**3GPP TSG RAN WG2 #119bis-e *draft R2-22xxxxx***

**Online, 10 - 19 Oct, 2022**

**Source:** Huawei, HiSilicon

**Title:** Report of [Offline-302][IoT NTN] RRC corrections (Huawei)

**Agenda Item:** 8.3.2

**Document for:** Discussion and decision

# Introduction

This document is a report of the following offline discussion:

* [AT119bis][302][NES] Cell Selection/Reselection and SSB/SIB-less (Huawei)

- Discuss and agree aspects of cell selection/reselection based on contributions submitted to meeting (including both legacy and NES capable devices)

- Discuss and agree on aspects of SSB adaptation/SIB-less based on contributions submitted to meeting (both SSB/SIB-less and adaptation are included)

Deadline: to be set by rapporteur so agreeable proposals can be ready by Monday morning for review.

Since time is limited, in this offline we will focus on the issues proposed by multiple companies and more likely to achieve some progress. The situation in the post119-e email discussion is also taken into account [1].

Please share your comments before Friday 2022-10-14 10:00 UTC.

Please note that for the sake of progress, we will use the same principle for all NES candidate techniques, i.e., we focus on RAN2 impacts for these techniques and do not debate on whether this is RAN1-led or RAN2-led techniques. This is exactly what we have done for DTX/DRX discussion.

1. Contact Information

To make it easier to find the contact delegate for potential follow-up questions, delegates are encouraged to provide their contact information in the following table:

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# Discussion

## Cell selection/reselection

During the post119-e email discussion, the solution of cell selection/reselection was summarized as follows:

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| Introduction | NES cells can be (de-)prioritized for NES capable UEs or legacy UEs during cell selection/reselection, optionally, UE is made aware of cell state (NES or non-NES). |
| Scenario | Single-carrier, multi-carrier; UEs in Idle/Inactive |
| NES gain | Reduced time domain SSB symbols if the cell is in NES state. Legacy UEs can avoid reselecting to an NES cell. |
| Impact to legacy UEs | 1. In case legacy mechanism (frequency priority, or adding frequency/cell-specific offsets) is used, there is no impact on legacy UEs
2. In case cell state (NES, or non-NES, or other states) is introduced, legacy UEs are not aware. The NES cells can be barred to legacy UEs for backward compatibility.
 |
| UE assistance needed | No |
| RAN2 impact | Cell selection/reselection enhancement etc. |

Some companies indicated that the solution itself does not provide NES gain, but it can assist other solution to minimize negative impacts to legacy UEs.

Based on companies’ contributions submitted to RAN2 #119bis-e, there is plenty of discussion on the following:

1. Legacy UEs: prevent legacy UEs camping on NES cells
2. NES capable UEs: (de)prioritization (including per-frequency, or per cell)

For legacy UEs, it is proposed in [2][3][5][10][11][12][19][27] to prevent legacy UEs camping on NES cells for backward compatibility. From the rapporteur’s observation, for some NES techniques, the legacy UEs cannot camp on the NES cells automatically, e.g., SSB-less, cells potentially using NES WUS. Therefore, this discussion should be based on the assumption that there is a need to have additional enhancement to prevent legacy UEs camping on NES cells when legacy UEs can identify these NES cells as usual.

**Q1: Do you agree that there is a need to prevent legacy UEs from camping on NES cells, when legacy UEs can identify these NES cells as normal cells?**

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| **Company** | **Yes/No** | **Comments** |
| Apple | Yes, but.. | We agree the need to allow NES cell to prevent legacy UEs, at least from backward compatibility perspective. However, we think the current formulation of this proposal / question may cause below misunderstanding: 1) The wording "a need to prevent legacy UE" may cause misunderstanding that NES cell must prevent legacy UE camping. However, we believe NES cell should have flexibility to decide whether to bar legacy UE or not (e.g. legacy UE may still be served by NES cell if this NES cell just uses sparse reference signal). 2) We are not sure what is intention of 2nd sentence (**when legacy UEs can identify these NES cells as normal cells).** It looks obvious and unnecessary.Thus, we suggest below wording change:**there is a need to allow NES cells to prevent legacy UEs from camping ~~on NES cells, when legacy UEs can identify these NES cells as normal cells~~** |
| MediaTek | Yes | When the NES-capable cell behaves as a normal cell to legacy UEs, it is nature to have such prevention enhancement in NW side. |
| Ericsson | Yes |  |
| CATT | Yes | Considering we support starting with the multi-carrier configuration (see Q5), we assume legacy UEs will camp on an anchor cell, not on a NES cell. |
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The solutions proposed are mainly divided into the below two directions:

