz equally in our view. |
| Sharp | We support case A if the specification impact issue can be addressed. |
| WILUS | We support Case A and Case B for single numerology operation for data, control, and initial access, and we do not prefer Case C. |
| Sony | We support at least Case A. Case B is 1st preference. Case C is 2nd preference if Case B is not accepted for all. |
| Fujitsu | We support Case A and Case B. |
| Apple | We are open to consider Case A assuming it is operated based on UE capability report of 480kHz and 960kHz SCS support.  We do NOT support Case B with 960kHz due to the associated UE complexity.  For Case C), we can support on condition that Case B) is NOT supported. However, if Case B with 480kHz is used for initial access, we do not support Case C). The main reason is that if both Case C and Case B with 480kHz SCS are supported for initial access, total 3 SCS needs to be hypothetically detected for cell search. We would like to keep it up to 2 as in current FR2. |

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

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

Based on feedback so far, its seems among case A, B, and C, case A has the most support (25 yes/3 no), followed by case B (16 yes/7 no), and case C (8 yes/2 conditional yes/5 no), respectively.

* Case A) For non-initial access case, a SSB with 480 kHz and 960kHz SCS and Type0-PDCCH configuration in the MIB.
  + Support (25): Nokia, NSB, OPPO, Samsung, Intel, Samsung, Charter, Interdigital, CATT, ZTE, Sanechips, AT&T, NTT Docomo, MediaTek, Convida, vivo, Lenovo, Motorola Mobility, Xiaomi, Spreadtrum, Sharp, WILUS, Sony, Fujitsu, Apple
    - Main reasons: supporting ANR and CGI reporting, better timing estimation
  + Do not Support (3): Huawei, HiSilicon, Ericsson (support other means of indicating Type0-PDCCH)
    - Main concern: additional specification work
    - Main reasons: system would be operational with 120kHz SSB, ‘no-SIB1’ report in CGI is sufficient for ANR, PCI collision not an issue in 60GHz
  + Samsung asked clarification question:
    - For companies that do not support Case A, does this mean Type0-PDCCH configuration in the MIB is only supported for 120kHz SCS SSB? Or whether Type0-PDCCH configuration is conveyed for 480/960kHz SCS SSB by alternative means (other than 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.
  + Support (16): OPPO, Samsung, Intel, Charter, Interdigital, ZTE, Sanechips, AT&T, NTT Docomo, Convida, vivo, Lenovo, Motorola Mobilityc, WILUS, Sony (1st preference between B/C), Fujitsu
    - Main reasons: enablement of single numerology operation, better timing estimation, more complexity without this (from supporting dual BWP one with 120kHz and 480/960kHz)
  + Do not support (7): Futurewei, Huawei, HiSilicon, MediaTek, Qualcomm, Ericsson, Apple
    - Main concerns: added (cell search) complexity for the UE, additional specification work
* Case C) Support SSB with 240 kHz SCS for both initial access and non-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.
  + Support (10): Nokia, NSB, Futurewei, CATT, Ericsson, Qualcomm, NTT Docomo (2nd preference if case B cannot be supported), Xiaomi, Sony (2nd preference between B/C), Apple (only if case B is not supported)
    - Main reasons: commonality with FR2 framework
  + Do not support (5): OPPO, Intel, Huawei, HiSilicon, WILUS
* Suggestion from AT&T: UEs supporting 480 and or 960 kHz, i.e., SSB and PDSCH for 480 and 960 kHz are not separate capabilities

#### **2nd Round Discussion – Part 1:**

Moderator asks companies to further comment on issues that is missing from the 1st round discussion summary. Keep in mind, the summary did not try to capture every little detail about the main concerns or main reasons for support. Moderator just summarized what seemed to be the most outstanding concerns and reasons in short text. With this said, if there is something else that companies wanted to add/fix, please provide further feedback, including any corrections of companies views from the summary.

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| **Company** | **Comment** |
| Spreadtrum | The main concern on Case B is cell search complexity for the UE. But, perhaps, there could be some solutions to mitigate, e.g. very sparse SS raster(s) in a channel, UE optional capability… We can further discuss Case B. |
| LG Electronics | Our view is missing. We support only Case C which should be the natural choice since 240 kHz SSB and {240 kHz SSB, 120 kHz CORESET#0} are already supported for FR2. |

#### **2nd Round Discussion – Part 2:**

Based on the comments received, pretty good majority of the companies seems to support case A and/or B, and there is some support for supporting C, and some additional companies willing to discuss further about case C. Case A does have wide support and smaller number of companies with concerns. Since in both case A and B, the common aspect is Type0-PDCCH configuration in MIB support by SSB with 480/960kHz. If agreements on this is made, further discussion on SSB design can be discussed further along with whether 480/960kHz SSB would be applicable for non-initial access only vs initial & non-initial access.

Moderator suggest also provide comments on the following proposal (in addition to further comments continuing from 1st round discussion):

* SSB with 480 kHz and 960 kHz SCS to support Type0-PDCCH configuration in the MIB.
  + FFS: whether SSB with 480kHz and 960kHz will be applicable for only non-initial access, or initial access.
* FFS: Support SSB with 240 kHz SCS
  + If SSB with 240kHz SCS is supported, it will be supported for both initial access and non-initial access.

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| **Company** | **Comment** |
| Spreadtrum | Fine |
| Nokia | We would be OK with the proposal,and would also support 240kHz SSB (for initial access). |
| LG Electronics | We disagree with the proposal.  480/960 kHz SCS is an optional feature so initial access based on 480/960 kHz SCS is not necessitated.  For non-initial access, we don’t see a critical issue for PCI collision as we state before. Thus, ANR support cannot justify the necessity of cell-defining 480/960 kHz SCS SSB.  For 240 kHz SCS SSB, supporting it should be the natural choice since 240 kHz SSB and {240 kHz SSB, 120 kHz CORESET#0} are already supported for FR2. |

