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Agenda Item: 9.5.3

Source: Moderator (Ericsson)

Title: Summary of AI 9.5.3 for R19 NES

Document for: Discussion

# Introduction

This is the summary for AI 9.5.3 on the adaptation of common signalling for NES based on the views expressed by companies in the contributions listed in the Appendix A and providing topics and proposals for discussion/agreement.

# Adaptation of SSB in time domain

Topic 2.1.1

For the adaptation mechanisms of SSB in time-domain, several companies discussed which of the scenarios to support:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | Yes | No |
| Rel-19 NES-capable UE’s PCell (Connected mode) | A2  adaptation for SSB that is not CD-SSB | Xiaomi, Ericsson, Honor, ZTE, CATT, Tejas, ETRI, Interdigital, Samsung, Huawei/HiSi, Sharp, Sony | LG, Apple, vivo, CMCC (if cell has CD-SSB with normal periodicity),  [Qualcomm (marginal NES gains)?],  SPRD (use TRS instead) |
| Rel-19 NES-capable UE’s PCell (Connected mode) | A3  adaptation for SSB not on sync raster | Xiaomi, Ericsson, Honor, ZTE, CATT, Tejas, ETRI, Interdigital, Samsung, Mediatek, Huawei/HiSi, Sharp, Sony | LG, Apple, vivo,  CMCC (if cell has CD-SSB with normal periodicity),  [Qualcomm (marginal NES gains)?],  SPRD (use TRS instead) |
| Rel-19 NES-capable UE’s SCell | B1  adaptation for CD-SSB | Nokia, [Xiaomi?], Ericsson (not on sync raster), FW, Honor, ZTE, DoCoMo, ETRI, Huawei/HiSi (not on sync raster), Cewit/CT/Sony (for CD-SSB>20ms periodicity), Sharp | LG, Qualcomm, Tejas, vivo, Mediatek  Apple/Interdigital(for CD-SSB>20ms periodicity), Transsion (on sync raster) |
| Rel-19 NES-capable UE in idle/inactive mode |  | Xiaomi, DoCoMo, NEC, [Tejas?], ETRI, SPRD, Sony  Ericsson (at least for cell not providing initial cell selection),  ZTE (cell with only Rel-19 UEs), | LG, Apple, Qualcomm, vivo, Mediatek, Transsion |

Potential points to consider:

* Legacy UE impact when CD-SSB is adapted on the SCell
  + Handling: barring, another freq layer with normal periodicity CD-SSB, etc?
* One main contributor for increased gNB energy consumption is the default 20ms SSB assumption for initial access by legacy UEs
  + If CD-SSB with normal (e.g. 20ms) periodicity is transmitted, no/minimal NES gains when adapting only SSB that is not CD-SSB
* Impact to Rel-19 NES capable UEs in idle/inactive mode
  + Handling: cell accessible only via cell reselection?
* [Nokia] From a connected UE perspective, it does not matter if the adapted SSB is CD-SSB or NCD-SSB because the UE does not need to decode the SIB1 in SCell.

## Discussion point 2.1.1

For Rel-19 NES-capable UE in idle/inactive mode, companies are encouraged to provide their views on the following scenarios from the proponents.

* Scenario 1: Adaptation of CD-SSB in the scenario that cell has only Rel-19 NES-capable UEs.
* Scenario 2: Adaptation of SSB for the scenario where the cell does not provide initial cell selection based on the following:
  + Adaptation for SSB that is not CD-SSB
  + Adaptation for SSB not on sync raster
  + Note: A sparse CD-SSB is present in the cell along with the adaptable SSB that is not CD-SSB.

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| --- | --- |
| Company | Comment |
| CMCC | For scenario 1, CD-SSB adaptation can be applicable if only Rel-19 NES-capable UEs are allowed to access/camp on the cell. But it is relatively hard to find the corresponding scenario in current deployment.  For scenario 2, we do not support the note because a cell that have CD-SSB may be considered as a PCell, SCell or camped cell for UEs. Therefore, since it is already agreed that CD-SSB adaptation (i.e. the periodicity of CD-SSB is larger than 20ms) on PCell is not supported, CD-SSB sparsely transmitted on the corresponding cell may also not that applicable. |
| Spreadtrum | Scenario 2 may be more acceptable by companies |
| Nokia/NSB | Scenario 1: It should be clarified why only Rel-19 NES-capable UEs camp in the cell. Is some kind of cell barring applied for legacy UEs?  Scenario 2: It should be clarified, how idle mode UEs find the cell, why additional NCD-SSBs or SSBs not on the sync raster are needed and how the adaptation is indicated to idle mode UEs. |
| Qualcomm | Scenario 1 should not be supported due to impact to UEs and cell search latency.  For scenario 2, since gNB may not be aware of whether there are idle UEs in the cell and if there are some, gNB may not know how many UEs, we wonder how gNB would know when to activate the additional SSBs? |
| Apple | For Scenario 1, we have a general concern on supporting CD-SSB adaptation, since it was already agreed to not support CD-SSB adaptation for CONNECTED UEs’ PCell. We do not see the motivation to support it for IDLE/INACTIVE UEs.  For Scenario 2, since cell selection/reselection in IDLE/INACTIVE operation are all based on CD-SSBs on sync raster, we do not see the NES gain to support another set of not CD-SSBs for IDLE/INACTAIVE UEs. |
| ZTE, Sanechips | For Scenario 1, considering the refarming spreaturm, where legacy UE are not inherently aware of, CD-SSB can be adapted in PCell for Rel-19 NES capable UE in idle/inactive mode in order for obtaining large NES gain.  For Scenario 2, we can understand NCD-SSB adaptation for idle/inactive mode UEs is to reduce the sync delay for paging. In current specification, TRS is able to do the same work. So our concern is that the difference between this scheme and the TRS mechanism is unclear. |
| CATT | For scenario 1, adaptation of CD-SSB can be considered if Rel-19 NES-capable UE can support initial access on the adapted CD-SSB.  For scenario 2, since NCD-SSB is configured by RRC signaling, it should be clarified how does idle/inactive UE aware of NCD-SSB configuration? If the intention of scenario 2 is to add some SSB before paging PDCCH, it can be resolved by legacy TRS mechanism. We don’t the clear motivation on scenario 2. |
| Moderator | Proposal in 2.1.1.  If either of Option 1 or 2 are not agreed, moderator suggests to conclude the discussion by capturing the following conclusion.  No consensus to support adaptation of SSB in time domain for Rel-19 NES-capable UE in idle/inactive mode. |
| Fujitsu | We support proposal 2.1.1.  Regarding option 1, our understanding is that scenario 1 is different from that in the following agreement.  **Agreement**  For adaptation mechanism(s) of SSB in time-domain,   * For Rel-19 NES-capable UE’s PCell (Connected mode), adaptation of CD-SSB on sync raster is not supported   The above agreement is subject to a cell with both legacy and Rel.19 NES capable UEs. This is because currently we only have the agreement (the one shown below) to support a cell with both legacy and Rel.19 NES capable UEs. In that sense, a cell with only Rel.19 NES-capable UEs is a completely new case, and the above agreement is not applied for it.  **Agreement**  Adaptation mechanism(s) of SSB in time-domain is supported at least for one of the following scenario(s):   * For cell with both legacy UEs and Rel-19 NES-capable UEs   + Rel-19 NES-capable UE’s PCell (Connected mode)     - Study from the following options:       * Option A1: adaptation for CD-SSB       * Option A2: adaptation for SSB that is not CD-SSB       * Option A3: adaptation for SSB not on sync raster   + Rel-19 NES-capable UE’s SCell     - Study from the following options:       * Option B1: adaptation for CD-SSB       * Option B2: adaptation for SSB that is not CD-SSB       * Option B3: adaptation for SSB not on sync raster   + FFS: Rel-19 NES-capable UE in idle/inactive mode * Note: Impact to idle/inactive UEs shall be minimized |
| ITRI | For a cell with only Rel.19 NES-capable UEs, adaptation of CD-SSB 1 can be supported.  For a cell with CD-SSB periodicity > 20ms, adaptation for SSB that is not CD-SSB can be supported. |
| LGE | Do not support Proposal 2.1.1.  We support to capture the conclusion above suggested by Moderator. |

## Proposal 2.1.1

For Rel-19 NES-capable UE in idle/inactive mode, select from the following options.