* Option 1: Use Intra/InterFreqExcludedCellList [2][4]

This is basically using the legacy frequency list or black cell list to indicate whether those NES frequencies or cells are disabled. It would be good that proponents can clarify the exact specification impact as this seems already supported by legacy mechanism.

* Option 2: Use *cellBarred* in MIB and add a new *cellBarred-NES* in SIB1[3]

This is basically to reuse the legacy mechanism adopted for NTN and IAB-MT.

**Q2: Which is the preferred option to bar legacy UEs:**

* **Option 1: Use Intra/InterFreqExcludedCellList [2][4]**
* **Option 2: Use *cellBarred* in MIB and add a new *cellBarred-NES* in SIB1 (similar to NTN) [3]**

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| **Company** | **Option** | **Comments (including technical views, specification impacts etc.)** |
| Apple | Option 2 with comments(Option 1 needs clarification) | We think the direction of option 2 makes more sense. However, it includes stage 3 details (e.g. whether new barring bit needs to include in SIB1, considering SIB1 is already quite heavy). Besides the barring solution of NTN, we have another barring mechanism of Redcap with some difference of signalling details. Since it is study item phase, we think RAN2 only need a high level agreement. For example:***NES cells may bar legacy UEs, and allow NES capable UEs to camp via new barring bit in MIB/SIB.*** For Option 1, we understand there is no spec impact because legacy UE can only read existing intra/interFreqExcludedCellList (i.e. can't read new NES dedicated list if introduced). So, it requires some clarifications. However, we think a new NES dedicated cell list can be introduced to enhance cell reselection of NES capable UEs (i.e. if NES cells are prioritized by NES capable UE, it can only consider cells in this new list during cell reselection)  |
| MediaTek | Option 2 | Existed OSI reusability could be preserved to some extent, hence lower impact to legacy UE power consumption. |
| Ericsson | At least Option 2 | The solutions are essentially for different cases, Option 2 is mainly for cell selection while Option 1 is for cell reselection. Option 2 could work for cell reselection as well, so we should have at least Option 2. However, Option 1 would be more optimal for cell reselection than Option 2 (e.g., the UE would not need to perform the measurements needed for Option 2), so it could be good to have both. |
| CATT | Option 2, if visible | Alternately such NES cells may not be visible at all by idle/inactive UEs (e.g. SSB/MIB/SIB-less NES cell). |
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For NES capable UEs, it is proposed in [4][5][6][8][12] to discuss (de)prioritization of NES cells. However, there is no general rule that NES cells should always be prioritized for NES capable UEs, or always deprioritized. Further, it is mentioned by [8] that UEs’ cell reselection prioritization should be under network’s control, and reselection prioritization for NES can be handled per frequency, but not per cell. [6] also wants to clarify whether it is per frequency or per cell.

**Q3: For NES capable UEs, whether there is a need to prioritize or deprioritize the cell reselection for NES cells? If so, whether it is frequency level or cell level?**

