3GPP TSG-RAN WG2 #116-e R2-21xxxxx

Electronic meeting 1st - 12th November, 2021

Agenda Item: 8.13.2.2

Source: CATT

Title: [Post115-e][898][SON/MDT] 2-step RA related SON aspects(CATT)

Document for: Discussion and Decision

# 1 Introduction

This document captures the outcome of the following email discussion

* [POST 115e][898][SON/MDT] 2-step RA related SON aspects (CATT)

**Scope:**

 Technical discussion rather than voting yes/no on open issues in 8.13.2.2 2-step RA related SON aspects.

 How to capture all the related agreements we got so far.

 **Intended outcome**: Report

 **Deadline**: until next meeting

Please provide your comments for phase I before 9/27/2021 23:59 UTC and for phase II before 10/19/2021 23:59 UTC.

Phase I: progress on FFS

* Expected outcome: agreeable proposals

Phase II: progress on FFS of phase I and ASN.1 structure for all agreements

* Expected outcome: potential ASN.1 structure

If the convergence can be achieved in phase I, the corresponding conclusion can be captured in ASN.1 structure in phase II.

This document is organized as the following. For phase I, the discussions are in section 2, and the proposals are in section 3. For phase II, the content in section 4 and 5 are FFS, it will include the draft CR for all the agreements, and the possible ASN.1 structure depending on the progress in phase I.

# 2 Discussion

Rapporteur encourages the participating delegates to provide their contact information in this table.

|  |  |
| --- | --- |
| Company | Contact: Name (E-mail) |
| Samsung | Sb07.kim@samsung.com |
| CATT | shijie@catt.cn |
| vivo | (Ming WEN) ming.wen@vivo.com |
| Huawei, HiSilicon | jun.chen@huawei.com |
| ZTE | qiu.zhihong@zte.com.cn |
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## 2.1 Switching information related

There are two options for switching information summarized in [1]:

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| --- |
| **Proposal 2: FFS which option should be made for RACH type switch indication in the RACH report:*** **Option 1: including an explicit switch indication in the IE related to the last/first RA attempt before/after the 2-step to 4-step RA switch.**
* **Option 2: including the parameter MsgA-Transmax in each RA-InformationCommon IE.**
 |

Besides the 2 options above, one company points out that using stage-3 signaling design, i.e. to introduce a new fieldfor reporting whether the DL beam quality, associated to the used 2 step RA resource, is above or below the *msgA-RSRP-ThresholdSSB,* could implicitly indicate the switching RA attempt in [1]. Therefore rapporteur lists this method as option 3, and there are three options for indicating switching point:

* Option 1: including an explicit switch indication in the *PerRAAttemptInfo* IE related to the last/first RA attempt before/after the 2-step to 4-step RA switch;
* Option 2: including the field *msgA-Transmax* in *RA-InformationCommon* IE;
* Option 3: switching indication from 2-step RA to 4-step RA can be implicitly indicated by introducing a new field, i.e. whether the DL beam quality, associated to the used 2 step RA resource, is above or below the *msgA-RSRP-ThresholdSSB*.

Since there is no consensus on bits consumption of the above three options in offline discussion [1], rapporteur analyzes the ASN.1 structure and bits consumption of the above options in the following.

* Option 1: including an explicit switch indication in the PerRAAttemptInfo IE related to the last/first RA attempt before/after the 2-step to 4-step RA switch

The ASN.1 structure could be:

PerRAAttemptInfoList-r16 ::= SEQUENCE (SIZE (1..200)) OF PerRAAttemptInfo-r16

PerRAAttemptInfo-r16 ::= SEQUENCE {

 contentionDetected-r16 BOOLEAN OPTIONAL,

 dlRSRPAboveThreshold-r16 BOOLEAN OPTIONAL,

...,

[[

lastRAAttemptOf2sRA-r17 ENUMERATED {true} OPTIONAL

]]

}

The bits consumption:

Since the structure of “ENUMERATED {true}” will not cost bit, the consumption of option 1 is introduced by the “OPTIONAL”, it will cost 1 bit in each RA attempt to indicate whether the *lastRAAttemptOf2sRA* occurs or not. If there are N numbers of RA attempts, as many as 1\*N bits are needed for option 1, the possible maximum number of bits could be 200.