* Option 1: Support adaptation of SSB for Scenario 1
  + Scenario 1: Adaptation of CD-SSB in the scenario that cell has only Rel-19 NES-capable UEs.
* Option 2: Support adaptation of SSB for Scenario 2
  + Scenario 2: Adaptation of SSB for the scenario where the cell does not provide 20ms (or smaller than 20ms) periodicity CD-SSB for initial cell selection based on the following:
    - Adaptation for SSB that is not CD-SSB
    - Adaptation for SSB not on sync raster and is not CD-SSB
    - Note: A sparse CD-SSB is present in the cell along with the adaptable SSB that is not CD-SSB.

## Discussion point 2.1.2

Companies are encouraged to provide their comments on whether/how to support adaptation of SSB in time domain for Rel-19 NES-capable UE’s PCell for the following cases:

* Adaptation for SSB that is not CD-SSB is supported (A2)
* Adaptation for SSB not on sync raster is supported (A3)

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| --- | --- |
| Company | Comment |
| CMCC | Not support this proposal.   * A PCell shall have the periodically transmitted CD-SSB. * CD-SSB adaptation on PCell is not supported in previous agreement. * As we mentioned in our tdoc, SSB not on sync raster/not CD-SSB adaptation while CD-SSB is always transmitted per 20ms has very marginal NES gain.   Thus, the motivation to support SSB not on sync raster/not CD-SSB adaptation on PCell is unclear. |
| Spreadtrum | Adaptation for SSB not on sync raster can be prioritized |
| Panasonic | When the cell is operating fast adaptation on SSB in time-domain, SSB should be “not located on synchronization raster” or “non-cell-defining SSB” regardless of PCell or SCell.  When the cell is not operating fast adaptation on SSB in time-domain, SSB can be located on synchronization raster and it can be cell-defining SSB regardless of PCell or SCell |
| Nokia/NSB | We do not see a reason why network would send A2 or A3 SSBs in addition to CD-SSB with 20ms periodicity in the same BWP. So, we assume that SSBs A2 and A3 are transmitted in a different BWP than CD-SSB. We are fine to consider adaptation of those NCD-SSBs (A2 or A3) configured in the UE specific DL BWP configuration. |
| Qualcomm | For Pcell, the motivation to adapt SSBs in A2/A3 is weak (NCD-SSB on or off sync raster) or unclear (CD-SSB off sync raster):   * In the current specification for Pcell, CD-SSB is always transmitted and NCD-SSB can be configured to support redcap in the BWP without CD-SSB. If NCD-SSB is transmitted, its periodicity and timing match those of CD-SSB (see NonCellDeginingSSB-r17 from TS38.331). This means that the gNB will be in an active state to transmit the CD-SSB when it is transmitting the NCD-SSB. If at a given time instance the network doesn’t transmit the NCD-SSB in the same time it is transmitting CD-SSB, the energy saving gain will be marginal. Hence, energy saving gain of time domain adaptation of NCD-SSB in Pcell is marginal. * For the CD-SSB that is not on sync-raster, it is not clear what is the use case of this SSB in the practical deployment. |
| Apple | For PCell, on top of CD-SSB on sync raster, we do not see where the NES gain comes from by configuring another set of NCD-SSBs for adaptation. |
| ZTE, Sanechips | We support NCD-SSB adaptation in the PCell. In the scenario that the Pcell is other UEs’ SCell, and NCD-SSB adaptation is supported in the SCell, why cannot support it in PCell, because gNB would transmit the SSB based on single SSB configuration in the same Cell. |
| CATT | We prefer to support NCD-SSB. There are two reasons:   1. NCD-SSB adaptation on SCell has been supported in last meeting. And one UE’s SCell can be another UE’s PCell, so NCD-SSB adaptation on PCell should be also supported. 2. When a NCD-SSB is configured on a cell with CD-SSB, a time offset between NCD-SSB and CD-SSB can be configured, then NCD-SSB and CD-SSB are in TDM mode. In this case, the NCD-SSB adaptation can obtain NES gains by adapting the periodicity of NCD-SSB.   And in current spec, what’s the use case for the SSB not on sync raster? Could proponent provide an explanation? |
| Moderator | Companies can continue to provide comments on the discussion point. |
| ITRI | We prefer A2 (Adaptation for SSB that is not CD-SSB is supported) for adaptation of SSB in time domain for Rel-19 NES-capable UE’s PCell. |
| LGE | We prefer to support SSB adaptation only in the SCell for the reasons mentioned in our contribution. |

## Discussion point 2.1.3

Companies are encouraged to provide their comments on whether/how to support adaptation of SSB in time domain for Rel-19 NES-capable UE’s SCell for the following case:

* Adaptation for CD-SSB (B1)

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| --- | --- |
| Company | Comment |
| CMCC | Not support this proposal.  As we mentioned in our tdoc, a SCell for one UE may also be considered as a PCell, SCell or camped cell for another UEs. Therefore, since it is already agreed that CD-SSB adaptation (i.e. the periodicity of CD-SSB is larger than 20ms) on PCell is not supported, adaptation for CD-SSB on SCell may also not that applicable. |
| Spreadtrum | For SCell, CD-SSB adaptation is deprioritized |
| Panasonic | Same comment as 2.1.2. |
| Nokia/NSB | We support adaptation of CD-SSB in Scell. Whether SSB in Scell is CD-SSB or NCD-SSB does not matter because UE does not need to decode SIB1 in Scell. If the cell is used as Pcell for some other UE, gNb can decide not to adapt CD-SSB. Cell barring can be used to prevent idle mode UEs to camp in the cell. |
| Qualcomm | We do not support adapting of CD-SSB on the sync raster. In addition, the use cases of CD-SSB off sync raster is unclear to us. |
| Apple | Similar to 2.1.1, we have a general concern on supporting CD-SSB adaptation, since it was already agreed to not support CD-SSB adaptation for CONNECTED UEs’ PCell. We do not see the motivation to support it for SCell. |
| ZTE, Sanechips | We support adaptation of CD-SSB in SCell. From the perspective of existing specification, either CD-SSB or not CD-SSB can be configured based existing network, and adapting CD-SSB/not CD-SSB may yield significant NES benefits. In order to address concern of legacy UE impact, cell barring in the MIB of CD-SSB and SIB1 can be considered. |
| Moderator | Companies can continue to provide comments on the discussion point. |
| ITRI | For adaptation of SSB in time domain for Rel-19 NES-capable UE’s SCell, adaptation for CD-SSB (B1) should not be a prioritized solution. In our opinion, adaptation for NCD-SSB is sufficient for adaptation of SSB in time domain for Rel-19 NES-capable UE’s SCell. |
| LGE | Agree with Apple. |
| CEWiT | SImilar views as Nokia |

Several companies provided their views on extending Cell DTX to SSB adaptation.

