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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) | A1  adaptation for CD-SSB | Nokia(consider) , Xiaomi, Fujitsu (at least for non-initial access cell),FW, ZTE (at least for non-initial access cell) , Panasonic, Honor, Interdigital (at least), NEC (at least), ETRI (at least), DoCoMo (at least), Intel (at least), Sharp (at least), Cewit(at least) | LG, Qualcomm, Mediatek, vivo, Apple, CT (deprioritize) |
| Rel-19 NES-capable UE’s PCell (Connected mode) | A2  adaptation for SSB that is not CD-SSB | Nokia(consider), Ericsson (at least), FW, Samsung, Panasonic, Honor, CATT (at least), Mediatek, CT (at least) | CMCC (if cell has CD-SSB with normal periodicity) |
| Rel-19 NES-capable UE’s PCell (Connected mode) | A3  adaptation for SSB not on sync raster | Nokia(consider), FW, Samsung, Panasonic, Honor, Mediatek, Transsion | CMCC (if cell has CD-SSB with normal periodicity) |
| Rel-19 NES-capable UE’s SCell | B1  adaptation for CD-SSB | Nokia(consider) , Xiaomi, Fujitsu, FW, Panasonic, Honor, Interdigital (at least) , NEC (at least) , ETRI (at least), DoCoMo (at least) , Intel (at least), Sharp (at least) , Cewit(at least) | LG, Qualcomm, Mediatek, vivo, Apple |
| Rel-19 NES-capable UE’s SCell | B2  adaptation for SSB that is not CD-SSB | Nokia(consider), Xiaomi, LG, Ericsson (at least), FW, Samsung, , Panasonic, Honor, CATT (at least), Mediatek, Huawei/HiSi, CT (at least) | CMCC (if cell has CD-SSB with normal periodicity) |
| Rel-19 NES-capable UE’s SCell | B3  adaptation for SSB not on sync raster | Nokia(consider), Xiaomi, LG, FW, Samsung, Panasonic, Honor, vivo, Mediatek, Huawei/HiSi, Transsion | CMCC (if cell has CD-SSB with normal periodicity) |
| Rel-19 NES-capable UE in idle/inactive mode |  | Nokia (discuss UE impacts), Xiaomi, Fujitsu (consider adapting CD-SSB for >20ms), Ericsson (not CD-SSB, at least for non-initial access cell), FW, ZTE (within 20ms for initial access cell), Panasonic, Honor, Interdigital, NEC, ETRI, DoCoMo, Intel, Cewit?, Sony, Spreadtrum | LG, Qualcomm, Apple, vivo, Mediatek, Transsion |

Potential points to consider:

* Legacy UE impact when CD-SSB is adapted
  + 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?

## Proposal 2.1.1a

For cell with both legacy UEs and Rel-19 NES-capable UEs

* For Rel-19 NES-capable UE’s PCell (Connected mode) not providing initial cell selection
  + Adaptation for SSB that is not CD-SSB is supported (A2)
  + Adaptation for SSB not on sync raster is supported (A3)
  + FFS: Adaptation for CD-SSB
* For Rel-19 NES-capable UE’s PCell (Connected mode) providing initial cell selection
  + Adaptation of CD-SSB not supported at least for cases resulting in SSB periodicity >20ms
  + FFS: adaptation for CD-SSB between SSB periodicity <=20ms
  + FFS: Adaptation for SSB that is not CD-SSB is supported (A2)
  + FFS: Adaptation for SSB not on sync raster is supported (A3)

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| --- | --- | --- |
| Company | Support (Y/N) | Comments |
| Spreadtrum |  | For connected UEs, if SSB periodicity is reduced, TRS should be assisted, since performance of reception is critical for connected UEs. |
| CMCC |  | Regarding the first bullet, in current NR, a PCell shall always be a cell that can provide initial cell selection (or transmit CD-SSB). Thus, how to achieve this need some further study.  Regarding the second bullet, we are confused for the case that CD-SSB adaptation within the periodicity of 20ms. In real deployment, the CD-SSB is normally transmit with the periodicity of 20ms. Thus, can proponents explain how the NES gain is obtained? |
| Google | Y |  |
| LG Electronics | No | It is not clear to us in which case PCell does not provide initial cell selection. |
| Panasonic | Y | Adaptation for CD-SSB, non-CD-SSB and SSB not on sync raster should be supported. The adaptation of SSB not on sync raster can be prioritized. |
| Moderator |  | Proposal is updated to 2.1.1ab-rev1. |