#### **2nd Round Discussion Summary:**

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):
    - *??*

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| **Company** | **Comment** |
| Nokia | As indicated in our paper we see that there would be need to support DBTW. We think that DBTW is needed at least for 120kHz sub-carrier spacing.  Assuming that ‘configuration of DB/DBTW’ refers to informing the UE whether the DBTW is used/assumed, we think that different approaches may apply in different cases. I.e. if UE is configured a specific cell in CONNECTED mode (e.g. measurement configuration), explicit signaling would be appropriate, but different method may be needed e.g. for initial cell search case.  We think that we need further discussion how the DBTW is supported in terms of SSB candidate locations. The NR-U based mechanism does to seem to be able to provide additional candidate locations in even/fair manner to all SSBs, if we assume large number of SSBs (with 120kHz sub-carrier spacing). |
| Samsung | We support DBTW at least for 120 kHz SCS, and actually we didn’t see why it cannot be used for 480 kHz and 960 kHz if it’s already supported 120 kHz.  In our contribution, we have performed a detailed analysis on the feasibility of support DBTW, regarding the concern on the payload size of PBCH.  Regarding the indication of enabling/disabling, implicit indication can be used for initial access case (e.g. band number and synchronization raster locations) and explicit indication can be used for non-initial access case (e.g. RRC parameter). |
| Intel | We support DB/DBTW at least for SCS 120 kHz and at least based on SS burst transmission with this SCS and FFS for SCS 480 kHz/960 kHz. We also think that DB/DBTW could be always supported. |
| Qualcomm | Considering the high beam directivity for 60 GHz range compared to FR1, LBT failure rates may be low. Hence, supporting DBTW may add to the specification and UE complexity, e.g.:   * Signaling the Q factor may be challenging (without changing the PBCH payload and DMRS sequence, per the agreement) * Enabling/disabling DBTW depending on licensed/unlicensed bands   It would be beneficial to clarify what DB/DBTW support means. Is this only about Q, or there are more?  For 480/960 kHz, the SSB sweeping is fast, and even if Q is introduced, it will not help much (the interference correlation in time will be high within the SSB sweeping).  For 120 kHz, beam directivity will reduce the benefit of Q, in addition to power consumption penalty.  Hence, we are not supportive of DBTW. |
| Charter Communications | While LBT failure is expected to be much lower at 60 GHz and Cat-3 LBT makes it even likelier to successfully start a CO without skipping multiple SSBs, the R16 DBTW framework should simplify defining a similar feature in R17.  Hence, we support DB/DBTW. |
| Futurewei | We are supportive to DB/DBTW and gNB controlling it enable/disable it as it sees necessary. |
| InterDigital | We support DBTW for 120kHz and 480kHz SCS. Since the gaps are shorter than 16us in 960kHz SCS, it seems that DBTW may not be necessary.  As for the indication of the licensed/unlicensed or disabled/enabled DBTW, we propose to use implicit and explicit methods. For the implicit, different sync raster ranges can be used to identify the mode of operation. As for the explicit identification, we propose using an explicit index configured by pdcch-ConfigSIB1 included in MIB. Also, reinterpreting the unused bits in MIB can be used for the explicit identification of the mode of operation, e.g., the unused bits in the controlResourceSetZero and/or searchSpaceZero in pdcch-ConfigSIB1 included in MIB. |
| LG Electronics | Prefer to support DBTW for 480/960 kHz SCS SSB as well. If MIB does not suffice to express increased number of candidate SSB indices, we can keep 64 candidate SSB indices but allow Q less than 64. |
| CATT | We support DBTW for 120 kHz SCS. For SSB with SCS 480 KHz/ 960KHz, the duty cycle is less than 6% if up to 64 SSBs are transmitted. Therefore, DBTW is not needed for SSB of 480KHz/960KHz. |
| Ericsson | Similar view as Qualcomm; the need for DBTW when LBT failure rate is so rare is highly questionable. Even for NR-U in 5/6 GHz it was an optimization. Furthermore, our expectation is that discovery burst will be classified as short control signaling, meaning DBTW is further demotivated. This needs to be concluded before any decision on DBTW.  As in the agreement from last meeting, there are also quite a few unknowns that would need to be addressed before knowing if DBTW is feasible. The chief unknown is the following:   * + How to indicate candidate SSB indices and QCL relation without exceeding limit on PBCH payload size   For 52.6 – 71 GHz band, all bits of k\_SSB are needed in general (need to signal 0 .. 11) unless RAN4 comes up with a very specific channel design that would avoid odd values of k\_SSB. If Case C is supported, need to indicate SSB numerology (120/240 kHz), so can’t steal a bit from ssbSubcarrierSpacingCommon. Also, it is not clear how many values of Q are needed. So, where will the bits come from? Does Q need to be signaled in SIB1 instead? How can DBTW be turned off before the UE reads SIB1? Does this require additional bits in MIB? |
| ZTE, Sanechips | We think DB and DBTW should be supported at least for 120 kHz SSB SCS. For other SSB SCSs, DB and DBTW can also be considered if they are agreed to be supported in the discussion of section 2.1.1. Enabling/Disabling DBTW can be achieved by configuration implementation, i.e. by a implicit method. |
| NEC | We support DB and DBTW at least for 120 kHz SCS and be open to the discussion for 480/960 kHz SCS. With regarding to the DB/DBTW configuration or indication, we think both implicit and explicit methods could be furtherly investigated considering the indication of Q value and candidate SSB index. |
| Huawei/HiSilicon | We support both DB and DBTW. DB definition can follow that of Rel-16 NR-U. Details design of DBTW can be discussed in next meeting. |
| NTT DOCOMO | For DB, we are fine with supporting it. SSB with 120 kHz SCS and 20 ms periodicity cannot be treated as Short Control Signalling, which means LBT is required to initiate SSB transmissions in some cases. In Rel-16 NR-U, cat-2 LBT can be applied for DRS in certain cases. Similar can be considered in 52.6 – 71 GHz in case that LBT is required for SSB transmissions, where multiplexing some signals/channels with SSB would be beneficial.  For DBTW, we have already made an agreement at the last meeting, saying that PBCH payload size is no greater than that for FR2, duration of DBTW is no greater than 5 ms and number of PBCH DMRS sequences is the same as for FR2. With these restrictions, we are not sure if it is possible to support the same mechanism as in Rel-16 NR-U with reasonable amount of enhancements. |
| Mediatek | Considering the much lower probability of LBT collision, we don’t think DBTW needs to be supported. |
| Convida Wireless | We support DB and DBTW. The enabling of DB/DBTW can be further considered. |
| Vivo | The introduction of DB and DBTW is due to the characteristics of unlicensed band, that is, increasing the transmission opportunities of signals and channels. Thus, For NR operation from 52.6 GHz to 71 GHz, due to the existence of licensed band and unlicensed band, the DB and DBTW should be supported no matter which SSB SCS. |
| Lenovo, Motorola Mobility | We support DB and DBTW at least for 120kHz SCS. |
| Xiaomi | We support both DB and DBTW. |
| Spreadtrum | DB and DBTW can be supported, even if LBT exempt (short control signaling) is supported. They can be coexistence in the spec. Disabling/enabling DB and DBTW can be supported by SIB1, as DBTW length is also configured in SIB1 in NR-U. |
| Sharp | We support DB and DBTW at least for 120kHz SCS. |
| WILUS | We support DB/DBTW at least for SCS 120 kHz and we are open to support DB/DBTW for 480/960 kHz SCS SSB. If DBTW is supported at least for 120kHz SSB SCS, how to define the candidate SSB positions and how to indicate candidate SSB indices and QCL relationship can be further discussed. |
| Sony | We support DBTW at least for 120 kHz SCS since the condition of short control ignaling cannot be met for SSB transmission with 120 kHz SCS. Whether DBTW for SSB with 480 kHz and 960 kHz SCS is supported or not should be discussed later since short control ignaling for SSB transmission has not been agreed yet.  We support to enable/disable configuration of DB/DBTW for the environment where LBT is not mandated. |
| Apple | Our view is that LBT failure rate is rare in a heavy-beam form system. The short control signaling can further reduce the possibility, if applicable. Nevertheless, we are open to discuss this issue. |

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

This is a quick reminder of the agreement from last RAN1 meeting:

|  |
| --- |
| Agreement:   * For an unlicensed band that requires LBT, further study whether/how to support discovery burst (DB) and discovery burst transmission window (DBTW) at least for 120 kHz SSB SCS   + If DB supported     - FFS: What signals/channels are included in DB other than SS/PBCH block   + If DBTW is supported     - Support mechanism to indicate or inform that DBTW is enabled/disabled for both IDLE and CONNECTED mode Ues       * FFS: how to support Ues performing initial access that do not have any prior information on DBTW.     - 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   + The following points are additionally FFS:     - How to indicate candidate SSB indices and QCL relation without exceeding limit on PBCH payload size     - Details of the mechanism for enabling/disabling DBTW considering LBT exempt operation and overlapping licensed/unlicensed bands     - Whether or not to support DBTW for SSB SCS(s) other than 120 kHz if other SSB SCS(s) are supported |

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

* Discovery burst (DB) and discovery burst transmission window (DBTW) for SSB
  + Do not support DB or DBTW
    - Qualcomm, Ericsson, MediaTek
      * Main concerns: signaling needed to support DB/DBTW in MIB not clear, added UE complexity, in case LBT failure rate is low there is no need for DB/DBTW
  + Support DB or DBW at least for 120kHz
    - Nokia, Nokia Shanghai Bell, Samsung, Intel, Charter, Futurewei, Interdigital (also for 480kHz), LG Electronics, ZTE, Sanechip, NEC, Huawei, HiSilicon, CATT, NTT Docomo, Convida, vivo, Lenovo, Motorola Mobility, Spreadtrum, Sharp, WILUS, Sony, Xiaomi
      * Main reasons: LBT for SSB
  + Support DB or DBTW for all SCS
    - Samsung, LG Electronics
      * Main reasons: if DB/DBTW can be supported for 120kHz, no reason to not support it for other SCS.

#### **2nd Round Discussion:**

Given that we agreed to study whether and how to support DB and DBTW, moderator suggests focusing on the whether and how components of DB and DBTW. The following seems to have the greatest support. Therefore, moderator suggest continuing discussion based on the following proposal.