* Option 1 (One SSB burst periodicity is configured for the UE and UEs assumes SSB transmissions are not present during Cell DTX non-active period)
  + CATT, Samsung, CT
* Option 2 (UE assumes SSB transmission with different periodicities during Cell DTX non-active period and during Cell DTX active period)
  + LG, FW, NEC, Oppo
* Option 3 (Cell DTX does not impact UE assumption on SSB transmissions (i.e. legacy behavior) – no spec impact)
  + Fujitsu, Apple, Interdigital, vivo, Huawei, Google, Ericsson, Mediatek, Honor, [Xiaomi?],[Nokia?], [DoCoMo?]

## Proposal 2.1.4

For Cell DTX extension to SSBs not on sync-raster for connected mode UEs, select Option 3, i.e. Cell DTX does not impact UE assumption on SSB transmissions (i.e. legacy behavior).

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| --- | --- | --- |
| Company | Support (Y/N) | Comment |
| CMCC | Y, and | This can be deprioritized until the scenario for SSB adaptation is crystal clear. |
| Spreadtrum | Y | For connected UEs, TRS is not impacted by cell DTX, but SSB as QCL source of TRS is impacted by cell DTX. It is strange. |
| Nokia/NSB | Y |  |
| Qualcomm |  | We are ok with the proposal |
| Apple | Y |  |
| NEC | N | We do not support Option 3. To enable network sleeping during cell DTX non-active duration, ideally all channels including SSB should be inactive, SMTC configuration alignment and TRS impact could be resolved by network implementation. |
| Samsung | N | NOT support.  As we clarified in our contribution, cell DTX outperforms other proposed solutions for the SSB adaptation, before deprioritizing cell DTX, proponents of other solutions should justify the performance gain of other solutions over cell DTX. |
| Moderator |  | Companies can continue to provide their views on the proposal, including addressing issues raised above. |
| ITRI | N | In our opinion, cell DTX operation can be jointly consider with the adaptation of SSB since the combination can provide more NES gain. |
| LGE |  | We are not opposed to supporting Option 3, but may follow the majority view for the sake of progress. |
| CEWiT | N | DTX can provide better energy savings and enable more oppurtunities for the gNB to sleep |

# Adaptation of PRACH

Several companies provided their views on the adaptation mechanisms for the PRACH in time-domain, including configuration aspects, SSB-RO mapping, adaptation mechanisms.

* Alt 1 only (i.e. Same PRACH configuration index between legacy and additional PRACH resources)
  + Qualcomm, DoCoMo
* Alt 2 only (i.e. Different PRACH configuration index between legacy and additional PRACH resources)
  + FW, Apple, NEC, Panasonic, ZTE, Honor, Tejas, Interdigital, Oppo
* Both Alt 1 and Alt 2 (Same or different PRACH configuration between legacy and additional PRACH resources)
  + Nokia, LG, Huawei/HiSi, Samsung, Ericsson, Mediatek, vivo, Xiaomi, Fujitsu, CATT, CMCC, Google, CT

## Proposal 3.1.1

For adaptation of PRACH in time-domain, support both of the following

* Alt 1: The PRACH configuration index for the additional PRACH resources is same as the PRACH configuration index for the legacy resources
* Alt 2: The PRACH configuration index for the additional PRACH resources is different from the PRACH configuration index for the legacy resources
* FFS: Additional details

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| --- | --- | --- |
| Company | Support (Y/N) | Comment |
| Nokia/NSB | Y | None |
| CMCC | Y | Fine with the proposal |
| Tejas | Y |  |
| Panasonic |  | Want to clarify regarding the sub-options below these alternatives. In the previous agreement alt 1 had two more options (as below) in addition to muting/masking and timing offset.   * Opt 1-1: Scaled/adjusted PRACH configuration period * Opt 1-2: Adjusting the parameters (e.g., (x, y) value and slot number) of the PRACH configuration   This can lead to too many options for RO positions and increases complexity at both UE side PRACH preparation and network side detection without substantial merits. |
| Qualcomm |  | We prefer discussing Proposal 3.1.3 first or jointly discuss this proposal with Proposal 3.1.3 |
| Moderator |  | Closed. |

Additional frequency domain parameters

Several companies discussed supporting configuration of additional frequency domain parameters, such as frequency offset and frequency starting point.

* Support configuration of additional frequency domain parameters.
  + Vivo, LGE, Fujitsu, Nokia, CATT, Huawei/HiSi
* No need for additional frequency domain parameters. The legacy frequency offset parameter , can be configured independently for legacy and additional PRACH resources.
  + Tejas

## Proposal 3.1.2

For adaptation of PRACH in time-domain, frequency domain parameters can be configured separately for the additional PRACH resources.

|  |  |  |
| --- | --- | --- |
| Company | Support (Y/N) | Comment |
| Nokia/NSB | N | We would prefer to have a more step-by-step approach here. Which frequency domain parameters are we considering here? For instance, if we support the configuration of more than 1 , i.e., one for legacy and one for additional RO resources, this can have an impact on the overall spectrum occupancy of ROs, significantly reducing spectral efficiency as well. This will trivially impact other network operations, e.g., scheduling of other UL channels/signals, which may prevent gNB from entering any meaningful sleeping mode. This is also one of the reasons why typical implementations minimize the bandwidth footprint of ROs on the field. Could FL list the “frequency domain parameters” we are considering in this proposal and check whether companies are OK with all of them, please? |
| CMCC | Y | Ok with the proposal. Separately configure frequency domain parameter can be useful while the time domain configuration for both legacy and additional PRACH resources are fully/partly overlapped. |
| Tejas | Y | From 38.211 🡪”The quantity is given by the higher-layer parameter *msgA-RO-FrequencyStart* if configured and a type-2 random-access procedure is initiated as described in clause 8.1 of [5, TS 38.213], otherwise by *msg1-FrequencyStart* as described in clause 8.1 of [5 TS 38.213];”  For multiplexing additional and legacy PRACH resources across frequency, the parameters and *msg1-FDM,* can be configured independently to legacy and additional PRACH resources. |
| Qualcomm |  | After taking another look at the proposal after the offline, we think “frequency domain parameters” is too broad. We believe the proposal only needs to focus on configuration of *msg1-FrequencyStart* for 4-step RACH or *msgA-RO-FrequencyStart* for 2-step RACH  Furthermore, this discussion should only be applicable to Case 2 that was agreed before.  **Agreement**  For adaptation of PRACH in time-domain, support at least the following case(s)   * Case 1: no time-domain overlap between the additional PRACH resources for NES-capable UEs and the PRACH resources for legacy UEs * Case 2: time-domain overlap but no overlap in frequency domain between the additional PRACH resources for NES-capable UEs and the PRACH resources for legacy UEs * Case 3: additional PRACH resources for NES-capable UEs and legacy PRACH resources overlap neither in time nor frequency domains * FFS: whether additional conditions are needed to support the above cases * FFS: Additional case whether full/partial overlap in both time and frequency is allowed * Above does not preclude discussion for the case where the configuration for additional PRACH resources contains legacy PRACH resources   **Suggested proposal:**   * **For adaptation of PRACH in time-domain, the following parameter(s) can be configured separately for the additional PRACH resources.**   + ***msg1-FrequencyStart* for 4-step RACH**   + ***msgA-RO-FrequencyStart* if PRACH adaptation is applied to 2-step RACH**   **This is only applicable to Case 2.** |
| Moderator |  | Proposal is updated to 3.1.2-rev1 |

## Proposal 3.1.2-rev1

For adaptation of PRACH in time-domain, the frequency domain resources for the additional PRACH resources and legacy PRACH resources can be separate