## Proposal 2.1.1b

For Rel-19 NES-capable UE’s SCell (from UE perspective)

* Adaptation of SSB configured for the SCell is supported for the following cases
  + Adaptation for CD-SSB (B1)
  + Adaptation for SSB that is not CD-SSB(B2)
  + Adaptation for SSB not on sync raster (B3)

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| Company | Support (Y/N) | Comments |
| CMCC | Y, and | We suggest to further study whether legacy UE can treat the corresponding cell as a SCell. |
| Google | Y |  |
| LG Electronics | No | Support Option B2 and/or Option B3.  If SSB adaptation is applied to CD-SSB, it would have an impact on idle/inactive mode UEs, resulting in performance degradation due to inaccurate time/frequency synchronization, initial access, etc. |
| Panasonic | Y | Adaptation for CD-SSB, non-CD-SSB and SSB not on sync raster should be supported. The adaptation of SSB not on sync raster can be prioritized. |
| Moderator |  | Proposal is updated to 2.1.1ab-rev1. |

## Proposal 2.1.1ab-rev1

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

* For Rel-19 NES-capable UE’s PCell (Connected mode) providing initial cell selection
  + Adaptation of CD-SSB is not supported [at least for cases resulting in SSB periodicity >20ms]
  + [FFS: adaptation for CD-SSB between SSB periodicity <=20ms]
  + 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 (from UE perspective)
  + Adaptation of SSB configured for the SCell is supported for the following cases
    - Adaptation for CD-SSB (B1)
    - Adaptation for SSB that is not CD-SSB(B2)
    - Adaptation for SSB not on sync raster (B3)
* FFS: For Rel-19 NES-capable UE’s PCell (Connected mode) not providing initial cell selection

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| Company | Comment |
| Moderator | Closed. |

## Proposal 2.1.1c

Study further the following for Rel-19 NES-capable UE in idle/inactive mode

* + Option 1: Adaptation of CD-SSB
  + Option 2: Adaptation of CD-SSB at least for a cell not providing initial cell selection
    - FFS: whether R19 NES-capable UE can use the cell for initial cell selection
  + Option 3: Adaptation of SSB that is not CD-SSB at least for a cell not providing initial cell selection
    - FFS: whether R19 NES-capable UE can use the cell for initial cell selection
    - FFS: Adaptation for CD-SSB
  + Option 4: No additional SSB adaptation mechanism is specified

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| --- | --- | --- |
| Company | Support (Y/N) | Comments |
| Spreadtrum | Y |  |
| CMCC | Y |  |
| Google | Y |  |
| LG Electronics | Y | Option 4 is preferred. |
| Panasonic | Y |  |
| Moderator |  | Proposal is updated to 2.1.1c-rev1. |

## Proposal 2.1.1c-rev1

Study further the following for Rel-19 NES-capable UE in idle/inactive mode

* + [Option 1: Adaptation of CD-SSB]
  + Option 2: Adaptation of CD-SSB at least for a cell not providing initial cell selection
    - FFS: whether R19 NES-capable UE can use the cell for initial cell selection
  + Option 3: Adaptation of SSB that is not CD-SSB at least for a cell not providing initial cell selection
    - FFS: whether R19 NES-capable UE can use the cell for initial cell selection
    - FFS: Adaptation for CD-SSB
  + Option 4: No additional SSB adaptation mechanism is specified

Topic 2.1.2

Several companies provided their views on how to adapt SSB burst periodicity for the SSB in time-domain.