Please continue to provide inputs on changes and concerns on the proposal, including any alternative/compromise proposal(s).

* Discovery burst (DB) and discovery burst transmission window (DBTW) at least for SSB with 120 kHz SCS
  + 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
  + FFS: applicability of DB/DBTW design for 120kHz to SSB with 480kHz and 960kHz SCS
  + FFS: details of how to inform Ues of the configuration of DB/DBTW, including enable/disable mechanics (if needed)

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| **Company** | **Comment** |
| Spreadtrum | Disabling/enabling DBTW should be supported, if DBTW is supported, according to the RAN1#104e agreement:   * If DBTW is supported   + Support mechanism to indicate or inform that DBTW is enabled/disabled for both IDLE and CONNECTED mode Ues     - FFS: how to support Ues performing initial access that do not have any prior information on DBTW.   + 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 |
| Nokia | We would be OK to support discovery burst (DB) and discovery burst transmission window (DBTW) at least for SSB with 120 kHz SCS. Depending on the regulatory requirements, if short control signal exemption cannot be applied, supporting DB/DBTW also for other sub-carrier spacing could be considered. |
| LG Electronics | Generally fine. It seems that a verb (e.g., support?) is needed for the main bullet.  In addition, the discussion on DB should be taken under channel access agenda. |

#### **2nd Round Discussion Summary:**

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.

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| **Company** | **Comment** |
| Nokia | Prior going to detailed pattern designs, it would be good to try to agree some baselines (as was done in Rel-15):   * Do we need to provide gap for LBT for each SSB/group of SSBs? The need and type of LBT may depend on agreements on Channel Access side. * Do we preserve symbols for e.g. PDCCH in the slots where SSBs are, and if yes how these symbols should be located?   + Relates also to LBT gap and the number of SSBs per slot (e.g. 2) * Do we want to provide ‘gaps’ for (UL) data transmission and if yes, how frequently?   + The frequency of “UL gaps” would relate mostly to 480kHz and 960kHz sub-carrier spacings accounting also the RX-TX switching time (pending on RAN4 feedback). With 120kHz sub-carrier spacings the total time of 5ms restricts the distribution/total duration of “UL gaps” * Do we need beam switching gap?   + Like discussed in last meeting, the need for beam switching gap (for 480kHz and/or 960kHz) would need to be confirmed by RAN4. Based on our understanding this would not be needed, but we are OK to wait RAN4 feedback on this. |
| OPPO | For 120kHz SCS, we don’t see the need to change the legacy SSB pattern.  For 480kHz/960kHz SCS, a new SSB pattern design may be discussed if the beam switching gap is identified necessary after we receive response from RAN4. |
| Samsung | For 120 kHz SCS, we didn’t a strong need to modify legacy SSB pattern.  For 480 kHz/960 kHz SCS, a new SSB pattern is surely needed (based on the agreement from Tuesday GTW), and existing cases can be utilized as a reference for the design. Although we are still waiting for RAN4 to feedback the beam sweeping gap, there are existing patterns already reserving symbols between neighboring SSBs, so we can reuse Case A or Case C for the SSB locations within a slot regardless of RAN4 feedback on the beam sweeping gap. |
| Intel | For SCS 120 kHz, reuse existing SSB pattern from FR2.  For SCS 480 kHz/960 kHz, reuse SSB pattern for 120 kHz and additionally introduce an SSB pattern with a time gap between two consecutive SSBs to accommodate beam switching time. |
| Qualcomm | For 120 kHz SCS, there is no strong need to change the current Rel-16 FR2 design.  For 480/960 kHz SCS, we share the same view as Nokia where before getting into details of the design, certain aspects need to be clarified. These include:   * Do we need beam switching gaps (may be wait for RAN4 feedback on timing) * Do we need URLLC and UL traffic and how many (may be wait for RAN4 feedback on timing for UL/DL switching) * Do we need to multiplex CORESET0/SIB1 PDSCH in the slot having the SSB   Do we need to “nest” the SSB pattern within a 120 kHz pattern to avoid beam direction blockage in certain cases (e.g., CA) |
| Charter Communications | Agree with Qualcomm and Nokia |
| Futurewei | Same as other companies. Reuse current FR2 design for 120kHz SCS, wait for RAN4 decisions, and SCS decision for initial access. |
| InterDigital | For 120kHz SCS, we prefer to use the legacy SSB pattern, i.e. Case D.  For 480 kHz/960kHz, SSB patterns can be used that are based on the legacy SSB patterns as reference. |
| LG Electronics | No change for 120 kHz SCS SSB.  For 480/960 kHz SCS SSB, SS/PBCH block Case D (defined for 120 kHz SCS) can be reused, considering the description in TR 38.808 that no explicit switching gap is needed between successive SSB blocks. However, we can wait for RAN4’s response to RAN1’s LS. |
| CATT | For 120kHz SCS, we don’t see the need to change the legacy SSB pattern.  For 480kHz/960kHz SCS, we may need to wait to hear from RAN4 on whether the beam switching gap is necessary before we make decision about the new SSB pattern |
| Ericsson | Our first preference is to reuse the Case D pattern from FR2 if possible.  We also acknowledge that feedback from RAN4 is still needed on the issue of beam switching gap and Tx/Rx, Rx/Tx switching times, so it is difficult to make progress on the precise time domain pattern. |
| ZTE, Sanechips | For SSB 120kHz SCS, Case D can be reused.  For SSB 480/960kHz SCS, although RAN4 in the approved TP R4-2103260 thinks both CPs of SCS 480 kHz and 960 kHz are feasible for beam switching, but their analysis may be only from beam switching point of view. RAN1 can continue to wait for reply LS and clarifications from RAN4. If CP is enough for beam switching and other functions, Case D can be as a baseline. Otherwise, Case A/C or a new pattern/transmission-mechanism for SSB 480/960kHz SCS can be considered.  In addition, we also agree to reserve some slots/symbols between SSBs for UL traffic transmission. |
| NEC | For 120kHz SCS, we prefer to reuse the legacy Case D SSB pattern for FR2.  For 480kHz/960kHz SCS, a new SSB pattern may be discussed based on the details from RAN4 feedback about beam sweeping gap. |
| Huawei/HiSilicon | We don’t see the need for any change in SSB pattern design for 120 kHz. Please note that we still support DBTW for 120 kHz SSB: 120 kHz SSB burst can slide within the 5 ms DBTW if Q<64 (e.g., Q=32)  For the design regarding 480/960 kHz SSB, we agree that is better to follow a step-by-step approach. Agreeing on the answers to Nokia’s questions would be a good start. |
| NTT DOCOMO | We do not see the significant necessity to make changes on SSB resource pattern for 120 kHz SCS.  For SSB with 480 and 960 kHz SCS, at least guard period to ensure the required time for beam switching should be considered between SSBs as CP length is shortened. |
| Mediatek | Agree with Qualcomm and Nokia |
| vivo | For 120KHz SCS, no change to legacy Case D pattern.  For 480/960KHz SCS, use legacy Case D pattern as baseline and possible change considering beam switching gap. |
| Lenovo, Motorola Mobility | Our preference is to reuse the SSB pattern design for 120kHz from Rel16 FR2. For 480/960kHz, wait for RAN4 feedback regarding introducing a symbol gab for beam switching TDD switching (at least for 960kHz) which might lead to a different time domain pattern. |
| Xiaomi | For 480kHz/960kHz SCS, FFS after response from RAN4. |
| Spreadtrum | For 120kHz SCS, legacy pattern can be reused.  For 480/960kHz SCS, the pattern may depend on some questions like those proposed by Nokia and Qualcomm. As well, legacy pattern can be candidate. |
| Sharp | 120kHz SCS: reuse FR2 case D in general. |
| WILUS | For 120kHz SCS SSB, we don’t see the need to change the legacy SSB pattern in FR2.  For 480kHz/960kHz SCS SSB, a new SSB pattern should be discussed based on the details from RAN4 feedback about beam switching gap. |
| Sony | For 120 kHz SCS, legacy SSB pattern could be reused.  For 480 kHz and 960 kHz SCS, we can wait for RAN4’s response. |
| Apple | For 120kHz SCS, reuse the legacy pattern.  For 480kHz and 960kHz SCS, we share same view with Qualcomm and suggest reaching consensus on design requirement first, if possible. This would make discussions on exact pattern much easier. |

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

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

All companies stated that for 120kHz SSB, legacy SSB pattern can be re-used. Also given that most companies are also suggesting to support DB/DBTW, it would be good to clarify whether the slots positions, i.e. values of n, within a half-frame is also re-used or not.