* FFS: applicable case(s) (i.e. case(s) from the RAN1#117 agreement).
* Discuss further following options for signaling
* Option 1: The following parameter(s) can be configured separately for the additional PRACH resources.
  + msg1-FrequencyStart for 4-step RACH
  + msgA-RO-FrequencyStart if PRACH adaptation is applied to 2-step RACH
* Option 2: Offset(s) to legacy frequency domain parameter(s) are configured for the additional PRACH resources
  + FFS: applicable legacy frequency domain parameter(s)

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| --- | --- | --- |
| Company | Support (Y/N) | Comment |
| CATT | Y | The frequency domain resources for the additional PRACH resources should be supported to avoid overlapping between legacy and additional PRACH resources. We believe the simplest method is to define a unified solution for all the applicable cases. Since once legacy and additional PRACH resources have different periodicities, it is possible parts of ROs are time-domain overlapping, and another parts of ROs are non-time domain overlapping. It’s hard to define hat the frequency domain resources are valid only for the ROs in time-domain overlapping, and are invalid for the ROs in non-time domain overlapping.  For the options for signalling, we slight prefer Option1 which follows legacy configuration. |
| Moderator |  | Proposal is updated in 3.1.2-rev2. |

## Proposal 3.1.2-rev2

For adaptation of PRACH in time-domain, the frequency domain resources for the additional PRACH resources and legacy PRACH resources can be same or different

* FFS: applicable case(s) (i.e. case(s) from the RAN1#117 agreement).
* Discuss further following options for signaling
* Option 1: at least the following parameter(s) can be configured separately for the additional PRACH resources.
  + msg1-FrequencyStart for 4-step RACH
  + FFS: other applicable legacy frequency domain parameter(s)
* Option 2: Offset(s) to legacy frequency domain parameter(s) are configured for the additional PRACH resources
  + FFS: applicable legacy frequency domain parameter(s)

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| --- | --- | --- |
| Moderator |  | Closed. |

Preamble format

Some companies mentioned that the preamble format should be the same for legacy and additional PRACH resources.

* + Nokia, Apple, Transsion

## Proposal 3.1.3

For adaptation of PRACH in time-domain, the same PRACH preamble format is used for the additional RACH resources and legacy PRACH resources.

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| Company | Support (Y/N) | Comment |
| Nokia/NSB | Y | None |
| CMCC | Y | Fine with the proposal. |
| Tejas | Y | Support |
| Spreadtrum | Y |  |
| Qualcomm | Y | Please see our comments in Proposal 3.1.1 |
| Apple | Y |  |
| Moderator |  | Closed. |

Several companies provided inputs on the DCI formats and RNTIs for carrying the adaptation indication, for connected and idle modes,

* DCI format 1\_0
  + Nokia, Huawei/HiSi, Qualcomm, Apple, Mediatek, DoCoMo, Xiaomi, CT, Fujitsu, Ericsson, CMCC, ZTE, CATT, Panasonic, vivo, Sony, Lenovo, Interdigital, Google
    - P-RNTI
      * Nokia, Xiaomi, Ericsson, Fujitsu, Apple, CATT, DoCoMo, Interdigital. Lenovo
    - SI-RNTI
      * Xiaomi, Ericsson, Fujitsu, CMCC
    - RA-RNTI
      * Xiaomi
    - C-RNTI
      * Lenovo/Google/Apple (for connected mode)
    - New RNTI
      * Fujitsu, Interdigital, ZTE, Tejas, ETRI, Sony
* DCI format 2\_7
  + Huawei/HiSi, Qualcomm, CMCC, ZTE, Panasonic, vivo, Oppo, Interdigital
  + No: DoCoMo
* DCI format 2\_9
  + FW, ZTE/vivo/Oppo (for connected mode), Sony, CT (if enhanced cell DRX for PRACH is supported),
  + No: DoCoMo

## Proposal 3.1.4

For DCI-based adaptation for additional PRACH resources, at least DCI format 1\_0 can carry the adaptation indication for UEs in idle/inactive and connected mode.

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| --- | --- | --- |
| Company | Support (Y/N) | Comments |
| Nokia/NSB | Y | Support |
| CMCC | Y | Support the proposal |
| Tejas | Y | Support the proposal |
| Lenovo | Y+comment | We think it is not necessary to support all discussed RNTIs with DCI format 1\_0, so a further agreement on applicable RNTIs is necessary. |
| Spreadtrum | Y |  |
| Panasonic | N | DCI 1\_0 scrambled with P-RNTI requires paging to all NES-capable UEs which can cause large overhead. A new RNTI can be used with DCI 1\_0 to resolve this issue but there will be issue regarding interpretation of DCI 1\_0 format.  It is also huge standardization effort to discuss which field should be used and/or reinterpreted for PRACH resource adaptation. |
| Qualcomm |  | We suggest narrowing down the RNTI in the proposal **as follows**:   * For DCI-based adaptation for additional PRACH resources, at least DCI format 1\_0 **with P-RNTI** can carry the adaptation indication for UEs in idle/inactive and connected mode.   + **FFS: DCI format 1\_0 with other RNTI** |
| Moderator |  | To be handled directly in main session. |
| Moderator |  | Closed. |

In last meeting, the following was agreed for the DCI-based adaptation for additional PRACH resources.

***Agreement***

*For DCI-based adaptation for additional PRACH resources, select only from the following alternatives*

* *Alt 1: (PRACH resource configuration level) DCI-based adaptation to indicate whether the additional PRACH resources provided by semi-static signalling are available or not*
  + *FFS: details*
* *Alt 2: (subset of PRACH resource level) DCI-based adaptation to indicate whether a subset of the additional PRACH resources provided by semi-static signalling are available or not*
  + *FFS: whether the subset of the additional PRACH resources is in* 
    - *Alt 2-1: RO level per SSB*
    - *Alt 2-2: SSB-to-RO mapping cycle level*
    - *Alt 2-3: PRACH association period level*
    - *Alt 2-4: PRACH association pattern period level*
    - *Alt 2-5: SFN level*
* *Alt 3: DCI-based Enhanced/new Cell DRX to indicate whether the enhanced/new Cell DRX is activated or deactivated.*
  + *If activated, the additional configured PRACH provided by semi-static signalling within non-active period are not available.*
  + *FFS: whether Alt 1 and/or Alt 2 can be applied to the active period*
  + *FFS: details*

Several companies provided their views on adaptation mechanism for PRACH in time domain.

* Alt 1 (PRACH resource configuration level)
  + Huawei/HiSi, FW, Mediatek, DoCoMo, vivo, Xiaomi, CATT, Ericsson, ZTE, Oppo
* Alt 2 (subset of PRACH resource level)
  + Nokia, Qualcomm, Apple, Samsung, DoCoMo, Xiaomi, Panasonic, CT, Fujitsu, Oppo, Cewit, Sony
* Alt 3: DCI-based Enhanced/new Cell DRX for PRACH
  + FW, Samsung, CT, NEC
  + No/deprioritize: Nokia, Apple, DoCoMo

## Discussion point 3.1.5

Given company inputs, FL suggestion is to focus further discussion on Alt 1 and Alt 2. Companies are requested to provide their comments on it.