* Adaptation of SSB burst periodicity
  + Nokia, [Xiaomi?], [Fujitsu?], Ericsson, Tejas, Qualcomm, ZTE, Panasonic, CMCC, [Apple?],CATT ETRI, DoCoMo,[vivo?], [Oppo?], Mediatek, [Lenovo?], [Fraunhofer?], [Sharp?], [Transsion?], Google, [Sony?], [Spreadtrum?]
* Adaptation based on two SSB configurations
  + Nokia, LG, Ericsson, FW?, Tejas, CMCC, Honor, Interdigital, Intel, Huawei/HiSi (for SCell), Cewit, ITRI
* Extending Cell DTX for SSB adaptation
  + LG,FW, Samsung, CMCC, NEC, CATT, DoCoMo(for SCell only), Fraunhofer, China Telecom, Denso

It seems the only difference between the two SSB configuration would be related to the involved periodicities.

## Proposal 2.1.2a

For adaptation of SSB in time-domain, support SSB adaptation based on two SSB configurations

* At least SSB periodicity is different between the two SSB configurations
* Note: at least ssb-PositionsInBurst" and "ss-PBCH-BlockPower" are same between the two SSB configurations
* FFS: other settings between the two SSB configurations
* FFS: whether the two SSB configurations can be active

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| --- | --- | --- |
| Company | Support (Y/N) | Comments |
| Spreadtrum |  | Two SSB configurations are too complicated |
| CEWiT |  | We are not supportive of the note in the proposal. Since the number of transmitted SSBs can be different for additional SSB burst based on the traffic or UE densities at the time of adaptation. For e.g. more SSBs can be there in always on SSB burst with larger periodiity however the number of SSBs may be reduced for SSBs with shorter periodicity at the time of adaptation. |
| CMCC |  | We are open to discuss, but it is better to have a common understanding for applicable scenario at first. |
| Google |  | We think it is better to clarify whether only one SSB configuration can be activated or not. |
| LG Electronics |  | We are fine with the main bullet and first sub-bullet, but it is better to change Note to FFS for the second bullet. |
| ITRI | Y | At least two SSB configurations |
| Tejas | Y | SSB periodicity can be same or different between the two SSB configurations. Don’t restrict them to be different. |
| CATT | Y | We think only ssb periodicity is different between two SSB configurations.  For second bullet, if two SSB configurations can active, then it equals only the SSB configuration with short ssb periodicity is active. |
| Moderator |  | Proposal is updated to 2.1.2a-rev1. |
| ZTE, Sanechips | Y | If only periodicity parameter is different from two SSB configurations, we think that configuring two SSB periodicity in one SSB configuration should be the straightforward way for SSB adaptation in time domain. |
| Qualcomm |  | The current formulation of the proposal goes beyond the Option 1 that was agreed last meeting since SSB configuration is broad. We should also note that adaptation based on *ss-PBCH-BlockPower* is equivalent to power domain SSB adaptation which is out of the WI scope while it is debatable on whether adaptation based on ssb-PositionsInBurst is equivalent to time or spatial domain adaptation. We don’t see any other SSB-related parameters that can be adapted for time domain SSB adaptation.  To make further progress based on agreed Option 1 and possible use of Option 2 to realize Option 1, we suggest the following modification. Proposal 2.1.2a-rev1 For adaptation of SSB in time-domain, support SSB adaptation based on two SSB burst periodicity configurations where at least one SSB burst periodicity configuration is active   * FFS: time domain adaptation based on *ssb-PositionsInBurst* * FFS: whether more than one SSB burst periodicity configuration can be active |

## Proposal 2.1.2a-rev1

For adaptation of SSB in time-domain, support SSB adaptation based on two SSB configurations where at least one configuration is active

* At least SSB periodicity can be same or different between the SSB configurations
* ssb-PositionsInBurst" and "ss-PBCH-BlockPower" are same between the SSB configurations
* FFS: whether ssb-PositionsInBurst" and "ss-PBCH-BlockPower" can be different between the SSB configurations is supported
* FFS: other settings between the SSB configurations
* FFS: whether more than one SSB configuration can be active