For 120kHz SSB:

* No strong need to modify legacy SSB pattern
  + OPPO, Samsung, Intel, Qualcomm, Charter, Futurewei, Interdigital, Apple, Sony, WILUS, Sharp, Spreadtrum, Lenovo, Motorola Mobility, vivo, NTT Docomo, Huawei, HiSilicon, NEC, ZTE, Sanechip, CATT, LGE

For 480/960kHz SSB:

* Several companies suggested to work with trying to narrow down design principles first.

#### **2nd Round Discussion – Part 1:**

Given that most companies are also suggesting to support DB/DBTW, it would be good to clarify whether the slots positions, i.e. values of n, within a half-frame is also re-used or not when stating re-use of 120kHz SSB pattern from FR2. Moderator asks companies to provide input/comment on the following:

For SSB with 120kHz SCS, re-use of 120kHz SSB pattern from FR2 for NR above 52.6 GHz means the following:

* Case D - 120 kHz SCS: the first symbols of the candidate SS/PBCH blocks have indexes {4, 8,16, 20} + 28×n, where index 0 corresponds to the first symbol of the first slot in a half-frame.
* For carrier frequencies within 52.6 GHz to 71GHz, 𝑛 = 0, 1, 2, 3, 5, 6, 7, 8, 10, 11, 12, 13, 15, 16, 17, 18.

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| **Company** | **Comment** |
| Nokia | While re-use would be simplest, we think that in order to enable DB/DBTW with larger number of SSB, introducing additional candidate locations for SSBs is needed. Current SSB time location pattern in the 5ms window leaves certain slots among the 40 slots unused, namely slot indexes {8,9,18,19,28,29,38,39}. Additional SSB candidate locations could be introduced to these.  In principle the symbol level locations could be kept unchanged, but it is not clear if we need to have different symbol locations in different slots i.e. {4…7} and {8…11} versus {2…5}and {6…9}. Also the applicability of symbol level pattern has some dependency of the Channel Access (8.2.6) decisions. |
| LG Electronics | Support the proposal. |

#### **2nd Round Discussion – Part 2:**

As suggested by companies, moderator would like to get further input on the following issues:

For SSB with 480/960kHz SCS:

* Gap for LBT for each SSB within a slot needed?
* Gap for LBT for group of SSBs (between slots) needed?
* Gap for beam switching between SSB needed?
* Gap for beam switching between SSB (and potential PDCCH) needed?
* Preserving symbol(s) for PDCCH within the slots that contain SSB needed?
  + If Yes, where are these symbols located.
* Support multiplexing of CORESET#0 and Type0-PDCCH
* Preserving symbol(s) for uplink and/or ULRRC data transmission within the slots that contain SSB needed?

Please note that for some questions, RAN1 may need to wait for RAN4 response. In case, companies already have some input, please provide them. If companies think we need to wait for RAN4 input, please state so as well. Moderator thinks having more information will be beneficial for further discussions.

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| **Company** | **Comment** |
| Nokia | Firstly note that there is also some dependency also in the Channel Access (8.2.6) discussion and pending decisions. Hence, it may not be yet possible to conclude the design of SSB pattern.  After that being said, if based on RAN4 feedback no beam switching gap between SSBs is needed, and if LBT for different SSBs can be done simultaneously/consecutively we don’t see need to have gap between each SSB. If, for example beam switching gap is needed based on RAN4 feedback, we would then prefer to bundle SSB and corresponding Type0-PDCCH occasion to consecutive symbols to minimize the number of beams switches. Thus, we would prefer to enable multiplexing Type0-PDCCH and SSB in the same slot, but the location of these would depend on the RAN4 feedback.  Option to preserve symbols for UL transmission in same slots with SSBs would depend on the need of the afore discussed gaps i.e. beam switching. Currently, assuming that we can have slots without SSBs sufficiently frequently e.g. ~<0.5ms, we don’t see a strong need to have UL symbols in the SSB slot. |
| LG Electronics | LBT gap: should be discussed under channel access agenda  Beam switching gap: can postpone until RAN4 respond to RAN1 LS  CORESET#0 and Type0-PDCCH: should be first agreed to support cell-defining 480/960 kHz SCS SSB  Preserving DL/UL symbols: we do not see the strong need, but if we reuse legacy SSB pattern, then it’s up to gNB where DL/UL symbols can be used. |

