**3GPP T****SG-RAN WG2 Meeting #114-electronic R2-210xxxx**

**Online, May 19th – May 27th, 2021**

**Agenda item: 8.6.1**

**Source: vivo**

**Title:** **Report of [Post113bis-e][507][SDT] Resource configuration aspects**

**Document for: Discussion and Decision**

# 1 Introduction

This contribution is aimed at reporting the discussion and results of the following email discussion:

* **[POST113bis-e][507][SDT] Resource configuration aspects (Vivo)**
  + - For RA (details of RACH resource configuration, and search space for SDT (USS vs CSS – see RAN1 LS in R2-2102620))
    - For CG (details of CG configuration and also the FFS on CG-SDT resource to be configured on BWPs other than initial BWP)

Then, the rapporteur would like to point out the specific deadline for companies inputs to May 10th (Monday) 23:59 PDT, as per the schedule.

# 2 Participants

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| --- | --- | --- |
| Company | Participant name | E-mail |
| vivo | Yitao Mo (Stephen) | yitao.mo@vivo.com |
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# 3 Resource configuration for RA-SDT

## 3.1 RACH resource configuration

In RAN2#112-e and RAN2#113-e, the following agreements regarding RA-SDT resource configuration were achieved [1][2]:

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| RAN2#112-e Agreement:  As a baseline, the RACH resource i.e. (RO+preamble combination) is different between SDT and non-SDT   * If ROs for SDT and non SDT are different, preamble partitioning between SDT and non SDT is not needed. * If ROs for SDT and non SDT are same, preamble partitioning is needed   FFS if common configuration should be allowed  RAN2#113-e Agreement:  RAN2 continues to progress the work based the separate RACH resources for SDT (i.e. explicit mechanisms to support common resources won’t be pursued unless there is sufficient support for this. However, use of common RACH resources will not be precluded if possible via implementation |

In NR, for both 4-step and 2-step RACH, the network can configure CBRA resource (via SIB) and/or CFRA resource (via RRC dedicated signaling) to a UE. For RA-SDT in RRC INACTIVE, it might be also feasible for the network to provide CBRA resource (via SIB) and/or CFRA resource (via RRC Release message) from the signaling point of view. In this sense, it is worthy to collect companies’ views on whether it is possible to configure dedicated CFRA resources for a given UE for RA-SDT.

### **Q1: Do companies agree dedicated RACH resources can be configured for RA-SDT?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply (Yes/No/**  **Comments)** | **Detailed comments** |
| ZTE | No | No, we think CBRA is enough for Rel-17. |
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**Summary:**

As it was agreed that ROs can be shared with SDT and non-SDT with separate preambles, then we would consider how to indicate the separate SDT preambles for 4-step/2-step RA-SDT.

In Rel-16, when ROs are shared between 4-step and 2-step RACH, *msgA-CB-PreamblesPerSSB-PerSharedRO-r16* is configured to indicate the number of CBRA preambles associated with each SSB for 2-step RACH. And these 2-step RACH preambles are allocated from the beginning of non 4-step CBRA preambles based on TS 38.213. An example of preamble partition for 4-step and 2-step RACH is shown in the following figure.



Figure 1: example of preamble partition when ROs are shared between 4-step and 2-step RACH

For RA-SDT with shared ROs between SDT and non-SDT, it seems a spontaneous logic that the number of contention-based RACH preambles associated with per SSB shall be configured.

### **Q2: Do companies support configuring the number of contention-based 4-step/2-step RACH preambles per SSB for RA-SDT when ROs are shared between SDT and non-SDT?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply (Yes/No/**  **Comments)** | **Detailed comments** |
| ZTE | Yes | Yes, this seems fairly straightforward to agree.  However, the stage-3 details for signalling would need further discussion in RAN2 and may need some coordination across WIs  which require the separate configuration of RA resource pool.  For example, we may have a flat structure, in which the possible usage of preambles is configured for each preamble range. One possible structure can be as follows:  Preamble range   * Start preamble index * Number of preambles * SDT indication (whether SDT is allowed for such preambles) * Slice list (which slice(s) can be supported) * REDCAP indication (whether the related preambles can be used for REDCAP)   In the example above, the number of preambles is not only given for SDT but is shared between other use cases too. If we have a number specifically for SDT preambles, then we may need a layered structure, which may look like:  SDT preamble range   * Start preamble index * Number of preambles * Support Slice list (which slice can be supported) * REDCAP indication (whether the related preambles can be used for REDCAP)   Non-SDT preamble range   * Start preamble index * Number of preambles * Support Slice list (which slice can be supported) * REDCAP indication (whether the related preambles can be used for REDCAP)   We think the first structure provides better flexibility and is preferred. |
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**Summary:**

Further, for RA-SDT with shared RO between SDT and non-SDT, the CBRA preamble configuration is varied. For example, the network may simultaneously configure legacy 4-step CBRA preambles and at least one type of preambles in the following for one shared RO: 1) legacy 2-step CBRA preambles; 2) 4-step SDT CBRA preambles; 3) 2-step SDT CBRA preambles.