## Proposal 2.1.2b

For adaptation of SSB in time-domain, support extending Cell DTX to SSBs for connected mode UEs

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| --- | --- | --- |
| Company | Support (Y/N) | Comments |
| CEWiT | Y |  |
| CMCC |  | We are open to discuss, but it is better to have a common understanding for applicable scenario at first. |
| Google |  | We think this should be considered with low priority. It is better that the SSB time domain adaptation and Cell DTX are separate features. |
| LG Electronics | Y |  |
| ITRI | Y |  |
| CATT | Y | If only NCD-SSB is supported, extend Cell DTX to SSB should be considered. The spec impact is limited. |
| NEC | Y | We mainly prefer only SSB periodicity to be adapted in time domain. Hence, we are okay to discuss the above starting with the assumption that configuration here implies at least different SSB periodicities (rest of the parameters are FFS) |
| Moderator |  | Proposal is updated to 2.1.2b-rev1 below. |
| Tejas | Y |  |

## Proposal 2.1.2b-rev1

For Cell DTX extension to SSBs 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)

# 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.

## Proposal 3.1.1

For adaptation of PRACH in time-domain, select 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
  + at least additional timing offset(s)
  + 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
* 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)

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| --- | --- |
| Company | Comment |
| Moderator | Closed. |

Topic 3.1.2

For handling SSB-RO mapping rule for Case 1, some companies propose to extend the RAN1#117 agreement. For handling SSB-RO mapping rule for Case 2, companies have different views. Some companies think the RAN1#117 agreement can be extended (and leave handling up to gNB implementation), while others think that some additional mechanism may be needed to handling SSB-RO mapping (separate mapping, overlapped ROs unavailable, etc).

* 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

## Proposal 3.1.2a

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.*

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| --- | --- |
| Company | Comment |
| Moderator | Closed. |

## Proposal 3.1.2b

Downselect from the below options for SSB-RO mapping rule for additional PRACH resources for Case 2.

* Alt 1: Extend the RAN1#117 agreement on SSB-RO mapping
* Alt 2: Additional handling for SSB-RO mapping
  + Alt 2-1: Two separate mappings: for overlapping ROs and non-overlapping ROs, respectively
  + Alt 2-2: Consider overlapped ROs as unavailable for SSB-RO mapping

|  |  |
| --- | --- |
| Company | Comment |
| Moderator | Closed. |

Topic 3.1.3

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

* L1-based adaptation
  + Nokia, Qualcomm, vivo, Mediatek, Huawei/HiSi, xiaomi, LG, ZTE, CMCC, CT, CATT, Sony, interdigital, lenovo, docomo, sharp, Apple, Ericsson, Samsung, Tejas, Honor, Intel, Cewit, Transsion, Google, Denso, Spreadtrum, ITRI
* Higher-layer signaling
  + Nokia, Fujitsu,FW, Panasonic, Apple, Mediatek, interdigital, Intel, Cewit, ITRI
* Cell DRX for PRACH adaptation
  + NEC, Samsung, FW,Transsion?, CMCC

## Proposal 3.1.3

For the adaptation mechanism for additional PRACH resources,

* At least L1-based adaptation is supported.
* FFS between following options agreed in RAN1#117
  + 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 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)

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| --- | --- |
| Company | Comment |
| Moderator | Closed. |

## Proposal 3.1.4

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 or new RNTI used for detecting the DCI format

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| --- | --- | --- |
| Company | Support (Y/N) | Comments |
| CMCC | Yes, and | Support to further discuss the DCI format.  One thing is that DCI format 1\_0 can scrambled by various kinds of RNTIs. From our understanding, regarding the existing RNTI, only DCI format 1\_0 scrambled by SI-RNTI and P-RNTI can be feasible.  Thus, we suggest to revise the proposal as follow: Proposal 3.1.4-rev1 For DCI-based adaptation for additional PRACH resources,   * Select from the following DCI format(s) to carry the adaptation indication.   + DCI format 1\_0 scrambled by SI-RNTI   + DCI format 1\_0 scrambled by P-RNTI   + DCI format 1\_0 scrambled by new RNTI   + DCI format 2\_7   + DCI format 2\_9 * ~~FFS: existing or new RNTI used for detecting the DCI format~~ |
| Panasonic | Y |  |
| Moderator |  | Closed. |

At least two companies discussed some details related to L1 signaling mechanism.