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| **Company** | **Need for (de)prioritize NES cells (Yes/No)** | **Frequency level or cell level** | **Detailed Comments if any** |
| Apple | Yes | At least frequency level. FFS Cell level  | **On the need:** **1.** As legacy UE may be barred by NES cell,some NES capable UEs may be configured by NW to prioritize to camp in NES cells for load balancing. 2. Some NES capable UEs (e.g. UE with high priority traffic) may be configured by NW to prioritize non-NES cell for better performance. **On frequency level or cell level:**We think at least frequency level works, i.e. the NES capable UE may regard the frequency with NES cells as highest priority. RAN2 has specified similar solutions for V2X/eMBMS. We don't see any technique issue to introduce similar solution for NES.On Cell level, we think it can be FFS because best cell principle (i.e. UE has to pick cell with best radio condition in intra-frequency) shall be followed. However, LTE Rel-13 NB-IoT has introduced a dedicated Qoffset. So, if time allows, we think RAN2 can study similar solution (i.e. NES dedicated Qoffset).  |
| MediaTek | Yes | both | We think it is also related to which kind of NES technique is working and corresponding NW deployment strategy. It is better to keep flexibility in this stage. |
| Ericsson | No |  | Cell reselection should be based on cell quality, and hence there is no need to include further procedures. We think there is no particular issue if the NES capable UE cell reselection procedure is untouched, and we should rather focus on handling legacy UEs. |
| CATT | No |  | Even if NES capable UEs can camp on a NES cell (TBC from RAN1), there is no strong motivation or it is not easy to conclude that there is a need to always prioritize or deprioritize the cell reselection for NES cells for NES capable UEs. For example: If NES cells are prioritized for NES capable UEs to camp on, the load of NES cells in support of Idle/Inactive UEs (e.g. in terms of paging, on-demand SI, RACH) could become heavy and it is not preferred for energy saving. On the other hand, if NES cells are deprioritized for both NES capable UEs and legacy UEs to camp on, the benefit that NES cells are visible to idle/inactive UEs is less. |
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In [6][8], it is proposed to have (de)prioritization per frequency or per cell. [8] mentions that in MBS, the UE can prioritize the frequency which provides the service(s) of UE’s interest, and the similar solution can be adopted for NES. On the other hand, it is proposed in [7] that in the current spec, there are already several ways of re-distribute the UEs from a particular frequency layer to other frequency layers:

* Change the Frequency Priority
* Change the settings of offset values within Reselection Criteria, so that reselections would happen faster
* Provide/priorities particular frequencies within RRC Release
* Even the use of specific slicing for energy savings might be considered, resulting in reselections to a particular frequency layer

The above is about frequency (de)prioritization. Similarly, we already have cell offset, or the allowed/excluded list today, and if some cells are in NES state, this can be adjusted by these parameters.

Therefore, companies are invited to share their views on whether any enhancement is needed for cell (de)prioritized.

**Q4: if the answer to Q3 is Yes, whether there is any need to enhance the existing mechanism?**

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| **Company** | **Need for enhancements (Yes/No)** | **Comments (please be clear whether there is specification impacts)** |
| Apple | Yes | For above listed solutions by Rapporteur, we don't think it works well for cell (re)selection because these solutions need to either frequently update SIB (1/2) or force UE to CONNECTED state (3). We think a similar solution like existing eMBMS/V2X is sufficient: **"The NES capable UEs may regard the frequency with NES cells as highest priority"** |
| MediaTek | No | * + - 1. RAN2 can consider introducing NES specific parameters/settings but doesn’t have to enhance existed frameworks.
			2. We don’t think that NW power saving gain would be good if NES state is toggled frequently. Even if it is, we don’t think it should be reflected immediately over Uu interface because such a state transition could mean nothing changed to normal service providing (i.e., changed from NES cell to normal cell) so that it could be transparent to NES-capable UE.
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## SSB/SIB-less

During the post119-e email discussion, we discussed SSB/SIB-less and the solution was summarized as follows:

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| Introduction | Some NES Cells do not transmit SSB and/or SIB, UE receives SSB and/or SIB from a different cell (e.g. anchor cell).“anchor cell” refers to the cell transmitting SSB and SIB. |
| Scenario | Multi-carrier (FFS inter-frequency or intra-frequency), FFS single carrier; UEs in all states (Connected/Idle/Inactive) |
| NES gain | Reduced time domain symbols for SSB/SIB-less NES cell. Possibly increased power consumption for anchor cell when the anchor cell broadcasts system information for other NES cells. |
| Impact to legacy UEs | legacy UEs can access from anchor cell |
| UE assistance needed | No |
| RAN2 impact | extended SIB for anchor cell, cell selection/reselection, RACH, etc |

Several companies commented during email discussion that multi-carrier case should be prioritized. Among the contributions submitted to RAN2 #119bis-e, there are also proposals for prioritizing the multi-carrier case [17][18][21] [22][24].