The ASN.1 structure of indication related to first RA attempt after the 2-step to 4-step RA switch is similar as the above example.

If the option 1 is applied, the legacy field *dlRSRPAboveThreshold* can be reused with small description modification for 2-step RA report.

For RA procedure initiated for beam failure recovery, only *rsrp-ThresholdSSB* associated with 4-step RA can be configured in *beamFailureRecoveryConfig*. The *msgA-RSRP-ThresholdSSB* can be only configured in *RACH-ConfigCommonTwoStepRA*. Therefore, this field description can be modified as following to cover 2-step RA and 4-step RA cases:

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| --- |
| ***dlRSRPAboveThreshold***This field is used to indicate whether the DL beam (SSB) quality associated to the random access attempt was above or below the threshold *rsrp-ThresholdSSB(for 4-step random access)* in *beamFailureRecoveryConfig* in UL BWP configuration of UL BWP selected for random access procedure initiated for beam failure recovery; Otherwise, *rsrp-ThresholdSSB(for 4-step random access)* in *rach-ConfigCommon* or *msgA-RSRP-ThresholdSSB(for 2-step random access)* in *msgA-ConfigCommon* in UL BWP configuration of UL BWP selected for random access procedure. |

* Option 2: including the field *msgA-Transmax* in *RA-InformationCommon* IE

The ASN.1 structure could be:

RA-InformationCommon-r16 ::= SEQUENCE {

 absoluteFrequencyPointA-r16 ARFCN-ValueNR,

 locationAndBandwidth-r16 INTEGER (0..37949),

 subcarrierSpacing-r16 SubcarrierSpacing,

 msg1-FrequencyStart-r16 INTEGER (0..maxNrofPhysicalResourceBlocks-1) OPTIONAL,

 msg1-FrequencyStartCFRA-r16 INTEGER (0..maxNrofPhysicalResourceBlocks-1) OPTIONAL,

 msg1-SubcarrierSpacing-r16 SubcarrierSpacing OPTIONAL,

 msg1-SubcarrierSpacingCFRA-r16 SubcarrierSpacing OPTIONAL,

 msg1-FDM-r16 ENUMERATED {one, two, four, eight} OPTIONAL,

 msg1-FDMCFRA-r16 ENUMERATED {one, two, four, eight} OPTIONAL,

 perRAInfoList-r16 PerRAInfoList-r16,

...,

[[

 msgA-TransMax-r16 ENUMERATED {n1, n2, n4, n6, n8, n10, n20, n50, n100, n200} OPTIONAL

]]

}

The bits consumption:

The field is indicated per RA procedure. The structure of “ENUMERATED {n1, n2, n4, n6, n8, n10, n20, n50, n100, n200}” will cost 4 bits to indicate, and the consumption of the “OPTIONAL” is 1 bit. Therefore a mandatory size of 4+1=5 bits are needed for option 2.

If the option 2 is applied, similar as for the option1, the legacy field *dlRSRPAboveThreshold* can be reused with the small description modification for 2-step RA report.

* Option 3: switching indication from 2-step RA to 4-step RA can be implicitly indicated by introducing a new field, i.e. whether the DL beam quality, associated to the used 2 step RA resource, is above or below the msgA-RSRP-ThresholdSSB.

For option 3, there is a need to introduce a new field to indicate whether the DL beam quality, associated to the used 2 step RA resource, is above or below the *msgA-RSRP-ThresholdSSB*. Rapporteur gives the ASN.1 structure of the new field, e.g. *dlRSRPAboveThreshold2sRA*.