Figure 2: example of preamble configuration when ROs are shared between SDT and non-SDT

On the UE side, an SDT-capable UE may not be aware of the legacy 2-step preambles due to limited capability. As a result, the UE cannot assume the SDT CBRA preamble is allocated from the beginning of non 2-step CBRA preambles. Then an explicit starting preamble index for 4-step/2-step SDT preambles would be needed. Companies are invited to answer the following question for whether a preamble starting index is introduced for 4-step/2-step RA-SDT configuration.

### **Q3: Do companies support introducing a preamble starting index for RA-SDT when ROs are shared between SDT and non-SDT?**

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| **Company** | **Reply (Yes/No/**  **Comments)** | **Detailed comments** |
| ZTE | Yes | Yes, this parameter will be necessary. The RAN2 discussion needs to focus on whether we have a separate parameter for each WI requiring RACH partition or we share the preambles (see the answer to Q2 above). |
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**Summary:**

Furthermore, in Rel-16, when ROs are shared between 4-step and 2-step RACH, *msgA-SSB-SharedRO-MaskIndex-r16* can be configured to indicate the subset of 4-step type ROs that are shared with 2-step random access type. Similar to 2-step RACH, for RA-SDT, companies are invited to answer the following question for whether a shared RO mask index is introduced for 4-step/2-step RA-SDT configuration to indicate the subset of 4-step/2-step type ROs that are shared with 4-step/2-step RA-SDT.

### **Q4: Do companies support introducing a shared RO mask index for RA-SDT?**

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| --- | --- | --- |
| **Company** | **Reply (Yes/No/**  **Comments)** | **Detailed comments** |
| ZTE | Yes | In general, this also is required, but again stage-3 signalling aspects need to be coordinated for other WIs |
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**Summary:**

For separate ROs configured for SDT, the question comes to how to indicate the separate RACH configuration for SDT. In Rel-16, to configure a separate ROs, the network can configure *msgA-prach-ConfigurationIndex*, *MsgA-RO-FDM* and *msgA-RO-FrequencyStart* for UE performing 2-step RACH. Alternatively, the network can configure *prach-ConfigurationPeriodScaling-IAB*, *prach-ConfigurationFrameOffset-IAB*, *msgA-prach-ConfigurationSOffset-IAB* for IAB-MT node.

Based on the existing mechanism, to configure separate ROs for RA-SDT, RAN2 might consider the following two options (for possible down-selection or combination(s) of these options):

* Option 1: network can configure a separate prach-ConfigurationIndex, RO-FDM, and RO-FrequencyStart for RA-SDT (same as separate RO configuration for 2-step RACH);
* Option 2: network can configure a separate prach-ConfigurationPeriodScaling, prach-ConfigurationFrameOffset, prach-ConfigurationSOffset (same as separate RO configuration for IAB).

And companies are invited to provide their preferences.

### **Q5: Which option(s) do companies prefer for separate RO configuration for RA-SDT?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Reply (Option 1/2/**  **Comments)** | **Detailed comments** |
| ZTE |  | We prefer to support separate RACH-ConfigCommon and msgA-ConfigCommon-r16 for SDT. |
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**Summary:**

Similar to separate RACH configuration in legacy 2-step RACH, if Option 1 mentioned above is chosen for RA-SDT, then the number of SSBs per RO and the number of contention-based preambles for each SSB might be optionally configured for 2-step/4-step RA-SDT.

### **Q6: Do companies agree that the number of contention-based 4-step/2-step RACH preambles per SSB and the number of SSBs per RO can be configured for RA-SDT when ROs for SDT and non-SDT are separate?**

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| --- | --- | --- |
| **Company** | **Reply (Yes/No/**  **Comments)** | **Detailed comments** |
| ZTE | Yes | Yes, this seems fine. See also comments to Q2. |
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**Summary:**

Considering both 4-step type and 2-step RA type are supported for RA-SDT, it might be deserved to consider the relation of PRACH resource between 2-step RA-SDT and 4-step RA-SDT. In general, the rapporteur thinks that the existing rule (i.e. separate RO or shared RO but separate preambles) can be reused for 2-step RA-SDT and 4-step RA-SDT. Specifically,

* For the relation of PRACH resources between 4-step RA-SDT and 2-step RA-SDT, the following two option can be configured by the network
  + Option 1: Separate ROs are configured for 4-step RA-SDT and 2-step RA-SDT;
  + Option 2: Shared RO but separate preambles for 4-step RA-SDT and 2-step RA-SDT.