**Q5: For SSB/SIB-less solution, do you agree that RAN2 starts with multi-carrier case?**

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| **Company** | **Yes/No** | **Comments** |
| Apple | Yes | RAN2 study of single-carrier case will highly depend on RAN1 design (e.g. DRS, WUS) because SSB and/or SIB1 is absent. Without details of RAN1 design, we don't think RAN2 can make progress.  |
| MediaTek | - | We see a very limited energy saving gain for CA use cases with higher data activity [26]. |
| Ericsson | Yes | Single carrier case seems to have more impact on legacy UEs, and thus it makes sense to focus on multi-carrier case. |
| CATT | Yes | Same view as Apple |
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### SSB-less

In [14][16][17][24], it is mentioned that SSB-less SCell is already supported for intra-band CA in the current spec, and it is proposed to extend it to inter-band case.

Cited from 38.331:

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| --- |
| ***FrequencyInfoDL* field descriptions** |
| <skip> |
| ***absoluteFrequencySSB***Frequency of the SSB to be used for this serving cell. SSB related parameters (e.g. SSB index) provided for a serving cell refer to this SSB frequency unless mentioned otherwise. The cell-defining SSB of the PCell is always on the sync raster. Frequencies are considered to be on the sync raster if they are also identifiable with a GSCN value (see TS 38.101-1 [15]). If the field is absent, the SSB related parameters should be absent, e.g. *ssb-PositionsInBurst*, *ssb-periodicityServingCell* and *subcarrierSpacing* in *ServingCellConfigCommon* IE. If the field is absent, the UE obtains timing reference from the SpCell or an SCell if applicable as described in TS 38.213 [13], clause 4.1. This is only supported in case the SCell for which the UE obtains the timing reference is in the same frequency band as the cell (i.e. the SpCell or the SCell, respectively) from which the UE obtains the timing reference.For cells supporting RedCap, on handover, corresponds to the cell-defining SSB. |
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Cited from 38.306:

| ***scellWithoutSSB***Defines whether the UE supports configuration of SCell that does not transmit SS/PBCH block. This is conditionally mandatory with capability signalling for intra-band CA but not supported for inter-band CA. | FS | CY | N/A | N/A |
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In is further analysed in [16] that to support SSB-less SCell for inter-band case, RAN2 impacts include

* introduce a new UE capability to indicate the support of inter-band SCell without SSB; and
* small clarification in the specification (e.g. to extend the field description of the *absoluteFrequencySSB* IE to inter-band case).

**Q6: Do you agree with the following:**

**To extend the current SSB-less SCell from intra-band CA to inter-band CA, RAN2 impacts include** **a new UE capability and some essential field description clarification. The existing procedure defined for intra-band case can be re-used in general.**