The ASN.1 structure could be:

PerRAAttemptInfoList-r16 ::= SEQUENCE (SIZE (1..200)) OF PerRAAttemptInfo-r16

PerRAAttemptInfo-r16 ::= SEQUENCE {

 contentionDetected-r16 BOOLEAN OPTIONAL,

 dlRSRPAboveThreshold-r16 BOOLEAN OPTIONAL,

...,

[[

dlRSRPAboveThreshold2sRA-r17 BOOLEAN OPTIONAL

]]

}

The bits consumption:

The structure of “BOOLEAN” will cost 1 bit to indicate, and the “OPTIONAL” is also 1 bit cost. A size of 1+1=2 bits for each RA attempt is needed for the option 3. If there are N numbers of RA attempts, as many as 2\*N bits are needed for option 3, the possible maximum number of bits could be 2\*200.

**Q1: Do you agree the rapporteur’s analysis on the ASN.1 structure and bits consumption of three options? If No, please give your analysis.**

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| **Company**  | **Yes/No** | **comments if any** |
| **Samsung** | ~~No~~Yes | We have assumed that the analysis of bits consumption is correct.  ~~However, we are not sure if the option 2 can fully cover the original intention indicating whether to switch to 4RA.~~ ~~For instance, when UE has received no RAR corresponding to the UE’s preamble until the expiry of window, UE may perform the “Random Access Resource Selection” described in TS38.321 clause 5.1.2 and 5.1.4.~~~~In other words, UE can switch 2RA to 4RA, due to the RA resource Selection process, as well as reaching to msgA-TransMax.~~~~Thus, we don’t think that the option 2 is a valid solution.~~ |
| OPPO | Yes | Response to Samsung: when UE has not received RAR corresponding to the UE’S preamble until the expiry, according to TS 38.321, if the UE has selected the 2-step RACH type, the UE will only stick on performing the 2-step RA type Random access resource selection procedure. Details could be found in TS 38.321 as follows:[Samsung]Thank you for the clarification. We agree Oppo’s clarification. We have identified that we misled the current procedural text. Hence, we have changed our view.5.1.4a MSGB reception and contention resolution for 2-step RA type:[omit]2> if the Random Access procedure is not completed:3> if *msgA-TransMax* is applied (see clause 5.1.1a) and *PREAMBLE\_TRANSMISSION\_COUNTER* = *msgA-TransMax* + 1:4> set the *RA\_TYPE* to *4-stepRA*;4> perform initialization of variables specific to Random Access type as specified in clause 5.1.1a;4> if the Msg3 buffer is empty:5> obtain the MAC PDU to transmit from the MSGA buffer and store it in the Msg3 buffer;4> flush HARQ buffer used for the transmission of MAC PDU in the MSGA buffer;4> discard explicitly signalled contention-free 2-step RA type Random Access Resources, if any;4> perform the Random Access Resource selection procedure as specified in clause 5.1.2.3> else:4> select a random backoff time according to a uniform distribution between 0 and the *PREAMBLE\_BACKOFF*;4> if the criteria (as defined in clause 5.1.2a) to select contention-free Random Access Resources is met during the backoff time:5> perform the Random Access Resource selection procedure for 2-step RA type Random Access (see clause 5.1.2a).4> else:5> perform the Random Access Resource selection procedure for 2-step RA type Random Access (see clause 5.1.2a) after the backoff time. |
| CATT | Yes |  |
| vivo | Yes |  |
| Huawei, HiSilicon | Yes |  |
| ZTE | Yes |  |
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Rapporteur would like the companies give the most suitable option based on the above analysis.

**Q2: Which option do you prefer based on the analysis of the options?**

* Option 1: including an explicit switch indication in the PerRAAttemptInfo IE related to the last/first RA attempt before/after the 2-step to 4-step RA switch;
* Option 2: including the field *msgA-Transmax* in *RA-InformationCommon* IE;
* Option 3: switching indication from 2-step RA to 4-step RA can be implicitly indicated by introducing a new field, i.e. whether the DL beam quality, associated to the used 2 step RA resource, is above or below the *msgA-RSRP-ThresholdSSB*.