Figure 3: Relation of PRACH resources for SDT and non-SDT

A graphical representation about a potential relation of PRACH resource for SDT and non-SDT is given in Figure 3. Companies are invited to provide their views on the above relation.

### **Q7: Do companies agree that RO(s) for 4-step RA-SDT and 2-step RA-SDT can be either separate or shared with separate preambles?**

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| --- | --- | --- |
| **Company** | **Reply (Yes/No/**  **Comments)** | **Detailed comments** |
| ZTE | Yes | As already agreed, the RO + preamble combination can be unique for SDT vs non-SDT. This means ROs can be either separate (with shared preambles) or ROs can be shared (with separate preambles). |
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**Summary:**

## 3.2 Search space configuration for RA-SDT

In the RAN1#104-e meeting, RAN1 had discussed CORESET and search space for monitoring the PDCCH addressed to the C-RNTI after successful completion of the RACH procedure during RA-SDT. And the following conclusions have been finally made [3].

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| --- |
| **R1-2102125 Reply LS on physical layer aspects of small data transmission**   * From RAN1 perspective, at least a separate SearchSpace that is different from the existing common SearchSpace should be supported for monitoring the PDCCH addressed to the C-RNTI after successful completion of the RACH procedure during RA-SDT   + It is up to RAN2 decision if the separate SearchSpace is UE-specific or common to the UEs performing RA-SDT * If the separate SearchSpace is not configured, type-1 PDCCH CSS can be reused. * FFS UE-specific CORESET or common CORESET |

From the LS, RAN2 is requested to provide feedback on whether UE-specific (i.e. USS) or a separate common search space (i.e. separate CSS) can be configured for SDT. Thus, here comes the question:

### **Q8: Which kind of search space (e.g. USS or separate CSS) do companies prefer for RA-SDT?**

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| --- | --- | --- |
| **Company** | **Reply (USS/separate CSS/Comments)** | **Detailed comments** |
| ZTE | CSS | USS only works in same cell case and we think such optimisation is not really important for Rel-17. |
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**Summary:**

# 4 Resource configuration for CG-SDT

Firstly, the rapporteur would like to note the understanding that the legacy type-1 CG configuration mechanism in the licensed band is reused (e.g. HARQ process configuration and HARQ process ID determination are the same as Rel-16 NR) for the following discussion in principle (further enhancements for the association between SSB and CG PUSCH occasion is pending on RAN1’s further progress) [4][5].

## 4.1 BWP operation

In the previous RAN2#113b-e meeting that had just ended, a popular discussion had been launched regarding whether an SDT specific BWP can be configured for INACTIVE UE performing CG-SDT. The corresponding online discussion record and related agreement made are listed below [2].

|  |
| --- |
| R2-2103533 Report from [POST113-e][504][SDT] CG Open Issues Huawei, HiSilicon discussion Rel-17 NR\_SmallData\_INACTIVE-Core  Proposal10: *CG-SDT resource can be configured on BWPs other than initial BWP configured by system information* (17/24).  - Nokia would like to discuss how it impacts the paging if it moves to another BWP. Huawei explains that there is network implementation to solve this problem. Qualcomm also sees some issues.  RAN2#113bis-e Agreement:  *FFS CG-SDT resource can be configured on BWPs other than initial BWP* |

The main concern on the SDT-specific BWP (e.g. non-initial BWP) is mainly about BWP switching due to paging and SI reception. To make progress, the following two options can be considered for CG-SDT:

* Option 1: CG resource can be configured on initial BWP.
* Option 2: CG resource can be configured on SDT BWP that fully contains the initial BWP.

Then, it should be up to NW implementation to adopt either Option 1 or Option 2 to a CG-SDT configuration for a given UE (depending on the UE capability as well). Companies are warmly invited to provide their views on the feasibility of the above two options.