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| **Company** | **Yes/No** | **Comments** |
| Apple | No | 1. Whether inter-band SSB-less SCell is feasible is being actively discussed in RAN1 and RAN4. We are not sure why RAN2 can make this decision directly.2. Even RAN1/RAN4 can conclude it is feasible, we identify at least below potential extra RAN2 impacts: 1) The timing of PCell and SSB-less SCell of inter-band may have slot/frame level offset. How to indicate such timing offset to UE? Please note that different from intra-band case, this timing offset may not be zeros. In Rel-16 async CA, RAN1/RAN4 has specified complex RRC signaling for the offset (as numerology of PCell and SCell may be different). 2) For cell quality evaluation (i.e. RRM), will UE use SSB based measurements in PCell or allow to use CSI-RS based measurement in SSB-less SCell? Please note that different measurement quantities may be resulted because reference signal type is different.  3) For RLM, will UE use SSB based RLM in PCell or allow to use CSI-RS based RLM in SSB-less SCell? Please note CSI-RS based RLM seems not to be deployed yet. 4) For BFR, will UE use SSB based BFD in PCell or allow to use CSI-RS based BFD in SSB-less SCell? If BFD is allowed in SSB-less SCell, will UE can trigger BFR in this SCell? 5) In NR, RACH resource selection is based on selected SSB. However, if SSB is only present in PCell, it will be difficultly to ensure QCL b/w PCell and SSB-less SCell of inter-band. Then, does it mean UE always needs to retune to PCell if RACH is triggered ?  |
| MediaTek | No | We understand RAN2 impact is probably limited as long as RAN1/RAN4 could conclude and update their spec.. However, we may still need additional UE capabilities, for example the CSI-RS RRM measurement for inter-freq. SCell without SSB, therefore we should wait for RAN1/RAN4 conclusion to assess RAN2 impact.[Slightly off-topic but comment in this question where the reference listed]In [16] we learnt that the ES gain claimed to be up to 30% is achieved for low load case (e.g., <10% RU) while we have a very limited ES gain for light load (15% - 30%) in CA use cases with higher data activity [26]. Since the SSB-less technique is further clarified to be deployed as SCell specific [16], so we think the simulation result in [26] is closer to the practical deployment of SSB-less technique. Although the RAN2 impact seems limited but it may end up gaining ES in the initial access stage only. RAN2 should not rush to do early decision until the benefit(trade-off) is justified. |
| Ericsson | Yes, but | Further details may depend on RAN4 as well, e.g., there may be more than one capability and/or capability dependencies. |
| CATT | See comment | We prefer to leave the SSB and MIB part to RAN1 to decide/design. And RAN2 decides on SIB1 and other SI (i.e. Q7). |
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### SIB-less

Based on [16][17][18][24][27], the SIB-less solution can be summarized as: NES cell does not transmit SIB, and the anchor cell transmits SIB and other necessary information for UEs to access to NES cell directly.

RAN2 impacts mainly include

1. enhancements to System Information (of anchor cell) to include the necessary information to access via NES cell [16][18][27], the necessary information can be:
* SIB1 of NES cell [16][24]
* Common DL/UL parameters of NES cell [18]
* Measurement configuration of the NES cell; conditions for selecting the NES cell for access; radio resources of the NES cell [27]
1. RACH procedure on NES cell [16][22]

**Q7: Do you agree with the following:**

**For SIB-less solution, RAN2 understanding is that an NES cell does not transmit SIB, and the anchor cell transmits SIB and other necessary information for UEs to access to NES cell directly.**

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| **Company** | **Yes/No** | **Comments** |
| Apple | No | We are confused by the proposal: is the UE in CONNECTED state or IDLE/INACTIVE state? We can discuss separately: 1) If UE is in CONNECTED state (i.e. NES cell is added as SCell via CA after camping in anchor cell), the existing CA already allows SCell not to send SIB and provide UE SIB via dedicated RRC signalling. We think this solution can be supported without any spec impacts. 2) If UE is in IDLE/INACTIVE state (i.e. although UE can receive SIB via anchor cell, it chooses to camp in another NES cell). We are confused why this scenario can happen? A much simpler solution without spec impact can be: UE first camps in the anchor cell, enter CONNECTED state and then anchor cell redirects this UE to NES cell. Maybe proponent can clarify what is NES gain of this complex solution over this simpler solution without spec impact. |
| MediaTek | No | We understand the intention but do not see further clarification regarding to OSI part, should we revise the topic to be not “SIB-less” but “SIB1-less”? Then we can better assess the RAN2 impact scope.For paging in SIB1-less technique, would we have RAN2 impact to paging search space on ES cell since the search space for SIB1 acquisition is changed?Similarly, we saw a very limited ES gain result for SIB1-less technique [26]. |
| Ericsson |  | We understand the intention is to say that the network is not required to transmit SIB, but it is not prevented to do so either. Hence, the wording could be revised with the following addition in red “does not have to transmit SIB”. |
| CATT | Yes | Answering Apple: in legacy, the UE needs to enter CONNECTED state in the anchor cell. The difference here would be that the UE could enter CONNECTED state (i.e. perform the RACH procedure) in the NES cell directly. Thus alleviating the RACH load and associated signalling of the anchor cell. So UE needs to acquire necessary info of the NES cell from the anchor cell, while in Idle/Inactive. |
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**Q8: Do you agree with the following:**