[Qualcomm]

Proposal 12: The adaptation of additional PRACH resources is timer-based.

[vivo]

Proposal 7: For the contents of L1 signaling used to indicate PRACH adaptation and effective time for additional PRACH resources, the two alternatives can be considered:

- Alt-1: L1 signaling contains activation and deactivation information.

- Alt-2: L1 signaling contains activation information, and the length of effective time is configured by RRC.

Proposal 8: The starting time and ending time for the effective time should be specified.

Proposal 9: If the effective time is configured by RRC signaling, the unit time can be considered as a PRACH association period.

## Proposal 3.1.5

For DCI-based adaptation for additional PRACH resources, support at least the following

* DCI signalling contains activation information, and the length of validity time duration for the activation indication is configured by higher layers.
  + FFS: details of validity time duration

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| Company | Support (Y/N) | Comments |
| CMCC | N | Need to first discuss whether a validity time duration of the activation indication is needed. |
| Panasonic | Y | DCI signaling carries activation/adaptation indication and validity information. |
| ITRI | Y |  |
| CATT | N | Share same view as CMCC, no need to discuss the length of validity time duration for activation indication.  DCI signaling contains activation information and deactivation information should be considerred. Timer-based L1-signaling is not the only way to achieve the adaptation. |
| ZTE, Sanechips | Y | We support this proposal. |
| Fujitsu | N | Support the activation information.  For validity time duration, we share the same view as CMCC that the necessity of it and indicating it via DCI needs further discussion. |
| NEC | Y |  |
| Qualcomm |  | We don’t think DCI should indicate validity duration for the availability of the additional PRACH resources.  Per our understanding, the DCI is used to indicate the availability of all or a subset of additional PRACH resources. Hence, instead of discussing this proposal, we should discuss whether one of the following agreed options should be supported.   * Option 2: L1-based adaptation to indicate whether the additional PRACH resources provided by semi-static signalling are available or not * 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 |
| Nokia/NSB |  | Agree with Qualcomm. From our perspective the current proposal is not the natural extension of the previous agreement. We need to differentiate between:   * Configuration of additional PRACH resources [via semi-static signalling] * Adaptation of additional PRACH resources [via L1-based signalling and/or semi-static signalling] * Activation of the additional PRACH resources [via L1-based signalling or semi-static signalling]   In this context, what Qualcomm proposes is perfect, we need to first agree which of Option 2 and Option 4-rev1 is supported. Once we agree on this, rest becomes a bit easier to agree on.  Additionally, we are very much concerned by the fact that the RRC state of the UE is not being considered in this discussion, while we think this is a crucial aspect. If the UE is in *idle* or *inactive* mode, then the L1-based signalling does not create any possible issues, however for the UE in *connected* mode, the ability of the UE to adapt the PRACH based on L1-based signalling may or may not be possible depending on the capability of the UE. This case is relevant, for instance, at least for cases like CFRA (e.g., handover), BFR, etc. Please note that we are not arguing that this must be subject to UE capability, but we need to discuss about this now, because this may impact companies’ preferences related to using semi-static or L1-based signalling to adapt and/or activate the additional PRACH resources. |
| Samsung |  | We share some views from QC and Nokia,  Based on the agreement we have, the process is like: UE gets the additional PRACH configuration from RRC, and UE will gets the adaptation indication from DCI. Now for the latter part, we don’t need to directly jump to the DCI content before we agree what solution to do the adaptation. If it’s all additional resource to be on or off, then maybe activation/deactivation is enough, if it’s subset of the additional resource, then the DCI needs to carry the indication/configuration of which subset to be used/or not used. The validity of length is a separate/next step issue. So we suggest to discuss the agreement from last meeting with first,  **Proposals based on Agreement with change**  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 |

Discussion Point 3.1.6

Below was agreed in RAN1#118.