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| **Company**  | **Option 1/Option 2/Option 3** | **comments if any** |
| **Samsung** | ~~Option 1~~Option 2 | ~~The option 1 is a clear solution covering all cases.~~~~Alternatively, a RA type indicator can be intuitively introduced.~~ |
| OPPO | Option 2 | Option 2 is the most efficient reporting method in extreme cases (UE has tried many times of RACH attempts before succss). |
| CATT | Option 2 | If there are more than five RA attempts in one RA procedure, the option 2 can indicate the switching point with lower bits consumption. |
| vivo | Option 2 | Our original thought about Opt3 is that if a new field is necessary to be introduced (due to the signalling design), then there is no need to additionally include *msgA-Transmax*, but if majority thinks the new field (related to Opt3) is not needed, Opt2 seems to be the most efficient option. |
| Huawei, HiSilicon | Option 2 | Share similar views as CATT. |
| ZTE | Option 2 | Share similar comments as Rapporteur. In addition, another gain of option 2 is that NW can know whether absent of switching indication is due to no configuration of MsgA-Transmax or no reaching the maximum allowed number. |
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[Summary]

## 2.2 MSGA PUSCH related information

The companies as below suggest to include the MSGA PUSCH related information in RA report to optimize MSGA PUSCH transmission, the information suggested can be divided into two aspects: one is preamble group related, the other is MSGA PUSCH resource related.

* preamble group related

 As the options summarized in [1], rapporteur lists the preamble group related information in the table below:

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| * A: the payload size transmitted in MSGA for a 2-step RACH attempt (from [2] Nokia)
* B: indication of whether the payload size is above or below the ra-MsgA-SizeGroupA threshold (Ericsson[1]) [Samsung] We has then suggested a new indicator to indicate whether MSGA PUSCH was transmitted or not during this RA attempt
* C: the group type of a preamble i.e., group type A or B (from [2] Nokia, [4] Ericsson)
* D:PUSCH group information(from [3] ZTE, [4] Ericsson)
* E: indication of pathloss above or below the pathloss threshold for groupA/B (from [4] Ericsson)
 |

For the RACH optimization in Rel-16, the RACH preamble split (among dedicated, group A, group B) aspects was included in stage 1, i.e. TR37.816. However, it was not discussed in the subsequent WI stage. Since the corresponding optimization was not introduced for 4-step RA report, rapporteur thinks we should firstly discuss the necessity to include the preamble group related information into RA report which is out of the scope of 2-step RA report optimization.

In TS 38.321, for the contention-based Random Access preamble selection of 4-step RA type and 2-step RA type, there are two kinds of condition to select the RA preambles group B, one is contention-free Random Access Resources have not been configured, another is contention-free Random Access Resources have been configured.

For the first condition, the preamble group selection is based on the threshold *ra-Msg3SizeGroupA (ra-MsgA-SizeGroupA)* and/or pathloss. For the second condition, the preamble group selection based on whether the transport block size of the MSGA payload configured in the *rach-ConfigDedicated* corresponds to the transport block size of the MSGA payload associated with Random Access Preambles group B.

Since the preamble group selection procedure is similar for 4-step RA and for 2-step RA, if there is a need to optimize the preamble group, the optimization needs to cover both 2-step RA and 4-step RA cases.

Please take above information into account when considering whether there is a need to optimize preamble group for RACH optimization. Therefore, the rapporteur suggests: RAN2 first discusses whether there is a need to optimize preamble group for RACH optimization and the corresponding conclusion is applied to both 2-step RA report and 4-step RA report.

If companies consider the preamble group optimization is necessary, the information may be needed to achieve an acceptable proposal.