|  |  |
| --- | --- |
| Company | Comments |
| Nokia/NSB | We fully support FL’s indication. We suggest focusing on these two alternatives, which are the ones supported by most companies, given:   1. The limited available time, 2. the fact that no company argues that Alt. 1 or Alt. 2 cannot work, 3. that 3 out of 4 companies supporting Alt 3 also have a second preference in Alt.1 or Alt. 2. |
| CMCC | Support Alt1 as it is the most straightforward way. |
| Tejas | Support Alt2 as it is the most straightforward way. We support Alt 2-5 i.e., adaptation at SFN level. Using Alt 2-5 we can create condensed PRACH resources across time. And the overhead for indicating the available PRACH resources can be minimal. |
| Lenovo | Alt 1 seems sufficient, we are not aware of a strong need or benefit justifying any of the Alt 2 variants. |
| Spreadtrum | Slightly support Alt2 |
| Panasonic | Support |
| Apple | We would like to explain more on the benefit of Alt 2.  The motivation for the subset level of PRACH resources is to configure condensed/clusterd RO so that NW could stop monitoring PRACH in a longer duration, more over, this would also reduce the impact on RACH latency for the UE.  Take the following configuration as example:    Assuming that legacy UEs are configured with a PRACH resource with 80ms periodicity (illustrated in Fig.(a), assuming 2 SSBs and resulting in 160ms PRACH association pattern period for simplicity), for the additional PRACH resource, 40ms periodicity is assumed, so 80ms PRACH association pattern period is resulted, see Fig.(b). NW could stop PRACH monitoring for almost 40ms if the additional PRACH resources are activated. If 10ms periodicity for additional PRACH resources are configured, NW could sleep for only 10ms, see Fig. (c)  If a subset of the PRACH resources are muted on top of the additional PRACH resources, either in SSB-to-RO mapping cycle level, PRACH association period level or PRACH association pattern period level, resulting in a condensed PRACH resource effect, then it would create more opportunities for NW to stop PRACH monitoring without sacrificing UE RACH latency. In Fig.(d), three PRACH association (pattern) periods (20ms) are muted, while the available pattern periods provides a 80ms access latency which is the same as Fig.(b), while the NW sleep time is around 70ms which is almost doubled compared to Fig.(b) by using 40ms PRACH configuration periodicity. |
| Moderator | Proposal in 3.1.5 based on the above. |

## Proposal 3.1.5

For DCI-based adaptation for additional PRACH resources, further select from Alt 1, Alt 2 (from RAN1#118 agreement), and Alt 3 is deprioritized.

|  |  |  |
| --- | --- | --- |
| Company | Support (Y/N) | Comment |
| CATT | Y |  |
| NEC | N | Alt 3 supports better and easy alignment of PRACH transmissions with cell DRX active duration hence maximize NES gain during cell DTX non-active period. |
| Moderator |  | Companies can continue to provide their views, including addressing issues raised above as well as any further detailed aspects related to different alternatives. |
| LGE |  | Fine with proposal.  We think Alt 1 should be supported as baseline and prefer to support Alt 2. |
| CEWiT | N | we think a combination of the Alternatives can be considered including ALt 3 |

# Adaptation of Paging

Many proposals submitted for this are related to the PO/PF determination and paging-related configuration/procedures defined in RAN2 specifications. As per the agreement in earlier RAN1 meeting, such aspects are expected to be handled by RAN2.

Regarding the adaptation, some companies discussed/proposed that using SI update mechanism is sufficient, while some others proposed to consider/support dynamic adaptation of paging. Few companies also suggested to wait for RAN2 progress.

## **Moderator suggestion for RAN1#118bis: continue to wait for RAN2 progress.**

# Other

Some contributions also discussed joint adaptation of more than one common signal/channel.

# Conclusion

# Appendix A (Contributions)

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | **[R1-2407621](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407621.zip)** | Discussion of the adaptation of common signal/channel transmissions | FUTUREWEI |
| 2 | **[R1-2407687](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407687.zip)** | On common channel/signal adaptation for eNES | Huawei, HiSilicon |
| 3 | **[R1-2407713](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407713.zip)** | Discussion on adaptation of common signal/channel transmissions | Spreadtrum Communications |
| 4 | **[R1-2407740](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407740.zip)** | Discussion on common signal/channel adaptation | China Telecom |
| 5 | **[R1-2407759](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407759.zip)** | Adaptation of common signals/channels | Tejas Network Limited |
| 6 | **[R1-2407794](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407794.zip)** | Adaptation of common signal/channel transmissions | Nokia, Nokia Shanghai Bell |
| 7 | **[R1-2407868](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407868.zip)** | Discussions on adaptation of common signal/channel transmissions | vivo |
| 8 | **[R1-2407912](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407912.zip)** | Discussion on adaptation of common signal/channel transmissions | CMCC |
| 9 | **[R1-2407976](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407976.zip)** | Discussion on adaptation of common signal and channel transmissions | Xiaomi |
| 10 | **[R1-2407997](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2407997.zip)** | Adaptation of Common Signals | Google |
| 11 | **[R1-2408054](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408054.zip)** | Discussion on adaptation of common signal/channel transmissions | CATT |
| 12 | **[R1-2408073](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408073.zip)** | Discussion on common signal channel for NES | ZTE Corporation, Sanechips |
| 13 | **[R1-2408123](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408123.zip)** | Discussion on adaptive transmission of common signal or common channel | Transsion Holdings |
| 14 | **[R1-2408134](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408134.zip)** | Discussion on adaptation of common signal/channel transmission | OPPO |
| 15 | **[R1-2408235](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408235.zip)** | Discussion on adaptation of common signal channel transmissions | HONOR |
| 16 | **[R1-2408313](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408313.zip)** | Discussion on adaptation of common signal/channel transmissions | InterDigital, Inc. |
| 17 | **[R1-2408352](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408352.zip)** | Discussion on adaptation of common signal/channel transmission | Panasonic |
| 18 | **[R1-2408367](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408367.zip)** | Adaptation of common signals and channels | Lenovo |
| 19 | **[R1-2408378](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408378.zip)** | Discussion on adaptation of common signal/channel transmissions | NEC |
| 20 | **[R1-2408415](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408415.zip)** | Adaptation of common signal/channel transmissions | Sony |
| 21 | **[R1-2408475](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408475.zip)** | On adaptation of common signal/channel for NES enhancements+B19 | Apple |
| 22 | **[R1-2408501](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408501.zip)** | Discussion on adaptation of common signal / channel transmissions | Fujitsu |
| 23 | **[R1-2408574](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408574.zip)** | Adaptation of common signal/channel transmissions | ETRI |
| 24 | **[R1-2408607](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408607.zip)** | Discussion on adaptation of common signal/channel transmissions | Sharp |
| 25 | **[R1-2408653](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408653.zip)** | Adaptation of common signal/channel transmissions | Samsung |
| 26 | **[R1-2408678](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408678.zip)** | Adaptation of common signal/channel transmissions | LG Electronics |
| 27 | **[R1-2408708](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408708.zip)** | Adaptation of common signal/channel transmissions | MediaTek Inc. |
| 28 | **[R1-2408793](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408793.zip)** | Discussion on adaptation of common signal/channel transmissions | NTT DOCOMO, INC. |
| 29 | **[R1-2408819](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408819.zip)** | Adaptation of common signal/channel transmissions for NES | Ericsson |
| 30 | **[R1-2408857](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408857.zip)** | Adaptation of common channel transmissions | Qualcomm Incorporated |
| 31 | **[R1-2408936](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408936.zip)** | Discussion on adaptation of common signal and channel transmissions | CEWiT |
| 32 | **[R1-2408950](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118b/Docs/R1-2408950.zip)** | Adaptation of Common Signals and Channels for NES | Fraunhofer IIS, Fraunhofer HHI |

# Appendix B (WI objectives from WID in [RP-242354](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_105/Docs/RP-242354.zip))