*Proposal 3.1.1*

*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)*

Companies are encouraged to provide their views on the alternatives for selection and the needed additional mechanism(s) for the alternative.

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Support Alt 1 (Y/N) | Support Alt 2(Y/N) | Comments (including what additional mechanism(s) is needed for the supported alternative) |
| CMCC | Partly support | Partly support | For Alt 1, support Opt 1-1, 1-2 and 1-4.  For Alt 2, support the baseline without enhancement on Opt 2-1 and Opt 2-2.  The mechanism shall avoid complicated design, thus, we prefer the straightforward one. |
| Panasonic |  |  | Just need to clarify that PRACH configuration index for additional PRACH resources is different from the PRACH configuration index for legacy resources does not mean a different/new PRACH configuration table for additional PRACH resources. |
| CATT |  |  | In our understanding, for alt 2, at least one additional PRACH configuration index should provide to UE. It can be same as/different from the PRACH configuration index of legacy resource.  For obtained a condensed additional PRACH resource, we support opt 1-3/opt 1-4, and opt 2-1 and opt 2-2. |
| Sharp | Support w/ additional mechanism | Support w/ additional mechanism | At least overlapping between legacy PRACH resources and additional PRACH resources should be avoided, and we think Alt 2 w/o additional mechanism has some issues on configuration flexibility in that point.  Although our preference is Alt.1 with Option 1-1+1-4 (or 1-1+1-3), we are open to configure PRACH configuration index for additional PRACH resources independently from legacy PRACH resources (i.e. Option 2-2 (or 2-1)). |
| Fujitsu | Support | Support | Alt-1: support Opt 1-1 and Opt 1-4.  Alt-2: support both options. |
| Qualcomm |  |  | We understand supporting both alternatives can provide flexibility to NW configuration. However, the burden is on UE to prepare support of an unnecessarily high number of PRACH resource configurations that both options provide. Hence, we should support only one of the options.  Even for one given option, the number of PRACH configurations for additional PRACH is already very high for some options. For example, with Option 1-4 under Alt-1, if we introduce new parameter for time offset, this offset potentially adds a lot more PRACH configurations.  From our perspectives, we prefer supporting Alt-1 with Option 1-1 or some sort of Option 1-2 (e.g., adapting value for (x,y)) only. If Alt-1 is pursued, we should limit that PRACH format is identical for both legacy PRACH configuration index and new PRACH configuration index for additional PRACH resources. |
| Apple |  |  | For Alt 1, we think Option 1-2 is a mixed of Option 1-1 and 1-4.   * *Opt 1-1: Scaled/adjusted PRACH configuration period (x value of the PRACH configuration )* * *~~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: Adjusted ~~additional~~ timing offset(s) (including y value and subframe number or slot number of the PRACH configuration)*   For option 1-3, we think this could provide a way to configure condensed ROs after the additional PRACH resources are activated to further save network energy, so Alt 1 with updated options are preferred. We are also open to consider Alt 2. |
|  |  |  | We would propose that Option 1-1, 1-3 and 1-4 could be considered.  Option 1-7: Option 1-1, 1-3 and 1-4 |
| ZTE, Sanechips | Not support | Support w/ revision | For Alt 2, the sub options may be not necessary.  It is clear that we can use one PRACH configuration index for configuring the additional PRACH resources. Perhaps additional frequency domain parameter(s) is also needed(as in the FFS)  Therefore, we suggest to have following modifications on Alt 2:   * Alt 2: The PRACH configuration index for the additional PRACH resources is different from the PRACH configuration index for the legacy resources and/or   + - 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)     - Opt 2-3: Opt 2-1 and Opt 2-2     - Opt 2-4: None of above options is needed. |
| Samsung | Support | Support | Support both options, as we mentioned during previous discussion, the UE behavior is not complicated, the current spec already asks UE to receive multiple PRACH configurations. There is nothing new for the NES, UE gets the configuration from gNB, read the table (no new rows), gets the RO pattern, do whatever usually UE needs to do.  In general, with PRACH configuration index + masking method, the flexibility of the RO pattern to be configured is high, and without adding UE implementation complexity. We do not need to limit the configuration index to be same or different, it is up to gNB. |

## Proposal 3.1.6

Revise the RAN1#118 agreement to the following to reflect the combination of alternatives (PRACH configuration index) and options (for additional mechanisms) to consider further.