**Q3: Do you agree to optimize preamble group for RACH optimization, and the corresponding conclusion is applied to 2-step RA report and 4-step RA report?**

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| **Company**  | **Yes/No** | **comments if any (Reason or Benefit)** |
| Samsung | No |  |
| OPPO | No | It is more related to 4-step RACH optimization. |
| CATT | No |  |
| vivo | No |  |
| Huawei, HiSilicon | No |  |
| ZTE | Yes | Both 4step and 2step can benefit from preamble group information, especially for 2tepRA. The common benefits is that NW can based on this information to optimize the preamble division and assignment. And for 2stepRA, the preamble group information is also related to PUSCH group information which can help NW to understand which PUSCH resource has been used. Thus it is beneficial to add such information. |
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Since the option “D” is general information and covered in Q3, rapporteur excludes this option in Q4.

**Q4: If you agree with Q3, which option(s) do you prefer?**

* A: the payload size transmitted in MSGA for a 2-step RACH attempt
* B: indication of whether the payload size is above or below the ra-MsgA-SizeGroupA threshold
* C: the group type of a preamble i.e., group type A or B
* E: indication of pathloss above or below the pathloss threshold for groupA/B

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| **Company**  | **A/B/C/E/others** | **Comments if any** |
| **ZTE** | C |  |
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[Summary]

* MSGA PUSCH resource related

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| * F: the MCS index(from [3] ZTE)
* G: the number of PRB per PO of the PUSCH resource(from [3] ZTE)
* H: the combination of start symbol and length and PUSCH mapping type(from [3] ZTE)
* I: offset of lowest PUSCH occasion in frequency domain with respect to PRB 0(from [3] ZTE)
* J: the number of msgA PUSCH occasions FDMed in one time instance(from [3] ZTE)
* K:MSGA PUSCH resource information (from [4] Errcsson and [5] CMCC)
* M: whether MSGA PUSCH was transmitted or not during this RA attempt (from Samsung)
 |

For the MSGA PUSCH resource related, the rapporteur lists the detail parameters related the above information that configured in *MsgA-PUSCH-Resource*.

F: the MCS index

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| ***msgA-MCS***Indicates the MCS index for msgA PUSCH from the Table 6.1.4.1-1 for DFT-s-OFDM and Table 5.1.3.1-1 for CP-OFDM in TS 38.214. |

G: the number of PRB per PO of the PUSCH resource

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| ***nrofPRBs-PerMsgA-PO***Number of PRBs per PUSCH occasion (see TS 38.213, clause 8.1A). |

H: the combination of start symbol and length and PUSCH mapping type

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| ***msgA-PUSCH-TimeDomainAllocation***Indicates a combination of start symbol and length and PUSCH mapping type from the TDRA table (*PUSCH-TimeDomainResourceAllocationList* if provided in *PUSCH-ConfigCommon*, or else the default Table 6.1.2.1.1-2 in 38.214 is used if *pusch-TimeDomainAllocationList* is not provided in PUSCH-ConfigCommon). The parameter K2 in the table is not used for msgA PUSCH. The network configures one of *msgA-PUSCH-TimeDomainAllocation* and *startSymbolAndLengthMsgA-PO,* but not both. If the field is absent, the UE shall use the value of startSymbolAndLenghtMsgA-PO. |

I: Offset of lowest PUSCH occasion in frequency domain with respect to PRB 0

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| --- |
| ***frequencyStartMsgA-PUSCH***Offset of lowest PUSCH occasion in frequency domain with respect to PRB 0 (see TS 38.213, clause 8.1A). |

J: The number of msgA PUSCH occasions FDMed in one time instance

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| --- |
| ***nrofMsgA-PO-FDM***The number of msgA PUSCH occasions FDMed in one time instance (see TS 38.213, clause 8.1A). |

The detail information and configuration of the above parameters can be checked in TS 38.214 and TS 38.213.

In the previous meeting, a fallback indication is agreed to be included into 2-step RA report per RA attempt. This indication can be used for network to optimize the frequency and time domain allocation or MCS of MSGA PUSCH, e.g. if the fallback occurs frequently, the network can adjust the above mentioned parameters for MSGA PUSCH payload transmission. It is a coarse [granularity](https://fanyi.baidu.com/%22%20%5Cl%20%22en/zh/granularity) but efficient way to optimize MSGA PUSCH resource.

