**3GPP TSG RAN2 #116-e R2-21xxxxx**

**Online, 1 – 12 November 2021**

**Agenda Item:**  **8.13.3.1 Immediate MDT enhancements**

**Source: ZTE, Sanechips (email rapporteur)**

**Title:** **Report of [Post115-e][895][SON/MDT] IMM MDT (ZTE)**

**Document for: Discussion and Decision**

### 1 Introduction

This is the email report of [Post115-e][895] [SON/MDT] IMM MDT:

* [Post115-e][895][SON/MDT] IMM MDT (ZTE)

 Scope:

 - Based on the proposals in R2-2109021 progress the progress…

 Intended outcome: Report

 Deadline: until next meeting

It is proposed to set the following deadlines for this email discussion:

* Phase 1: collect companies’ opinions. Deadline: October 18th, 0900 UTC
* Phase 2: finalize the summary. Deadline: October 21th, 0900 UTC

Please add company contact details into the following table.

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| --- | --- | --- |
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### Discussion

The intention of this document is to discuss remaining topics summarized in[3] that haven’ t been treated due to limited online time. And the discussion will only focus on immediate MDT related topics.

####  Discussion on M6 measurement (including D1 measurement)

* + 1. **Background**

Following agreements have been achieved from previous meetings[1][2]:

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| **Agreements RAN2#113-e**1. RAN2 will NOT enhance the current delay measurement mechanism.
2. In case split bearer data goes through Xn/X2 interface, the delay over Xn/X2 interface should be taken into account in M6 for split bearers.
3. D3 is re-used to reflect the DL delay on F1-U/X2/Xn, D2.3 is re-used to reflect the UL delay on F1-U/X2/Xn, LS to RAN3 for further confirmation.
4. 6 The delay over Xn/X2/F1-U interface should be taken into account in M6 for MN terminated SCG bearers and SN terminated MCG bearers.
5. For QoS monitoring related delay reporting to CN, the minimum value between two legs is defined as the total delay measurement M6 over MCG/SCG for split bearers WITH PDCP duplication.
6. For QoS monitoring related delay reporting to CN, the delay estimation coordination (forwarding) between MN and SN is needed for split bearers.
7. For QoS monitoring related delay reporting to CN, the delay estimation coordination (forwarding) between MN and SN is needed for MN terminated SCG bearers and SN terminated MCG bearers.
8. For QoS monitoring related delay reporting to CN, ‘weighted average (consider the number of packets) over MN and SN’ is used to calculate the total delay measurement M6 over MCG/SCG for split bearers WITHOUT PDCP duplication.

**Agreements RAN2#113bis-e**For MN terminated SCG bearer and SN terminated MCG bearer, the terminated node, e.g., MN in case of MN terminated SCG bearer,configures the configuration to UE.=> RAN2 understanding is that for the accuracy of the result, the M6 result can be indicated with data marker (duplication indicator). |

The remaining issue is on how to calculate, report and configure D1 measurement in split bearer, which will be discussed in this section. And there are three contributions submitted under this topic[4][5][6].

* + 1. **Analysis**

In Summary R2-2109021[3], it is suggested to discuss whether to support D1 over split bearer, which seems to be overkill considering delay measurement is one of the most important KPI for performance monitoring. Also, some new observations have been provided in [4][5], thus it is suggested to continue the discussion.

**PART I: How to calculate D1 measurement in split bearer**

This topic has been discussed several meetings, and following options have been discussed for D1 calculation on D1 measurements in split bearer:

* Option 1: Two separate D1 is calculated separately for MN and SN
* Option 2: Single D1 is calculated

Following are arguments from proponents of option 1:

1. D1 is impact jointly by the scheduling strategies and radio in both MN and SN, thus D1 over MN and SN shall not be the same, separate delays provides more accurate measurement in split bearer;
2. For duplicated case, packets will be transmitted in both MN and SN, which results in different delay over MN/SN path due to different radio environment in two paths.

The arguments for option 2 are listed as below:

1. There is only one single PDCP entity at UE’s side, where PDCP buffer is the FIFO buffer. Therefore, the average packet delay will remain the same irrespective of whether the packet is scheduled over MN or SN.
2. For split bearer, UE distribute the delay with joint consideration on the conjunction on both MN and SN. Also according to behavior specified in TS 38.323, the UE is required to minimize the D1 delay for transmission between MN and SN, so the difference is negligible, and one averaged D1 is sufficient.

Based on above analysis, please indicate which solutions is preferred for D1 measurement in case of split bearers. Companies are also encouraged to provide more justifications if any in the comments to help facilitate discussion on this topic.