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
  + - 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)
    - Opt 1-5: Opt 1-1 and Opt 1-3
    - Opt 1-6: Opt 1-1 and Opt 1-4
* Alt 2: The PRACH configuration index for the additional PRACH resources is different from the PRACH configuration index for the legacy resources and
  + - 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)
    - Opt 2-3: Opt 2-1 and Opt 2-2
* 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)

# 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#118: wait for RAN2 progress.**

# Other

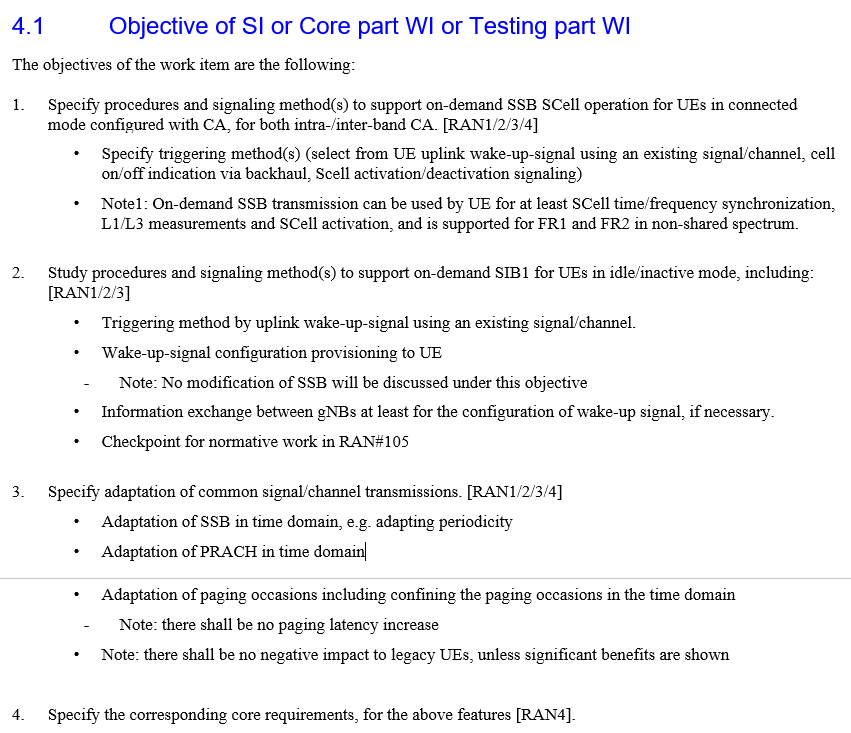
Some contributions also discussed joint adaptation of more than one common signal/channel.

# Conclusion

Appendix A (Contributions)