#### **2nd Round Discussion Summary:**

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** |
| Nokia | In context of CORESET with 120kHz sub-carrier spacings, we would propose to support ={96} in addition to ={24, 48}. |
| Samsung | For 120 kHz SCS SSB, we didn’t see a strong need to support 480 kHz or 960 kHz CORESET#0 SCS, so we support Alt 1 for the SCS of CORESET#0.  For the CORESET#0/Type0-PDCCH configuration, we believe 96 RB CORESET BW should be supported in addition to existing configurations in FR2, since the carrier bandwidth for 52.6 to 71 GHz is much larger than FR2 in Rel-15. Also, Pattern 2 can also be considered if there is reserved row in the configuration table, to allow more flexibility on allocating the CORESET#0.  One clarification to the second sub-bullet, the context should be for 120 kHz as the SCS of CORESET#0/Type0-PDCCH (i.e., Alt 1 of the first sub-bullet). |
| Intel | For SCS 120 kHz for CORESET#0, we support Alt 1, i.e., only 120 kHz Type0-PDCCH (current specification). The support of other SSB/CORESET SCS pair such as {120, 480} or {120, 960} kHz, while could be interesting, may pose issues when the UE is trying to obtain accurate timing for reception and detection. Further time/frequency synchronization for 480/960kHz SCS will need to be aided by potential use of TRS and other signal/channels, and this means configuring the TRS and other signal/channel along with a new DL BWP with 480/960kHz SCS after initial access.  For Type0-PDCCH, we support only configurations with mux pattern 1. The use of beams at gNB and lack of resource available make it quite difficult to multiplex PDCCH and PDSCH of SIB1 and SSB using mux pattern 3. Therefore, we don’t quite see the need for supporting such cases. However, if companies which to support the cases for flexibility and efficient signal packing purposes, we would be ok to support the other cases. |
| Qualcomm | For SSB with 120kHz, we support Alt 2 for the SCS for CORESET#0 (i.e., support 120kHz, 480kHz, and 960kHz Type0-PDCCH).   * This may be useful in some cases where single SCS operation (other than SSB) is needed   For the Type0-PDCCH configuration: we support Alt 1   * As a special case of mux pattern 1, consider introducing an SSB/CORESET0 multiplexing pattern for higher SCS Type0-PDCCH (480 and 960 kHz), where a time domain fixed location for the CORESET0 and SIB1 is considered. The CORESET0 and SIB1 PDSCH are inserted in the gap slots of the 120 kHz SSB pattern. The advantages of this design may include: After acquiring SSB, if the RSSI of the SSB is good enough and the UE decides not to detect any other SSBs, the UE may sleep until the corresponding CORESET0/SIB1, thus achieve some power saving. Also, a smaller delay between SSB and CORESET0/SIB1 (within the same frame).   For mux pattern 3 (FDM), it may involve mixed numerology at the transmitter |
| Charter Communications | We prefer to first settle the SSB numerology discussion for remaining non-initial access/initial access. If 480 kHz/960 kHz SSB is supported for initial access, then only support 120kHz Type0-PDCCH (current specification). |
| Futurewei | We support Alt-1, we do not see the need Type0-PDCCH for higher SCS. We are open to discuss it after the initial SCS is decided. |
| InterDigital | For the 120kHz SCS, we support Alt1 in the context of supporting the single numerology.  As for the CORESET#0/Type0-PDCCH configuration and allocations in time, we propose to use a (pre)configured configuration to ensure the occupancy of the channel as much as possible to avoid frequent need to LBT in unlicensed spectrums for all supported SCS frequencies. As such, the CORESET#0/Type0-PDCCH would be located either preceding or following the corresponding SSB to be transmitted with the same beam direction and to further reduce the beam switching occasions. |
| LG Electronics | For SCS for CORESET#0, prefer Alt 1 (i.e., current specification)  For Type0-PDCCH configuration, prefer Alt 1, but open to discuss other number of RBs (e.g., 96 RBs) |
| CATT | For 120 kHz SCS SSB, we don’t see evident benefit to support 480 kHz or 960 kHz CORESET#0 SCS. At the same time we see some implementation issues (timing etc)so we support Alt 1 for the SCS of CORESET#0.  For the Type0-PDCCH configuration we also support ALT1 since this configuration simplify implementation |
| Ericsson | We support Alt-1 in both cases.  On the SCS, we think from a coverage perspective, 120 kHz CORESET0 should be used for 120 kHz SSB.  On the CORESET0 configuration, we don't see a need for any changes. We analyzed this quite extensively in our contribution considering different potential outcomes from RAN4, and even the current SSB-CORESET0 offsets are sufficient too. |
| ZTE, Sanechips | For 120kHz SSB SCS, Alt-1 is preferred.  In principle, we think multiplexing between SSB and CORESET#0 with SCS combination {120kHz, 120kHz} should reuse the existing pattern/configuration as much as possible. But considering achieved transmission power and OCB requirements, a larger number of PRBs of CORESET#0 (e.g. 96 PRBs) can also be discussed. |
| NEC | For SSB with 120kHz SCS, we support Alt 1 for the SCS for CORESET#0. For the Type0-PDCCH configuration, we prefer Alt 1 in general, and be open to the discussion in detail. |
| Huawei/HiSilicon | For operation in a shared spectrum, both maximum transmission power limit and power spectrum density limit should be observed and to make full use of the transmit power. As such, in addition to what is already supported, we support 96 RB CORESET#0 for {SSB, CORESET#0} SCS={120, 120} kHz. Both Mux1 and Mux3 patterns can be supported for 96 RB CORESET#0. |
| NTT DOCOMO | For SCS for CORESET#0, our view is to have a middle ground between Alt 1 and Alt 2, i.e., Alt 3) support 120 kHz and 480 or 960 kHz SCS Type0-PDCCH, considering the overhead to be required for Type0-PDCCH SCS indication.  For Type0-PDCCH configuration other than Offset RB, it would not be clear to us if all the existing combinations of SSB/CORESET multiplexing patterns are necessary. For instance, if minimum channel bandwidth supported in 52.6 – 71 GHz is somehow larger, mux pattern with CORESET with smaller number of PRBs would not be necessary. As minimum channel bandwidth is fully up to RAN4 now, we believe Type0-PDCCH configuration should be discussed after RAN4’s decision even for 120 kHz SCS. |
| vivo | For the 120K SSB SCS, Alt. 1 is preferred since it is not beneficial but brings some issues like number of k\_offset bits if 480/960K SCS SSB is supported for initial access case. Otherwise, we are open to discuss Alt. 2.  On the Coreset#0 configurations, we are open to discuss the supported number of RBs. |
| Lenovo, Motorola Mobility | We support Alt1 for SSB with 120kHz (CORESET#0 with 120kHz SCS). Regarding Type0-PDCCH configuration for multiplexing patterns, we prefer Alt1. |
| Spreadtrum | For SCS of CORESET0, we support Alt-1. But if both 120kHz CORESET0 and 480/960kHz CORESET0 (for CGI reporting) are supported, it seems large overhead. Is it possible that only 480/960kHz CORESET exists and 120kHz SSB indicates the location of 480/960kHz SSB (current spec support the non-cell-defining SSB indicates the location of the cell-defining SSB)? |
| Sharp | SCS for CORESET 0: we prefer Alt 1. |
| WILUS | For SCS 120 kHz for CORESET#0, we support Alt 1.  For the Type0-PDCCH configuration, we support Alt 1 but are open to discuss other cases. |
| Sony | For SCS for CORESET#0, we support alt 1 if SSB with 480 kHz and 960 kHz SCS is supported for initial access case.  For Type0-PDCCH configuration, we prefer alt 1. All existing combination could be used. |
| Apple | For SSB with 120kHz SCS, Alt.1 for SCS for CORESET #0.  On the CORESET0 configuration, we prefer Alt.1. |

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

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

* For SSB with 120kHz,
  + SCS for CORESET#0/Type0-PDCCH
    - Alt 1) Only support 120kHz CORESET#0/Type0-PDCCH (current specification)
      * Supported by: Samsung, Intel, Charter (if 480/960kHz is only supported for non-initial access), Futurewei, Interdigital, LG Electronics, CATT, Ericsson, ZTE, Sanechips, NEC, vivo, Lenovo, Motorola Mobility, Spreadtrum, Sharp, WILUS, Sony, Apple
    - Alt 2) support 120kHz, 480kHz, and 960kHz CORESET#0/Type0-PDCCH
      * Supported by: Qualcomm
    - Alt 3) Support 120kHz and either of 480kHz or 960kHz CORESET#0/Type0-PDCCH
      * Supported by NTT Docomo
  + 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}
      * Supported by Qualcomm, LGE (open to support another configuration), CATT, Ericsson, Huawei, HiSilicon, Sony, WILUS, Apple
    - Alt 2) support ={24, 48, 96}.
      * Supported by Samsung, Nokia, Huawei, HiSilicon (support mux 1 & 3 for 96 RB case)
    - Alt 3) support mux pattern 1 only
      * Supported by Intel
    - Alt 4) the CORESET#0/Type0-PDCCH would be located either preceding or following the corresponding SSB
      * Supported by Interdigital

#### **2nd Round Discussion:**

There seems to be good amount of support for only support 120/120kHz SSB/CORESET#0 combination. Also several companies commented on supporting existing combinations, but few companies also mentioned support of 96PRB cases as well. Based on discussion, moderator put together a tentative proposal. Please provide further comments on the proposal.

* For SSB with 120kHz, only support 120kHz CORESET#0/Type0-PDCCH configuration by MIB
  + 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}
  + In addition to above, also support
    - {mux pattern 1, 96 PRB CORESET, 1 symbol CORESET}
    - {mux pattern 1, 96 PRB CORESET, 2 symbol CORESET}
    - {mux pattern 3, 96 PRB CORESET, 2 symbol CORESET}
  + FFS: CORESET#0/Type0-PDCCH CSS location in time domain changes to account for LBT operations

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| **Company** | **Comment** |
| Spreadtrum | Suggest agreeing the existing combinations first. Companies can further check new combinations. |
| Nokia | We are OK with the proposal. |
| LG Electronics | We are OK with the proposal. |

#### **2nd Round Discussion Summary:**

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** |
| Nokia | As noted in our paper, assuming that short control signal exemption is applied at least for SSB, we would need to discuss how to handle the case when only sub-set of SSBs can be transmitted under short control exemption. |
| Samsung | All these topics could be treated later after the major issues are resolved. Should have a better understanding of their necessity by then. |
| Intel | SSB coverage enhancements are out of the scope of the WID. |
| Qualcomm | We agree with Samsung’s comment about deferring these until the major issues are resolved |
| Charter Communications | Support SCSe for SSBs. |
| Futurewei | Support short control LBT exempt for various steps of the initial access. We could leave the discussion for later. |
| CATT | These proposals could be discussed at later stage. Some of the enhancement may not be necessary in this release. |
| Ericsson | We think the SCS exemption for discovery burst (DB) is important, but that is being treated in the Channel Access AI.  SSB coverage enhancement is out of scope for this WI. The WID contains the following note:   * + - Note: coverage enhancement for SSB is not pursued.   We think there is enough to do in this WI without considering additional RS/RS configurations for improved timing. |
| ZTE, Sanechips | These issues are in low priority and can be discussed later. |
| vivo | These issues could be discussed when the major issue is solved. |
| Lenovo, Motorola Mobility | Share the same view as other companies. These issues can be discussed later. |
| Xiaomi | These proposals could be FFS. |

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

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

* Several companies mentioned what we need to discuss short control signal exemption applicability to SSB.
* One companies mentioned RAN1 should discuss how to handle when only sub-set of SSBs can be transmitted under short control exemption.