### **Q9: Do companies agree that CG-SDT resources can be configured on either initial BWP or SDT BWP that fully contains the initial BWP?**

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| --- | --- | --- |
| **Company** | **Reply (Yes/No/**  **Comments)** | **Detailed comments** |
| ZTE | Partly yes (don’t think the restriction is needed) | We think separate SDT BWP can be supported. The UE anyway doesn’t need to monitor the UE specific paging ocacassion during SDT since RAN/CN paging is not applicable for SDT. Perhaps we should first agree this aspect (since network knows the UE is already performing SDT and hence it won’t page the UE for DL traffic but would rather send it to the UE or move to connected, CN paging is used to solve state-mismatch, but again since the UE is performing SDT, statemismatch is not applicable either).  We think first we **should agree whether or not UE needs to minotor UE specific paging whilst performing SDT:** It seems this is clearly not needed  Then the question is how to ensure the UE can receive the SI change indication in any paging occasion (for PWS etc). This can be done as long as there is common search space, with pagingSearchSpace in the configured active BWP and we think it is up to NW to ensure this if a separate BWP is configured.  **So, it seems separate BWP (not necessarily overlapping with initial BWP) is also feasible.**  Perhaps the question is whether companies support this or not. We think this is okay to relieve the congestion on initial BWP. |
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**Summary:**

## 4.2 CG resource configuration

In Rel-15/16, either 4-step CFRA preamble or 2-step CFRA preamble are associated with beam(s) (i.e. SSB or CSI-RS), according to the following highlighted parts.

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| --- |
| **TS 38.331 6.3.2 *RACH-ConfigDedicated***  CFRA ::= SEQUENCE {  occasions SEQUENCE {  rach-ConfigGeneric RACH-ConfigGeneric,  ssb-perRACH-Occasion ENUMERATED {oneEighth, oneFourth, oneHalf, one, two, four, eight, sixteen}  OPTIONAL -- Cond Mandatory  } OPTIONAL, -- Need S  resources CHOICE {  ssb SEQUENCE {  ssb-ResourceList SEQUENCE (SIZE(1..maxRA-SSB-Resources)) OF CFRA-SSB-Resource,  ra-ssb-OccasionMaskIndex INTEGER (0..15)  },  csirs SEQUENCE {  csirs-ResourceList SEQUENCE (SIZE(1..maxRA-CSIRS-Resources)) OF CFRA-CSIRS-Resource,  rsrp-ThresholdCSI-RS RSRP-Range  }  },  ...,  [[  totalNumberOfRA-Preambles INTEGER (1..63) OPTIONAL -- Cond Occasions  ]]  }  CFRA-TwoStep-r16 ::= SEQUENCE {  occasionsTwoStepRA-r16 SEQUENCE {  rach-ConfigGenericTwoStepRA-r16 RACH-ConfigGenericTwoStepRA-r16,  ssb-PerRACH-OccasionTwoStepRA-r16 ENUMERATED {oneEighth, oneFourth, oneHalf, one,  two, four, eight, sixteen}  } OPTIONAL, -- Need S  msgA-CFRA-PUSCH-r16 MsgA-PUSCH-Resource-r16,  msgA-TransMax-r16 ENUMERATED {n1, n2, n4, n6, n8, n10, n20, n50, n100, n200} OPTIONAL, -- Need S  resourcesTwoStep-r16 SEQUENCE {  ssb-ResourceList SEQUENCE (SIZE(1..maxRA-SSB-Resources)) OF CFRA-SSB-Resource,  ra-ssb-OccasionMaskIndex INTEGER (0..15)  },  ...  } |

With this design, the network can ensure the reserved CFRA preamble and UL transmission with beamforming can be restricted to the specific beam direction(s) preferred by gNB. Besides, taking the following RAN1 agreement, it seems necessary to explicitly configure a set of SSB(s) (via an SSB list) that are associated with a CG configuration.

|  |
| --- |
| RAN1#103bis-e agreement:  CG resources per CG configuration are associated with a set of SSB(s) configured by explicit signalling.   * + FFS how to define an SSB-to-PUSCH resource mapping within the CG configuration.   FFS specific changes to the CG configuration to support the additional SSB-to-PUSCH mapping, if any. |

Based on the above, companies are invited to provide their views on the following question.

### **Q10: Do companies agree explicitly signaling a set of SSB(s) associated with a CG configuration (via RRC Release) is needed for CG-SDT?**

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| --- | --- | --- |
| **Company** | **Reply (Yes/No/**  **Comments)** | **Detailed comments** |
| ZTE | Yes | This seems fesible, and it seems this is one of the options on the table in RAN1. So, perhaps we could wait for their input. If the intention of the email rapporteur is to inform RAN1 about the feasibility of this option, we are fine with this intention. |
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**Summary:**

## 4.3 Search space configuration for CG-SDT

For Rel-16 LTE PUR, UE-specific search space is configured for response reception after the UL transmission, according to the following highlighted part quoted from 36.213.