|  |  |  |  |
| --- | --- | --- | --- |
| 1 | [**R1-2405813**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2405813.zip) | Discussion of the adaptation of common signal/channel transmissions | FUTUREWEI |
| 2 | [**R1-2405858**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2405858.zip) | On common channel/signal adaptation for eNES | Huawei, HiSilicon |
| 3 | [**R1-2405892**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2405892.zip) | Adaptation of common signal/channel transmissions | Tejas Networks Limited |
| 4 | [**R1-2405918**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2405918.zip) | Discussion on adaptation of common signal/channel transmissions | Spreadtrum Communications |
| 5 | [**R1-2405959**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2405959.zip) | Adaptation of Common Signals | Google |
| 6 | [**R1-2405995**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2405995.zip) | Discussion on adaptation of common signal/channel transmissions | CMCC |
| 7 | [**R1-2406023**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406023.zip) | Adaptation of common signal/channel transmissions for Network Energy Saving | Intel Corporation |
| 8 | [**R1-2406051**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406051.zip) | Adaptation of common signal/channel transmissions | Nokia, Nokia Shanghai Bell |
| 9 | [**R1-2406097**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406097.zip) | Discussion on common signal/channel adaptation | China Telecom |
| 10 | [**R1-2406192**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406192.zip) | Discussions on adaptation of common signal/channel transmissions | vivo |
| 11 | [**R1-2406228**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406228.zip) | Discussion on adaptation of common signal/channel transmission | OPPO |
| 12 | [**R1-2406294**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406294.zip) | Discussion on adaptation of common signal and channel transmissions | Xiaomi |
| 13 | [**R1-2406378**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406378.zip) | Discussion on adaptation of common signal/channel transmissions | CATT |
| 14 | [**R1-2406411**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406411.zip) | Discussion on common signal channel for NES | ZTE Corporation, Sanechips |
| 15 | [**R1-2406479**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406479.zip) | Adaptation of common signal/channel transmissions | Sony |
| 16 | [**R1-2406509**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406509.zip) | Discussion on adaptation of common signal/channel transmissions | InterDigital, Inc. |
| 17 | [**R1-2406517**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406517.zip) | Discussion on adaptation of common signal / channel transmissions | Fujitsu |
| 18 | [**R1-2406582**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406582.zip) | Discussion on adaptation of common signal channel transmissions | HONOR |
| 19 | [**R1-2406610**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406610.zip) | Adaptation of common signal/channel transmissions | LG Electronics |
| 20 | [**R1-2406660**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406660.zip) | Adaptation of common signal/channel transmissions | Samsung |
| 21 | [**R1-2406687**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406687.zip) | Discussion on adaptation of common signal/channel transmission | PANASONIC R&D Center Germany |
| 22 | [**R1-2406696**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406696.zip) | Discussion on adaptation of common signal/channel transmissions for Cell DTX/DRX | NEC |
| 23 | [**R1-2406706**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406706.zip) | Discussion on adaptive transmission of common signal or common channel | Transsion Holdings |
| 24 | [**R1-2406712**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406712.zip) | Discussion on adaptation of common signal/channel transmission | Panasonic |
| 25 | [**R1-2406734**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406734.zip) | Adaptation of common signal/channel transmissions for NES | ETRI |
| 26 | [**R1-2406760**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406760.zip) | Adaptation of common signal/channel transmissions | MediaTek Inc. |
| 27 | [**R1-2406807**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406807.zip) | Adaptation of common signals and channels | Lenovo |
| 28 | [**R1-2406849**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406849.zip) | On adaptation of common signal/channel for NES enhancements | Apple |
| 29 | [**R1-2406940**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406940.zip) | Discussion on adaptation of common signal/channel transmissions | NTT DOCOMO, INC. |
| 30 | [**R1-2406973**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2406973.zip) | Discussion on adaptation of common signal/channel transmissions | Sharp |
| 31 | [**R1-2407039**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2407039.zip) | Adaptation of common channel transmissions | Qualcomm Incorporated |
| 32 | [**R1-2407058**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2407058.zip) | Adaptation of common signal/channel transmissions for NES | Ericsson |
| 33 | [**R1-2407069**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2407069.zip) | Discussion on adaptation of common signal/channel transmissions | ITRI |
| 34 | [**R1-2407082**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2407082.zip) | Discussion on adaptation of common signal and channel transmissions | CEWiT |
| 35 | [**R1-2407100**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2407100.zip) | Adaptation of Common Signals and Channels for NES | Fraunhofer IIS, Fraunhofer HHI |
| 36 | [**R1-2407157**](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_118/Docs/R1-2407157.zip) | Discussion on adaptation of common signal/channel transmissions | DENSO CORPORATION |

# Appendix B (WI objectives from WID in [RP-241650](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_104/Docs/RP-241650.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