#### **2nd Round Discussion:**

For other issues mentioned in the 1st round summary, the majority of company suggest to discuss once further details of SSB design is progressed. As for the issue commented by Nokia, companies asked to provide input on hoe to handle when only sub-set of SSBs can be transmitted under short control exemption.

* Alt 1) Specification to support a sub-set of all transmitted of SSBs to be transmitted without LBT under short control exemption, and sub-set of all transmitted of SSB to be transmitted with LBT.
  + If supported, please provide further input on how this case will be handled.
* Alt 2) Specification to only support all transmitted SSB to be transmitted without LBT under short control signal exemption or all transmitted SSB to be transmitted with LBT, i.e. no partial sub-set SSBs not performing LBT due to short control signal exemption rules.
* Alt 3) other alternative {company to provide detail}

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| **Company** | **Comment** |
| Nokia | We would prefer Alt 1). It would be preferable that network can dynamically determine/choose which SSBs are transmitted with short control exemption to allow equal opportunity for different SSBs to be transmitted. As with higher number of beams, with 120khz SSB, there will be limited number of additional candidate locations for SSBs with DBTW, it maybe be necessary to ‘rotate’ SSBs to be sent under short control exemption. |
| LG Electronics | It can be up to gNB’s implementation. |

#### **2nd Round Discussion Summary:**

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 [16] Samsung:
  + Support short PRACH format for all PRACH sequence lengths and all SCSs , and don’t support long PRACH format.
* 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*

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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). |
| Nokia | For non-initial access use cases we propose support following (in addition to the 120kHz):   * + Support 480 and 960 kHz PRACH SCS with sequence length L=139 for PRACH Formats A1~A3, B1~B4, C0, and C2, respectively.   We don’t see strong need to support L=571 and 1151 with 480kHz or 960kHz sub-carrier spacing.  Noting also that initial versus non-initial is not very well defined from RACH perspective, as in all cases, the UE is basically transmitting RACH. In our understanding at least following scenarios would be covered:   * RRC Connection Re-establishment after radio link failure (RRC\_CONNECTED) * Handover (RRC\_CONNECTED) * UL data arrival when the UE is in RRC\_CONNECTED state, with non-synchronized UL * DL data arrival when the UE is in RRC\_CONNECTED state, with non-synchronized UL * UL data arrival when the UE is in RRC\_CONNECTED state and no SR resources * The UE sends a scheduling request in response to UL data arrival but fails to receive an UL grant from the network (RRC\_CONNECTED) * Transition from RRC\_INACTIVE state to RRC\_CONNECTED state * Establishing time alignment when adding SCell (RRC\_CONNECTED) * Request of Other SI (RRC\_IDLE or RRC\_INACTIVE) * Beam failure recovery (RRC\_CONNECTED) |
| OPPO | We support 120, 480, 960 kHz SCS for PRACH |
| Intel | For the sake of truly supporting the single numerology operation, our preference is SCS 120 kHz, 480 kHz, 960 kHz for PRACH (for both initial access and non-initial access cases). |
| Qualcomm | We support 120, 480, 960 kHz SCS for PRACH |
| Charter Communications | We support 120, 480, 960 kHz SCS for PRACH |
| Futurewei | We support 120kHz for PRACH and 480, 960 kHz SCS for non-initial access PRACH as mentioned by LGE. |
| InterDigital | We support 120kHz, 480kHz, and 960kHz SCS to support single numerology operation. |
| CATT | We support 120, 480, 960 kHz SCS for PRACH |
| Ericsson | For non-initial access, we support 480 and 960 kHz SCS PRACH (in addition to 120 kHz). This is useful to be able to configure PRACH with the same SCS as the UL BWP. |
| ZTE, Sanechips | We support 120, 480, 960 kHz SCS for PRACH |
| Huawei/HiSilicon | We consider the support for 480, 960 kHz SCS for PRACH only for non-initial access purposes. For initial access purposes where RACH is configured in ServingCellConfigCommon -> UplinkConfigCommon, only 120 kHz RACH is supported to avoid using more than one SCS during initial access. |
| Samsung | We support 120, 480, 960 kHz SCS for PRACH  Seems our proposal in the tdoc is missing, so please help capturing it in the summary.  **Proposal 5: Support short PRACH format for all PRACH sequence lengths and all SCSs , and don’t support long PRACH format.** |
| NTT DOCOMO | 480 and 960 kHz SCS should be supported for PRACH to align with SSB SCS. The supported use cases should be revisited after completing the discussion on SSB SCS |
| Convida Wireless | We support 120, 480, 960 kHz SCS for PRACH. |
| vivo | We support 120, 480, 960KHz SCS for PRACH |
| Lenovo, Motorola Mobility | We support 480/960kHz in addition to 120kHz for PRACH |
| Sharp | We support 120, 480, 960 kHz SCS for PRACH. |
| Sony | We support 120, 480, 960 kHz SCS for PRACH |
| Fujitsu | We support 120, 480, 960 kHz SCS for PRACH. |
| Apple | For non-initial access case, we support 120, 480, 960 kHz SCS for PRACH |
| Moderator | Added Samsung proposal to the summary |

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

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

* All companies mentioned support for 480kHz and 960kHz.
* LG, Nokia, Futurewei, Huawei/HiSilicon mentioned support for 480kHz and 960kHz SCS PRACH should be for non-initial access.
* Intel mentioned support for 480kHz and 960kHz SCS PRACH should be for non-initial access and initial access cases.

#### **2nd Round Discussion:**

Moderator suggest further discussion based on the following proposal:

* For non-initial access case, support PRACH with 480kHz and 960kHz SCS (in addition to 120kHz SCS).
  + Non-initial access case includes (but may not be limited to):
    - RRC Connection Re-establishment after radio link failure (RRC\_CONNECTED)
    - Handover (RRC\_CONNECTED)
    - UL data arrival when the UE is in RRC\_CONNECTED state, with non-synchronized UL
    - DL data arrival when the UE is in RRC\_CONNECTED state, with non-synchronized UL
    - UL data arrival when the UE is in RRC\_CONNECTED state and no SR resources
    - The UE sends a scheduling request in response to UL data arrival but fails to receive an UL grant from the network (RRC\_CONNECTED)
    - Transition from RRC\_INACTIVE state to RRC\_CONNECTED state
    - Establishing time alignment when adding SCell (RRC\_CONNECTED)
    - Request of Other SI (RRC\_IDLE or RRC\_INACTIVE)
    - Beam failure recovery (RRC\_CONNECTED)

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| **Company** | **Comment** |
| Spreadtrum | Fine |
| Nokia | Firstly to clarify that if we support Type0-PDCCH for 480kHz and 960kHz SSB, we would also support enabling use of 480kHz and 960kHz for RACH in initial access. Our earlier comment referred to the agreement that had been made. As noted above, in RACH terms the split between these two cases is not large.  Hence, we think that afore mentioned cases should be (at least) supported, even if Type0-PDCCH is not provide in 480kHz and 960kHz SSB. |