**For SIB-less solution, RAN2 will further study which are the necessary information for UE to access to NES cell, and the impacts on RACH procedure on NES cell.**

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| **Company** | **Yes/No** | **Comments** |
| Apple | Premature to discuss | First, we think the motivation of this solution requires clarification as we discussed in Q7. And its NES gain is not clear to us (sending SIB1 alone seems not quite energy consuming in our understanding. And existing NR system already allows gNB to only send SIB1 with all other SIBs as on-demand). Then, why RAN2 need to study the impact on RACH procedure on NES cell is also not clear to us. In our understanding, the UE just needs to acquire RACH configuration from SIB. According to clause 5.1 of TS 38.321, the RACH procedure itself doesn't need to detect SIB, and only selected SSB will impact RACH procedure. So, as long as SSB is still sent in NES cell, we don't see why RACH procedure is impacted. For SSB-less SCell, we agree its RACH impact should be studied as we mentioned in Q6. |
| MediaTek | No | Based on our ES gain estimation shared in Q7, we do not see a strong motivation to support further study in RAN2. |
| Ericsson | Yes |  |
| CATT | Yes |  |
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# Conclusion

To be completed

# Reference

1. R2-2210792, Report of [POST119-e][313][NES] Details of solutions (Huawei), Huawei, HiSilicon

For Cell selection/Reselection

1. R2-2210129, Mobility and Access Control for NES, Nokia, Nokia Shanghai Bell
2. R2-2210255, Handling of Legacy UEs on a NES Capable Cell , Ericsson
3. R2-2210369, Network energy saving techniques, Qualcomm Incorporated
4. R2-2210019, Discussion on network energy savings, OPPO
5. R2-2209810, cell (re)selection and handover considering network energy saving, vivo
6. R2-2209886, Aspects on Network energy savings, VODAFONE Group Plc
7. R2-2210143, Discussion on Mobility issues, CMCC
8. R2-2210235, Aspects on Network Energy Saving Techniques, Fraunhofer IIS, Fraunhofer HHI
9. R2-2210337, UE awareness by gNB and coexistence with legacy UEs for NES, NEC Telecom MODUS Ltd.
10. R2-2210370, NES Proposed Common Signalling Techniques Assessment, Qualcomm Incorporated
11. R2-2210612, Cell Prioritization for NES, Samsung
12. R2-2210707, Discussion on Network Energy Saving in RAN2 study, NTT DOCOMO INC.

For SSB/SIB-less

1. R2-2210666, Techniques in various domains and UE assistance information for network energy saving ZTE corporation, Sanechips
2. R2-2210128, Common Channel Updates for NES, Nokia, Nokia Shanghai Bell
3. R2-2210418, Discussion on SSB-less and SIB1-less techniques for NES, Huawei, HiSilicon
4. R2-2210141, Discussion on time domain NES solutions, CMCC
5. R2-2209474, On solutions aiming at reducing periodic DL transmissions (1-4), CATT
6. R2-2209759, Discussion on Network energy saving for IDLE and INACTIVE UE - cell (re)selection and SSB-less, Apple
7. R2-2209811, Discussions on frequency domain techniques for network energy saving, vivo
8. R2-2210105, Consideration on network energy saving, Fujitsu
9. R2-2210226, SIB-less and UE wake up request signal, Sony
10. R2-2210283, Frequency domain NES aspects, InterDigital
11. R2-2210556, Considerations on Energy saving, KDDI Corporation
12. R2-2210653, SSB/SIB/Paging and Group HO, LG Electronics Finland
13. R2-2210772, Considerations on Network Energy Saving techniques, MediaTek Inc.
14. R2-2210665, Supporting access via NES cell, ZTE corporation, Sanechips