# List of RAN1 agreements

## RAN1#116

**Agreement**

For adaptation of SSB in time-domain, consider the following adaptation mechanisms for further study

* Adaptation of SSB burst periodicity
* Adaptation based on two SSB configurations where up to two configurations can be active
* Adaptation based on skipping/transmitting some SSB bursts non-uniformly with single SSB configuration
* Adapting the transmitted number of SSBs within a SSB burst
* Cell DTX for SSB adaptation
* Whether to support new SSB burst periodicity value(s)
* Whether to support new SSB burst(s) (i.e. how SSB transmission is made within a burst)
  + New compact SSB burst(s)
  + Adapting the position of SSBs within a SSB burst
* Other mechanisms/combinations are not precluded

**Agreement**

For adaptation of PRACH in time-domain, consider the following adaptation mechanisms for further study

* Adaptation based on configuration of additional[/different] PRACH resources for NES-capable UEs in addition to PRACH resources for legacy UEs (if any)
  + Note: NES-capable UEs can use both additional PRACH resources and PRACH resources for legacy UEs
* For the additional PRACH resources,
  + Adaptation of PRACH resource periodicity/PRACH occasion
  + Adaptation at PRACH configuration/association period/association pattern period level and SSB to RO mapping cycle
  + Adaptation based on extending cell DRX operation for PRACH
  + Concentrating ROs in time domain
* Other options are not precluded

**Agreement**

For adaptation of paging,

* Study further from RAN1 perspective, techniques for adaptation of paging occasions in time-domain and achievable network energy savings
* Note: Specification details for PO/PF determination and paging-related configuration/procedures to be handled by RAN2

**Agreement**

For the adaptation mechanisms of SSB in time-domain, study further applicable scenarios and associated legacy UE impact/handling (if any) based on the following:

* Applicability to UE in idle/inactive and/or connected mode
* Applicability to PCell and/or SCell(s)

**Agreement**

For the adaptation mechanisms of SSB in time-domain, study further following mechanisms:

* Adaptation mechanism indicated or configured by gNB without UE trigger
* Adaptation triggered by UE (if any)

FFS: Details of associated signaling/indication/configuration

**Agreement**

For the adaptation mechanisms of PRACH in time-domain

* Support at least PRACH adaptation provided by gNB without UE trigger
  + FFS: PRACH adaptation with UE trigger
  + Note: UE trigger means UE requests adaptation of PRACH
* Study at least the following,
  + Dynamic signaling and/or semi-static signaling of PRACH adaptation
  + Adaptation of PRACH transmission according to certain condition
  + Applicability to idle/inactive and/or connected mode UEs
  + Which scenarios the adaptation mechanism is applicable to (e.g. cell with both legacy and Rel-19 UE, cell with only Rel-19 UEs)

## RAN1#116bis

**Agreement**

For indication of adaptation of SSB in time-domain,

* Support at least SSB adaptation provided by gNB without UE trigger

**Agreement**

For adaptation of PRACH in time-domain, support at least the following:

* Adaptation based on additional PRACH resources for NES-capable UEs in addition to PRACH resources for legacy UEs (if any)
  + Note: NES-capable UEs can use both additional PRACH resources and PRACH resources for legacy UEs
  + Configuration of additional PRACH resources is provided by semi-static signalling
    - FFS: details including whether there is overlap of additional PRACH resources and PRACH resources for legacy UEs
  + FFS: adaptation mechanism for additional PRACH resources
  + Note: No change to the existing PRACH configuration tables in 38.211

**Agreement**

For adaptation of PRACH in time-domain, support the following:

* SSB-RO mapping for the additional PRACH resources is separate from the SSB-RO mapping of the PRACH resources for legacy UEs (if any)
  + FFS: whether/how to handle SSB-RO mapping if the additional PRACH resources overlap in both time and frequency with the PRACH resources for legacy UEs
  + Note: SSB-RO mapping of the PRACH resources for legacy UEs is not impacted if Rel-19 UE uses these PRACH resources
  + FFS: SSB-RO mapping for the additional PRACH resources

**Agreement**

Support adaptation mechanisms of PRACH in time-domain for following:

* UE in idle/inactive mode
* UE in connected mode

**Agreement**

Adaptation mechanism(s) of SSB in time-domain is supported at least for one of the following scenario(s):

* For cell with both legacy UEs and Rel-19 NES-capable UEs
  + Rel-19 NES-capable UE’s PCell (Connected mode)
    - Study from the following options:
      * Option A1: adaptation for CD-SSB
      * Option A2: adaptation for SSB that is not CD-SSB
      * Option A3: adaptation for SSB not on sync raster
  + Rel-19 NES-capable UE’s SCell
    - Study from the following options:
      * Option B1: adaptation for CD-SSB
      * Option B2: adaptation for SSB that is not CD-SSB
      * Option B3: adaptation for SSB not on sync raster
  + FFS: Rel-19 NES-capable UE in idle/inactive mode
* Note: Impact to idle/inactive UEs shall be minimized

Agreement

For adaptation of PRACH in spatial domain,

* Study possibility of scenarios with non-uniform distribution of UEs in different beams
  + - Note 6: Companies are encouraged to provide details on how they map UEs to different beams
* Study network energy savings gain achieved by non-uniform PRACH resource allocation across SSBs for scenarios with non-uniform distribution of UEs in different beams (if any),
  + - Assume the following framework for network energy evaluation in FR1 and companies to report at least the below settings used in the evaluation/simulation
      * 20ms SSB period
      * 30kHz SCS, DDDSU TDD pattern
      * Setting A: SIB1 period (20ms/40ms/160ms)
      * Setting B1: Cell load (Empty/low/medium)
      * Setting B2: Traffic model
      * Setting C: SIB1 PDSCH time domain resource index in 38.214 Table 5.1.2.1.1-2
      * Setting D: CORESET0/SSB multiplexing pattern including controlResourceSetZero (index) in 38.213 Table 13-6, and searchSpaceZero (index) in 38.213 Table 13-11
      * Setting E1: PRACH configurations
        + (legacy) PRACH resources according to the following PRACH configuration for all transmitted SSBs
      * Case A1-1: PRACH configuration #5 (20ms)
      * Case A1-2: PRACH configuration #17 (10ms)
      * Case A2-1: PRACH configuration #0 (160ms)
        + (time-domain PRACH adaptation) Additional and legacy PRACH resources yielding total PRACH resources that are according to one of the following PRACH configuration for all transmitted SSBs
      * Case B1: PRACH configuration #17 (10ms)
      * Case B2: PRACH configuration #0 (160ms)
      * Companies to report details of assumed time domain adaptation mechanism
        + (spatial-domain PRACH adaptation) Additional and legacy PRACH resources yielding total PRACH resources that are according to one of the following PRACH configuration
      * Case C1: PRACH configuration #17 (10ms)
      * Case C2: PRACH configuration #0 (160ms)
      * Companies to report details of assumed spatial domain adaptation mechanism, including details of non-uniform PRACH resource allocation across SSBs
      * Setting F: Cat 1/Cat 2 BS as defined in TR38.864
      * Setting G1: Number of SSB beams: 4,8 SSBs in a SSB burst with SSB pattern case C
      * Note 1: Baseline to compare is Case C1 vs Case B1/A1-1/A1-2, Case C2 vs Case B2/A2-1
      * Note 2: It is up to company to report the SSB-RO mapping ratio and FDMed RO number, etc
      * Note 3: Other PRACH configuration index with different PRACH format other than format 0 is not precluded
      * Note 4: Other SSB/SIB1/RACH periodicity/PRACH resource/configuration assumptions are not precluded (up to companies to report)
    - Other frameworks for network energy evaluation are not precluded, e.g. including for FR2