#### **2nd Round Discussion Summary:**

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, Sharp
    - L=139, 571, 1151: Intel, Futurewei, Samsung, [Interdigital], 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. |
| Nokia | As noted above, we would be fine to confirm the first sub-bullet (non-initial access) based on the agreement made in Tuesday GTW. Second sub-bullet (initial access) could be confirmed if corresponding agreement is made in DL. |
| OPPO | As discussed in our contribution, we don’t see the motivation to support sequence length L=571, 1151 for 480 and 960 kHz PRACH since it doesn’t bring power boosting gain. We support L=139 only for 480kHz and/or 960 kHz SCS PRACH for both initial access case and non-initial access case. |
| Intel | Support moderator’s suggestion.  As for selection of Alt 1 or 2 for the initial access use case, our preference is Alt 2. |
| Qualcomm | For both initial and non-initial access, if 480/960 kHz is agreed to be support, we only support L = 139 (this sequence length is enough to achieve the desired BW requirement for the maximum EIRP allowed) |
| Futurewei | For higher SCS (480/960 kHz) support only short sequence L=139. |
| InterDigital | We are fine to reuse the existing PRACH sequence lengths 571 and 1151. |
| CATT | We support Alt2 |
| Ericsson | For non-initial access we support 480/960 kHz PRACH, but only for L = 139. The PRACH bandwidth for L = 571/1151 far exceeds the bandwidth required to achieve max power under the regulatory requirements. Hence, the link budget will degrade. Note that L = 571/1151 translates to 274/552 MHz for 480 kHz SCS and to 548/1105 MHz for 960 kHz – excessively large bandwidths indeed!  The 2nd FFS for initial access should be deferred until discussions on SSB numerology are concluded. |
| ZTE, Sanechips | We support moderator’s suggestion.  For initial access, we prefer Alt2. |
| Huawei/HiSilicon | For non-initial access use cases, we do not support L=571, 1151 for 480 and/or 960 kHz PRACH SCS.  For initial access use cases, we do not support 480 and/or 960 kHz PRACH SCS as we believe all channels/signals during initial access should be on 120 kHz. |
| Samsung | For the first sub-bullet, we support 480 and 960 kHz PRACH SCS with sequence length L=571, 1151 for PRACH Formats A1~A3, B1~B4, C0, and C2, respectively.  For the second sub-bullet, we support Alt 2. We didn’t see a need to distinguish initial access or non-initial access use cases for PRACH, since anyway the sequence length is configured. |
| NTT DOCOMO | the 1st bullet can be agreed in general. For sequence length, we are not sure if the longer sequences supported in Rel-16 NR-U would be necessary for PRACH with 480/960 kHz SCS. L=139 with larger SCS can achieve sufficient absolute frequency resources. The 2nd bullet needs to be revisited after completing SSB SCS discussion for initial access case. |
| Mediatek | Support only short sequence L=139. |
| vivo | For initial access and non-initial access use cases, we support 480 and/or 960 kHz PRACH SCS with all PRACH sequence length (L=139,571,1151) for PRACH Formats A1~A3, B1~B4, C0, and C2, respectively. |
| Lenovo, Motorola Mobility | We support moderator’s proposal for non-initial access case. For initial access case we prefer Alt2 |
| Sharp | We support only L = 139 for 480kHz and 960 kHz (same as our proposal). |
| Fujitsu | We are fine with moderator’s proposal. |
| Apple | If 480/960 kHz is agreed to be support, we support L = 139 |

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

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

* Previous agreement:
  + 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
* Discussion on FFS:
  + Alt 1) only support L = 139 (current agreement, no FFS)
    - Supported by (10): LGE, OPPO, Qualcomm, Futurewei, Ericsson, Huawei, HiSilicon, NTT Docomo, Sharp, MediaTek, Apple
    - Main reasons: larger PRACH BW are not needed for improving Tx power from PSD limitations
  + Alt 2) support L = 139, 571, 1151
    - Supported by (9): Interdigital, Intel, CATT, ZTE, Sanechips, Samsung, vivo, Lenovo, Motorola Mobility,

#### **2nd Round Discussion:**

There seems to be even split between Alt 1 and Alt 2. Companies support of Alt 1 mentioned that L = 571 and 1151 may not help with improving maximum transmit power in regulatory domains with maximum PSD limitation. Companies supportive of Alt 2 are asked to provide some further clarification of the motivation.

Companies are asked to provide further comments on between Alt 1 and Alt 2 above.

|  |  |
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| **Company** | **Comment** |
| Nokia | We would support Alt1. We don’t see a strong need for L=571 and 1151 with 480kHz and 960kHz. |

#### **2nd Round Discussion Summary:**

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

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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. |
| Nokia | We are fine to support non-consecutive RO’s if they are needed from channel access perspective. For beam switching gap, we would agree with LGE to wait for RAN4 response.  We would support limiting the number of PRACH slots with 480kHz and 960kHz to 1 or 2 in 60kHz reference slot. In case of 2 slots (in reference slot), it could be preferable to distributed the PRACH slots with 480kHz and 960kHz in the 60kHz reference slot. |
| OPPO | Support non-consecutive RO to account for LBT.  For 480/960kHz PRACH, we propose to use the smallest SCS supported in the range of 52.6~71GHz, i.e., 120kHz, as the reference SCS for RO configuration. |
| Intel | Our preference is to have an option of supporting non-consecutive RO to account for beam switching in case of PRACH SCS 480 kHz/960 kHz. RO configuration could be discussed later on.  As for factoring into account LBT, this decision may need to be revisited after RAN1 decides whether or not we will support LBT for PRACH (by using the short control signal exemption rule). We believe the seldom transmission nature of PRACH, make it good candidate to consider PRACH transmission without LBT. In such case, RO definition to account for LBT may not be needed.  For the RO configuration for 480/960kHz SCS, our preference is to leverage existing NR RO configuration and limit 1 (or 2) 480/960kHz RO for each potential 60kHz RO position. |
| Qualcomm | We support non-consecutive ROs to account for beam switching (pending RAN4 feedback on beam switching timings). We don’t believe gaps to account for LBT are needed.  In addition, if we want to leave LBT gap, the LBT gap needs to be on the order of 20us which is already close to a slot or more than a slot. Hence, there is almost no way to do that. Essentially only can configure a PRACH with single RO in time domain, which is already supported in the spec. Note that in NR-U when LBT gap at RO level was proposed, each RO is relatively long due to 15/30 kHz SCS. |
| Charter Communications | There is no support for RO LBT gaps in R16, and the concept is less well-motivated at these higher SCSs with potential SCSe for RACH or Cat-3 LBT. |
| Futurewei | For higher SCS we support non-consecutive ROs for beam switching purposes. PRACH transmission may be LBT exempt (short control signal), however if it is necessary it should be based one shot-LBT. |
| CATT | Non-consecutive RO for beam switching should be discussed after RAN4 feedback. |
| Ericsson | Regarding gaps for beam switching, we are still awaiting feedback from RAN4 so too early to concluded.  Regarding gaps for LBT, we do not support, as we think that RACH should fall under SCS exemption, so LBT not needed.  Regarding RO configuration, perhaps a way forward to to first agree on a high level principle on how many ROs per 60 kHz reference slot should be supported. In FR2, if 120 kHz PRACH is configured, there can be up to 2 ROs per 60 kHz reference slot. Our preference is to maintain the same PRACH processing load at the gNB (operations/unit time) as for 120 kHz PRACH. Hence, for 480/960 kHz PRACH, we suggest the same limitation – up to two ROs per 60 kHz reference slot. It can be further discussed which two ROs can be configured, but knowing how many would be a good first step. |
| ZTE, Sanechips | For the purpose of LBT, it depends on whether PRACH signals can fulfill the short control signaling exemption requirements, and it is being discussed in channel access AI, we can wait for the conclusion.  For the purpose of beam switching, we need to wait for the feedback from RAN4. |
| Huawei/HiSilicon | We support non-consecutive RO to account for LBT. If there is no gap, LBT may fail due to the PRACH transmission from another UE in a preceding RO and different propagation delays at different UEs. |
| Samsung | We support non-consecutive RO to mitigate the impact from LBT. If such non-consecutive RO configuration is supported, it can also be used for the purpose of beam sweeping gap, then there is no need to distinguish the purpose to reserve gap between ROs.  For the RO configuration for 480/960 kHz SCS, we suggest to list all possible solutions based on using existing [60 or 120] kHz PRACH configuration as reference, because there are several aspects to be considered:  1. Whether the smallest PRACH configuration period is still 10ms? (as there will be quite large number of slots in 10ms, so it could be discussed that whether we need to design the RO configuration in such number of slots)?  2. if the smallest PRACH configuration period is still 10ms, then whether we still have RO spreads all 10ms? For example, in 960khz, limit the RO in 1.25ms of the 10ms, and we can total reuse the 120khz RO configuration. This is similar for current NR design that, in 160ms PRACH configuration period but only 10ms contains RO.  3. if the solutions for RO configuration is more clear, then their impact to RA-RNTI aspects could be more clear as well.  Some suggested changes to third bullet:   * RO configuration for 480/960kHz SCS (if agreed)   + FFS: details of how to configure the 480/960 kHz PRACH RO using [60 or 120 kHz] reference PRACH configuration considering at least:     - Whether support PRACH configuration periodicity smaller than 10ms     - Whether support PRACH duration (which actually contains ROs) within 10ms (the smallest PRACH configuration periodicity, and also the PRACH duration in current NR)     - The impact to RA-RNTI calculation     - Other aspects are not precluded. |
| NTT DOCOMO | From our perspective, the only potential motivation to support non-consecutive RO would be to account for beam switching, which is now up to LS reply from RAN4. We should wait for RAN4’s reaction. |
| Mediatek | If beam switching gap is needed, we are ok with non-consecutive. Otherwise, we do not see the need for non-consecutive RO. |
| vivo | We support non-consecutive RO in time domain to avoid LBT failure. Besides, since both PRACH processing load and access efficiency should be considered, the number of 480/960kHz PRACH RO per [60kHz] reference PRACH slot should be carefully selected. |
| Lenovo, Motorola Mobility | We are fine with supporting non-consecutive RO at least to account for beam switching gaps. Details can be discussed after RAN4 feedback. An agreement on whether PRACH is transmitted with LBT or as short control signaling need to be met first before considering non-consecutive RO to account for LBT. |
| Xiaomi | We support non-consecutive RO as an enhancement at least for LBT |
| Sharp | We are open to the discussion if enhancement is necessary. |
| Sony | For non-consecutive RO to account for LBT, it should be discussed after discussion on LBT for PRACH is concluded.  For non-consecutive RO to account for beam switching, we should wait for RAN4’s response. |
| Fujitsu | We support non-consecutive RO to avoid blocking between neighboring ROs due to LBT and/or to have gap for beam switching. We agree with Samsung that it is unnecessary to differentiate the purpose. |
| Apple | Regarding the RO configuration for 480/960kHz SCS (if agreed), our view is to keep the same RO capacity as that of FR2, i.e., up to 2 ROs within a 60kHz SCS reference slot. |