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| **TS 36.213 sub-clause 9.1.5:**  If the UE has initiated a PUSCH transmission using preconfigured uplink resource ending in subframe *n*, the UE shall monitor the MPDCCH UE-specific search space in a search space window starting in *n+5* subframewith duration given by higher layer parameter *pur-MPDCCH-SS-window-duration*. Upon detection of a MPDCCH with DCI format 6-0A/6-0B with CRC scrambled by PUR C-RNTI intended for the UE within the search space window and the corresponding DCI is for PUR ACK/fallback indication (as defined in [4]), the UE is not required to monitor the MPDCCH UE-specific search space for the remaining search space window duration. |

For CG-SDT, the same logic might be reused in terms of scheduling flexibility, UE power saving, spec impacts, and the support of non-fallback DCI format. The following question is given to collect companies’ views on the search space configuration for CG-SDT.

### **Q11: Do companies agree UE-specific search space is configured for CG-SDT?**

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| --- | --- | --- |
| **Company** | **Reply (Yes/No/**  **Comments)** | **Detailed comments** |
| ZTE | Yes | This seems feasible. RAN1 has left the decision on USS vs CSS for RA-SDT to RAN2 it seems. Then, it seems we can make an agreement on this and inform RAN1 too? |
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**Summary:**

## 4.4 CS-RNTI

For the existing NR system, CS-RNTI can be used for scheduling HARQ retransmission for a TB which is previously transmitted on CG PUSCH. In the past RAN2#113bis-e meeting, it was agreed that retransmission by DG is supported for CG-SDT. Then it is worthy to consider how to realize retransmission by DG for CG-SDT, taking the PUR mechanism for reference.

The following table summarizes how to interpret new transmission and retransmission when a UL grant is received in NR CG and LTE PUR, respectively.

Table 1 New transmission and retransmission in NR CG and LTE PUR

|  |  |  |
| --- | --- | --- |
|  | NR CG | LTE PUR |
| New transmission | C-RNTI regardless of NDI | preconfigured uplink grant for PUR |
| HARQ retransmission | CS-RNTI with NDI=1 | PUR-RNTI regardless of NDI |

For simplicity and flexibility, the legacy CS-RTNI based retransmission mechanism might be reused for CG-SDT. To realize this, the CS-RNTI shall be assigned along with the CG resources in the RRC Release message.

### **Q12: Do companies agree CS-RNTI is assigned along with CG-SDT resources?**

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| --- | --- | --- |
| **Company** | **Reply (Yes/No/**  **Comments)** | **Detailed comments** |
| ZTE | No | Since only one type of CG will be supported in INACTIVE state, it seems CS-RNTI is not needed? |
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**Summary:**

# 5 Conclusion

The contribution is summarized with proposals as follows,

# 6 References

1. RAN2#112-e, Session Chair Notes (Small data transmission), E-meeting
2. RAN2#113-e, Session Chair Notes (Small data transmission), E-meeting
3. R1-2102125, Reply LS on physical layer aspects of small data transmission, ZTE Corporation
4. RAN1#104bis-e, Chair’s Notes v012, E-meeting
5. 3GPP [RP-210870](http://www.3gpp.org/ftp/tsg_ran/TSG_RAN//TSGR_82/Docs/RP-182894.zip), Updated Work Item on NR small data transmissions in INACTIVE state, ZTE Corporation
6. [R2-2102710](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\113bise\Docs\R2-2102710.zip), Details of RACH based Small Data Transmission, Samsung Electronics Co., Ltd
7. [R2-2102757](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\113bise\Docs\R2-2102757.zip), Supporting Small Data Transmission via RA Procedure, vivo
8. [R2-2102847](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\113bise\Docs\R2-2102847.zip), Fallback issue for 2-step RA based small data transmission, Sharp
9. [R2-2103020](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\113bise\Docs\R2-2103020.zip), Open issues for RACH based SDT, ZTE Corporation, Sanechips
10. [R2-2103104](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\113bise\Docs\R2-2103104.zip), Considerations on Procedures without Anchor Relocation, CATT
11. [R2-2103105](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\113bise\Docs\R2-2103105.zip), Analysis on Search Space of RA-SDT, CATT
12. [R2-2103252](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\113bise\Docs\R2-2103252.zip), Discussion on RACH-based SDT, Spreadtrum Communications
13. [R2-2103264](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\113bise\Docs\R2-2103264.zip), PDCCH monitoring in subsequent data transmission period, Asia Pacific Telecom co. Ltd, FGI
14. [R2-2103403](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\113bise\Docs\R2-2103403.zip), Analysis on open issues of RA based SDT, Lenovo, Motorola Mobility
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