## RAN1#117

**Agreement**

For the study of adaptation of PRACH in spatial domain, following network energy savings gains were reported by sources based on the evaluation framework agreed in RAN1#116bis:

* Two sources showed following NES gain for TDD, CAT1 BS power model, case C1 vs A1-1, zero load [R1-2404409, R1-2405107]
  + -4% ~ -45%
* Seven sources showed following NES gain for TDD, CAT1 BS power model, case C1 vs B1/A1-2, zero load [R1-2404225, R1-2404185, R1-2404334, R1-2404123, R1-2404562, R1-2405107, R1-2405163]
  + 0% ~ 31%
  + Note: Five sources assumed that case B1 has same PRACH resources as case A1-2. Remaining two sources evaluated only A1-2.
  + Note: Three sources showed NES gains 0% ~ 10% [R1-2404225, R1-2404185, R1-2404334]
* One source showed following NES gain for TDD, CAT1 BS power model, case C1 vs B1, zero load [R1-2404464]
  + 1.0%~8.8%
  + Note: The evaluation results provide the extra NES gain of spatial domain PRACH adaptation compared to time domain PRACH adaptation, where spatial domain and time domain PRACH adaptations are based on dynamic switching between PRACH resources according to two PRACH configuration indexes.
* One source showed following NES gain for TDD, CAT1 BS power model, case C1 vs B1, zero load [R1-2404626]
  + -48.41%~0%
  + Note: For B1, it was assumed that periodicity of PRACH resources can be adapted. For C1, it was assumed that periodicity of PRACH resources is not adapted and some ROs within a periodicity can be deactivated.
* One source showed following NES gain for TDD, CAT1 BS power model, for case C1 vs A1-2, zero load [R1-2404626]
  + 4.59%~38.04%
  + Note: For C1, it was assumed that periodicity of PRACH resources is not adapted and some ROs within a periodicity can be deactivated.
* Four sources showed following NES gain for TDD, CAT2 BS power model, case C1 vs B1/A1-2, zero load [R1-2404562, R1-2404225, R1-2403943, R1-2404626]
  + 0% ~ 3.5%
  + Note: Three sources assumed that case B1 has same PRACH resources as case A1-2. One source evaluated only A1-2.
* One source showed following NES gain for TDD, CAT2 BS power model, case C1 vs B1, zero load [R1-2404464]
  + 0%~0.2%
  + Note: The evaluation results provide the extra NES gain of spatial domain PRACH adaptation compared to time domain PRACH adaptation, where spatial domain and time domain PRACH adaptations are based on dynamic switching between PRACH resources according to two PRACH configuration indexes
* One source showed following NES gain for TDD, CAT2 BS power model, case C1 vs B1, zero load [R1-2404626]
  + -1.19%~0%
  + Note: For B1, it was assumed that periodicity of PRACH resources can be adapted. For C1, it was assumed that periodicity of PRACH resources is not adapted and some ROs within a periodicity can be deactivated.
* Two sources showed following NES gain for TDD, CAT1 or CAT2 BS power model, case C2 vs B2, zero load [R1-2403943, R1-2405107]
  + Less than 0.2%
* One source showed following NES gain for TDD, CAT1 BS power model, (C1 vs A1-2 with changed PRACH format), PRACH format A, 10ms PRACH periodicity, different loads [R1-2403980]
  + 13.7%/8.7%/4.9%/2.6% for zero/low/light/medium cell load
* One source showed following NES gain for TDD, CAT1 BS power model, (C1 vs B1 with changed PRACH format), PRACH format A, 10ms PRACH periodicity, different loads [R1-2403980]
  + 8.03%/5.1%/3.06%/1.74% for zero/low/light/medium cell load
* One source showed following NES gain for TDD, C1 vs B1/A1-2, different loads [R1-2404562]
  + 16%/4.78% for light/medium cell load for CAT1 BS power model
  + 0.65%/0.29% for light/medium cell load for CAT2 BS power model
* One source showed following NES gain for TDD, C1 vs B1, different loads [R1-2404626]
  + -18.57%~0%/-2.52%~0% for low /medium cell load for CAT1 BS power model
  + -0.81%~0%/-0.42%~0% for low /medium cell load for CAT2 BS power model
  + Note: For B1, it was assumed that periodicity of PRACH resources can be adapted. For C1, it was assumed that periodicity of PRACH resources is not adapted and some ROs within a periodicity can be deactivated.
* One source showed following NES gain for TDD, C1 vs A1-2, different loads [R1-2404626]
  + 3.67%~19.88%/2.29%~5.22% for low /medium cell load for CAT1 BS power model
  + 0.67%~1.75%/0.39%~0.91% for low /medium cell load for CAT2 BS power model
  + Note: For C1, it was assumed that periodicity of PRACH resources is not adapted and some ROs within a periodicity can be deactivated.
* One source showed NES gain for FDD, C1 vs B1, zero load [R1-2404464]
  + 1.4%~7% for CAT1 BS power model
  + 0%~0.3% for CAT2 BS power model
  + Note: The evaluation results provide the extra NES gain of spatial domain PRACH adaptation compared to time domain PRACH adaptation, where spatial domain and time domain PRACH adaptations are based on dynamic switching between PRACH resources according to two PRACH configuration indexes
* One source showed NES gain for FR2, CAT1 BS power model, spatial domain adaptation of PRACH configuration index 75 vs a time domain adaptation of PRACH configuration index 75, zero load [R1-2405163]
  + 4%~7%
* Note 1: About possibility of scenarios with non-uniform distribution of UEs in different beams
  + Several companies indicated (and three companies showed data/analysis) that there can be scenarios with non-uniform distribution of UEs in different beams.
  + Several companies mentioned that for non-uniform UE distribution, it can be addressed by gNB implementation e.g. by adjusting SSB beamwidth, etc. Several companies also mentioned that it is not clear how gNB can predict the distribution of UEs in different beams, especially for Idle/Inactive UEs.
* Note 2: Most sources that showed the NES gains (if any) for adaptation of PRACH in spatial domain compared to A1-2/B1 observed that the gain would be due to reduction in the number of overall ROs in time domain in their evaluations. Most of these companies only accounted for ROs in time domain.
* Note 3: The evaluation results assumed the non-uniform distribution of UE is static during the evaluation time period.

**Conclusion**

There is no consensus in RAN1 on the support of PRACH adaptation in spatial domain

**Agreement**

For adaptation of PRACH in time-domain, support at least the following case(s)

* Case 1: no time-domain overlap between the additional PRACH resources for NES-capable UEs and the PRACH resources for legacy UEs
* Case 2: time-domain overlap but no overlap in frequency domain between the additional PRACH resources for NES-capable UEs and the PRACH resources for legacy UEs
* Case 3: additional PRACH resources for NES-capable UEs and legacy PRACH resources overlap neither in time nor frequency domains
* FFS: whether additional conditions are needed to support the above cases
* FFS: Additional case whether full/partial overlap in both time and frequency is allowed
* Above does not preclude discussion for the case where the configuration for additional PRACH resources contains legacy PRACH resources

**Agreement**

At least for the case where legacy ROs and additional ROs overlap in neither time nor frequency domain, for adaptation of PRACH in time-domain, the SSB-RO mapping rule for additional PRACH resources follows the legacy SSB-RO mapping rule.

* Mapping SS/PBCH block indexes to valid additional PRACH occasions provided by semi-static signalling follows the legacy mapping order for preamble/time resource/frequency/PRACH slot indexes.
  + Note: This mapping is not impacted by time domain PRACH adaptation
* Validation rules for the additional PRACH resources follow the legacy validation rules for PRACH resources configured for legacy UEs.