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

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

* Support of non-consecutive RO to account for LBT
  + Needed: Samsung, LGE, OPPO, Fujitsu, vivo, Huawei, HiSilicon, Xiaomi, Fujitsu
  + Not Needed: Intel, Ericsson, Qualcomm, Charter, NTT Docomo
* Support of non-consecutive RO to account for beam switching
  + Needed (for larger SCS): Qualcomm, Intel, Futurewei, MediaTek, Fujitsu
  + Wait for RAN4 LS to decide: Nokia, LGE, Ericsson, Sony, NTT Docomo

#### **2nd Round Discussion:**

Based on feedback, although many companies provide their preferences, it is true that the need to accommodate for LBT seems to depend on short control signal exemption for PRACH, and accounting for beam switching gap required RAN4 input. Therefore, moderator suggests to continue discussion once further progress has been made on beam switching gap in RAN4 and short control signal exemption applicability for PRACH.

As Samsung commented, we could focus on clarifying the FFS aspects of the RO further. Moderator copied the suggested from Samsung. Companies are asked to provide further input on the proposal.

* RO configuration for 480/960kHz SCS (if agreed)
  + FFS: details of how to configure the 480/960 kHz PRACH RO using [60 or 120 kHz] reference PRACH configuration considering at least:
    - Whether support PRACH configuration periodicity smaller than 10ms
    - Whether support PRACH duration (which actually contains ROs) within 10ms (the smallest PRACH configuration periodicity, and also the PRACH duration in current NR)
    - The impact to RA-RNTI calculation
    - Other aspects are not precluded.

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| **Company** | **Comment** |
| Nokia | We would prefer to keep the periodicity at 10ms. Also we would support limiting the number of PRACH slots with 480kHz and 960kHz to 1 or 2 in 60kHz reference slot. Mapping to e.g. 480kHz slot from the 60kHz slot could be defined preserving the distributed RO’s similar to Rel-15. We think that the RA-RNTI formula defined for 120 kHz SCS can be re-used by setting to assumes 480/960 kHz SCS and to assumes 120 kHz SCS. |

#### **2nd Round Discussion Summary:**

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)
    - Futurewei – Use existing formula with 160 for max t\_id
  + 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)
  + Option 4) No change compared to Rel-15/16
    - Note: reference subcarrier spacing for mu for computing t\_id may need to be updated.

#### **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. |
| Nokia | We share the same view as Moderator. |
| OPPO | We share the same view as Moderator. |
| Intel | We’re ok to wait some time for further progress in the discussion about RO. |
| Qualcomm | We share the same view as Moderator. |
| Charter Communications | OK with the moderator proposal. |
| Futurewei | We support Moderator proposal. |
| CATT | Agree that this can be discussed after RO configuration is resolved |
| Ericsson | A 4th option needs to be added to the FL proposal:   * + Option 4) No change compared to Rel-15/16   The reason is that the decision on modifying RA-RNTI computation depends on Issue 2.2.3, i.e., the number of ROs per 60 kHz reference slot. If only up to 2 ROs are supported (as for 120 kHz PRACH in FR2), no modification is needed to the RA-RNTI computation. |
| ZTE, Sanechips | We support moderator’s proposal.  For option 3, we sugggest the following modification:   * + Option 3) multiple RO blocks (segmented RO blocks) with indication ~~in RAR~~   Regarding Ericsson’s suggestion, we think that even with the same density of RO compared to 60kHz reference slot, we still need wo modify the RA-RNTI calculation, because t\_id is the absolute slot index, not logical RO index, we may at least revise the definition of t\_id. |
| Huawei/HiSilicon | Agree with the moderator. This can be discussed in later meetings when other aspects of RACH design are settled. |
| Samsung | As mentioned in above comment, it’s beneficial to combine the discussions and perform an assessment based on a whole picture. |
| NTT DOCOMO | Agree with the moderator’s assessment. |
| vivo | We share the same view as Moderator. |
| Lenovo, Motorola Mobility | Agree with Moderator’s view. |
| Sharp | We agree with moderator’s suggestion. |
| Sony | We share the same view as Moderator. |
| Fujitsu | Share the same view as Moderator. |
| Apple | Share the same view as Moderator. |
| Moderator | Question/Comment to Ericsson:  Moderator shared the same understanding as ZTE’ comment. TS38.321 states:  “t\_id is the index of the first slot of the PRACH occasion in a system frame (0 ≤ t\_id < 80), where the subcarrier spacing to determine t\_id is based on the value of μ specified in clause 5.3.2 in TS 38.211 [8],”, where the μ specified in clause 5.3.2 in TS 38.211 corresponds to the subcarrier spacing of the PRACH (except for the case when long PRACH sequence of 839 is used). Therefore, some updates to how t\_id is based on would need update even if the RO indices are made such that it mimics 60kHz cases.  Therefore, moderator assumed this would be part of option 1. With this said, added option 4 with a note. Please clarify further if this is correct or not. |

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

All companies seem to agree this issue should be discussed once further progress on RO configuration has been made.

#### **2nd Round Discussion:**

Please provide any further comments, if any.

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

#### **2nd Round Discussion Summary:**

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.

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Nokia | As noted, the short control exemption related behavior with RACH from UE and network perspective would need to be discussed, but this can wait until other details have been progressed. |
| Ericsson | We agree with Nokia, the short control signaling exemption is important, and this is being discussed in the Channel Access AI. |
| Huawei/HiSilicon | We think that also the supported SCS for Msg3 in initial UL BWP should be be discussed in this sub-AI. |
| Samsung | We agree with moderator that whether PRACH or other RACH related channels are included in short control signal should be discussed in channel access agenda. |

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

Companies provide comments on short control signal exemption applicability for PRACH and related signals. These issues are being discussed under channel access agenda. Therefore, suggest to revisit issues after channel access agenda conclude on the short control signal exemption applicability.

#### **2nd Round Discussion:**

Please provide any further comments, if any.

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

#### **2nd Round Discussion Summary:**

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.