If a finer [granularity](https://fanyi.baidu.com/%22%20%5Cl%20%22en/zh/granularity) method is needed, as in the above table, a lot of information may be needed to optimize MSGA PUSCH resource. Please take the complexity and the signalling overhead into account when considering this finer [granularity](https://fanyi.baidu.com/%22%20%5Cl%20%22en/zh/granularity) optimization of MSGA PUSCH resource.

M: whether MSGA PUSCH was transmitted or not during this RA attempt.

In NR-U, the LBT failure may happen in the MSGA PUSCH occasion, or SSB/PRACH occasion corresponding to MSGA PUSCH occasion may be invalid. Then, MSGA PUSCH cannot be transmitted. Hence, M is helpful to identify any problem in MSGA transmission.

**Q5: Do you agree that there is a need to introduce the MSGA resource related information in 2-step RA report?**

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| --- | --- | --- |
| **Company**  | **Yes/No** | **Comments if any(Reason or benefit)** |
| Samsung | Yes | See the new description above |
| CATT | No | The fallback indication can be used for MSGA PUSCH optimization. If further optimization for MSGA PUSCH resource is required, the complexity and the signaling overhead may be largely increased but with a little gain. |
| Huawei, HiSilicon | No | The above information may be userful for network optimization, but the extra signalling overhead needs to be justified. Currently for Rel-16 RA report, there are at most 200 PerRAInfo-r16 and there are at most 200 PerRAAttemptInfo-r16, so there are different calculations if including the MSGA resource information into different levels. |
| ZTE | Yes | There could be more than one set of PUSCH configuration configured, even with fallback indication, NW cannot know which sets of PUSCH resource is the problem, and the possible problematic configuration, thus do not know how to do optimization. To improve the successful rate of PUSCH transmission is one of the important optimization for 2stepRA, thus it is necessary to include PUSCH related information in 2stepRA report.Moreover, considering PUSCH resource will need to reserve resource in advance, thus with the actual intended PO size or the difference between transmitted MsgA size and actual required size NW can optimize the configuration of PO size which also can help improve the resource efficiency. Regarding to M, we agree Samsung’s analysis, thus it is also beneficial to includes.In response to Huawei, since once the preamble group or PUSCH group is decided UE will not switch the group again and won’t rebuilt the PUSCH payload, thus besides M proposed by Samsung, the rest of PUSCH information will only need to be included once for one RA procedure. Therefore the cost is acceptable comparing to the gain. If PUSCH resource cannot be optimized properly, then the performance gain of 2stepRA will be decreased, and that’ s why we think it is important to include PUSCH related information. |
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Since the option “K” is general information and covered in Q5, rapporteur excludes this option in Q6.

**Q6: If you agree with Q5, which option(s) do you prefer?**

* F: the MCS index
* G: the number of PRB per PO of the PUSCH resource
* H: the combination of start symbol and length and PUSCH mapping type
* I: offset of lowest PUSCH occasion in frequency domain with respect to PRB 0
* J: the number of msgA PUSCH occasions FDMed in one time instance
* M: whether MSGA PUSCH was transmitted or not during this RA attempt

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| **Company**  | **F/G/H/I/J/M/others** | **Comments if any** |
| Samsung | M | See the new description above |
| ZTE | ALL |  |
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[Summary]

# 3 Phase I Conclusion

Based on the discussion, we firstly have a set of proposals for RAN2 agreements:

# 4 Phase II

FFS.

# 5 Phase II Conclusion

FFS.

# 6 References

1. R2-2108963, Report of [AT115e][821][SON/MDT] 2-Step RA related SON (OPPO)
2. R2-2107507, Remaining Issues and New Aspects in 2-step NR UE RACH Report, Nokia
3. R2-2108354, 2-step RA related enhancements, ZTE
4. R2-2108418, 2-step RA information for SON purposes, Ericsson
5. R2-2108542, SON Enhancement for 2-step RA, CMCC