**Agreement**

For adaptation of SSB in time-domain, Option 1 is supported

* Option 1: Adaptation of SSB burst periodicity using one or more SSB burst periodicity value(s)
* Note: Using Option 2 to realize Option 1 is not precluded
  + Option 2: Adaptation based on two SSB configurations [where up to two configurations can be active]
    - FFS: details of the differences between the two SSB configurations, e.g. two different periodicities
* FFS: Details including applicable scenarios
* FFS: Support of Cell DTX for connected mode UEs for SSB

**Agreement**

For adaptation of PRACH in time-domain, the additional PRACH resources are configured based on at least:

* a PRACH configuration index
* FFS: whether the PRACH configuration index is same and/or different from the PRACH configuration index for the legacy PRACH resources

Study further the following

* When the PRACH configuration index for the additional PRACH resources is same as the PRACH configuration index for the legacy resource,
  + Additional parameter(s) for determining the additional PRACH resources e.g.
    - Scaled/adjusted PRACH configuration period
    - Additional timing offset
    - Adjusting the parameters (e.g., (x, y) value and slot number) of the PRACH configuration
    - Muting/masking ROs
* When the PRACH configuration index for the additional PRACH resources is different from the PRACH configuration index for the legacy resource
  + Additional mechanisms (if any) for determining the additional PRACH resources e.g.
    - Muting/masking ROs (e.g. for the case when the PRACH configuration index for the additional PRACH resources contains legacy resources)
* Additional parameters to facilitate condensed/cluster RACH resources in time-domain (including whether needed)

**Agreement**

For the adaptation mechanism for additional PRACH resources, study further the following:

* Option 1: Higher layer signalling (with potential enhancements) based PRACH resource adaptation
* Option 2: L1-based adaptation to indicate whether the additional PRACH resources provided by semi-static signalling are available or not
  + FFS: details
  + Strive to re-use existing DCI format(s)
* Option 3: Adaptation of PRACH transmission according to predefined condition(s)
  + FFS: details
* Option 4-rev1: L1-based adaptation to indicate whether a subset of the additional PRACH resources provided by semi-static signalling are available or not
  + FFS: whether the subset of the additional PRACH resources is in RO level / SSB-to-RO mapping cycle level/PRACH association period level/PRACH association pattern period level for time-domain PRACH adaptation
  + Strive to re-use existing DCI format(s)
* Option 5: Enhanced cell DRX

## RAN1#118

**Agreement**

For adaptation of PRACH in time-domain, select at least one from the following alternatives for configuration of the additional PRACH resources

* Alt 1: The PRACH configuration index for the additional PRACH resources is same as the PRACH configuration index for the legacy resources and
  + Discuss further additional mechanism(s) for determining the additional PRACH resources, e.g.
    - Opt 1-1: Scaled/adjusted PRACH configuration period
    - Opt 1-2: Adjusting the parameters (e.g., (x, y) value and slot number) of the PRACH configuration
    - Opt 1-3: Muting/masking ROs
    - Opt 1-4: additional timing offset(s)
* Alt 2: The PRACH configuration index for the additional PRACH resources is different from the PRACH configuration index for the legacy resources,
  + Discuss further additional mechanism(s) for determining the additional PRACH resources, e.g.
    - Opt 2-1: Muting/masking ROs (e.g. for the case when the PRACH configuration index for the additional PRACH resources contains legacy resources)
    - Opt 2-2: Additional timing offset(s)
* FFS: Additional parameters to facilitate condensed/cluster RACH resources in time-domain (including whether needed)
* FFS: Additional frequency domain parameter(s) (e.g., freq. starting offset)

**Agreement**

Extend the RAN1#117 agreement on SSB-RO mapping rule for additional PRACH resources to Case 1

* Case 1: no time-domain overlap between the additional PRACH resources for NES-capable UEs and the PRACH resources for legacy UEs

***RAN1#117 Agreement***

*At least for the case where legacy ROs and additional ROs overlap in neither time nor frequency domain, for adaptation of PRACH in time-domain, the SSB-RO mapping rule for additional PRACH resources follows the legacy SSB-RO mapping rule.*

* *Mapping SS/PBCH block indexes to valid additional PRACH occasions provided by semi-static signalling follows the legacy mapping order for preamble/time resource/frequency/PRACH slot indexes.*
  + *Note: This mapping is not impacted by time domain PRACH adaptation*
* *Validation rules for the additional PRACH resources follow the legacy validation rules for PRACH resources configured for legacy UEs.*

**Agreement**

For SSB-RO mapping rule for additional PRACH resources for Case 2.

* Extend the RAN1#117 and RAN1#118 agreements on SSB-RO mapping

**Agreement**

For the adaptation mechanism for additional PRACH resources (for CONNECTED mode UE and IDLE/INACTIVE mode UE),

* At least DCI based adaptation is supported. No introduction of new DCI format.

**Agreement**

For adaptation mechanism(s) of SSB in time-domain,

* For Rel-19 NES-capable UE’s PCell (Connected mode), adaptation of CD-SSB on sync raster is not supported
  + FFS: Adaptation for SSB that is not CD-SSB is supported (A2)
  + FFS: Adaptation for SSB not on sync raster is supported (A3)
* For Rel-19 NES-capable UE’s SCell
  + Adaptation of SSB configured for the SCell is supported for the following cases
    - FFS: Adaptation for CD-SSB (B1) including UE impact compared to legacy operation where the SSB is configured with periodicity>20msec for SCell
    - Adaptation for SSB that is not CD-SSB on sync raster (B2’)
    - Adaptation for SSB that is not CD-SSB not on sync raster (B3’)

**Agreement**

For DCI-based adaptation for additional PRACH resources,

* Select from the following DCI format(s) to carry the adaptation indication.
  + DCI format 1\_0
  + DCI format 2\_7
  + DCI format 2\_9
* FFS: existing (P-RNTI, SI-RNTI, CellDTRX-RNTI, PEI-RNTI, C-RNTI) or new RNTI used for detecting the DCI format

**Agreement**

For Cell DTX extension to SSBs not on sync-raster for connected mode UEs, select from following options

* Option 1: One SSB burst periodicity is configured for the UE and UEs assumes SSB transmissions are not present during Cell DTX non-active period
* Option 2: UE assumes SSB transmission with different periodicities during Cell DTX non-active period and during Cell DTX active period
* Option 3: Cell DTX does not impact UE assumption on SSB transmissions (i.e. legacy behavior) – no spec impact

**Agreement**

For DCI-based adaptation for additional PRACH resources, select only from the following alternatives

* Alt 1: (PRACH resource configuration level) DCI-based adaptation to indicate whether the additional PRACH resources provided by semi-static signalling are available or not
  + FFS: details
* Alt 2: (subset of PRACH resource level) DCI-based adaptation to indicate whether a subset of the additional PRACH resources provided by semi-static signalling are available or not
  + FFS: whether the subset of the additional PRACH resources is in
    - Alt 2-1: RO level per SSB
    - Alt 2-2: SSB-to-RO mapping cycle level
    - Alt 2-3: PRACH association period level
    - Alt 2-4: PRACH association pattern period level
    - Alt 2-5: SFN level
* Alt 3: DCI-based Enhanced/new Cell DRX to indicate whether the enhanced/new Cell DRX is activated or deactivated.
  + If activated, the additional configured PRACH provided by semi-static signalling within non-active period are not available.
  + FFS: whether Alt 1 and/or Alt 2 can be applied to the active period
  + FFS: details