**Question 1: Based on above analysis, which of the following options do you prefer for D1 measurement in split bearers? Please add your comments if any.**

* Option 1: Two D1 is calculated separately for MN and SN
* Option 2: Single D1 is calculated

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| **Company name** | **Option 1/2/others** | **Comments** |
| Qualcomm | Option 2 | As there is a single PDCP entity at the UE per DRB, and the PDCP entity is FIFO. Therefore, there will be a single value of D1. |
| Huawei, HiSilicon | Option 1 | We agree with the arguments above.For option 2, our concerns are as below:* The data transmission of the two legs for duplication case are independent, so the average of D1 over MN and SN is still different
* For the following text in TS38.323, we do not think it is applied to the dulication case, and “minimize the PDCP SN gap” is not equal to “minimize the difference of delay”

*If the transmitting PDCP entity is associated with two RLC entities, the UE should minimize the amount of PDCP PDUs submitted to lower layers before receiving request from lower layers and minimize the PDCP SN gap between PDCP PDUs submitted to two associated RLC entities to minimize PDCP reordering delay in the receiving PDCP entity.* |
| Ericsson | Option 1 | We agree with arguments provided for Option-1 by the rapporteur. Also, we share the same understanding as Huawei when it comes to the reference to TS 38.323 in the option-2 related arguments.  |
| Nokia | Option 2 | In average, UL Delay measurement (see from the UE) in MN and SN can be given as a single value.  |
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**PART I: How to configure and report D1 measurement in split bearer**

Based on previous discussion, following solutions are identified for configuration and report of D1 in split bearer:

* Option 1: MN and SN can separately configure D1 to UE, and UE reports D1 to corresponding node where configuration is received;
* Option 2: Only one node (i.e., terminated node ) can configures D1 to UE, and UE reports D1 to corresponding node where configuration is received;

The Pros and Cons of each options are summarized in following table:

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|  | Pros | Cons |
| Option 1 | * More flexible
* MN and SN can based on its need to monitoring the delay performance and perform corresponding optimization
 | * More specs impact
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| Option 2 | * Easier to implement;
* Unified solution can be used for different bearer types, e.g., SN terminated MCG bearer/MN terminated SCG bearer
 | * Less flexible;
* limits the O&M to gather comprehensive performance measurements from the other node (SN/MN)
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Based on above analysis, please indicate which options do you prefer for configuration and report of D1 in split bearers, also options can also be included if any. Companies are encouraged to provide more justifications if any in the comments to help facilitate discussion on this topic.

**Question 2: Based on above analysis, which of the following options do you prefer for D1 measurement in split bearers? Please add your comments if any.**

* Option 1: MN and SN can separately configure D1 to UE, and UE reports D1 to corresponding node where configuration is received;
* Option 2: Only one node (e.g., terminated node ) can configures D1 to UE, and UE reports D1 to corresponding node where configuration is received;

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| **Company name** | **Option 1/2/others** | **Comments** |
| Qualcomm  | Option 2 | There will be a single value of D1. Therefore, only terminating node should be allowed to configure D1. |
| Huawei, HiSilicon | Option 2 | Option 1 has more specs impact (e.g. for the MN terminated split bearer, SN need send the D1 to the MN) and more signalling overload (e.g. UE needs to send two UL RRC message to MN and SN).For option 1, we have some concerns on the Pros “the MN and SN can based on its need to monitoring the delay performance and perform corresponding optimization”. The delay measurements are mainly used for the QoS monitoring (initiated by SA2) and MDT, so we wonder how MN/SN performs optimizations based on the measurements. |
| Ericsson | Option-1 | Regarding the ‘Consequences’ of the option-1, we believe the amount of spec work needed is the same for both option-1 and option-2 as the UE will be configured with a D1 delay on the respective cell group which is already supported. So, we do not agree with ‘more spec impact’.Further, addressing the concern rasised by Huawei, we believe that the measurements can be used by the RAN to its internal optimization although the same measurement gets reported to the OAM. There is nothing precluding that the D1 measurement can be used for scheduling optimization at the RAN as part of the D1 measurement comes from the scheduler decision.  |
| Nokia | Option 1 | To follow the agreed principle: terminating node should be able to configure the measurement |
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####  Discussion on M5 /M7 measurement

* + 1. **Background**

This section intends to discuss how to support M5 and M7 measurement for split bearers, and discuss whether further enhancements are needed. There are three papers provides solution under this topic [4][5][7].

**2.2.2 Analysis**

**Part I: How MN and SN collects M5 measurements in split bearer**

Currently M5 defined in TS 28.552 is the DL/UL UE average throughput measurement, which is measured at DU. It is observed in [4][5] that PDCP is unable to compute correct M5 measurement due to lack of information on the number of RLC SDU transmitted and acknowledged. Therefore it is straightforward to reuse the measurement for split bearers, where MN and SN can calculates M5 measurements separately.

Based on above observations, following proposals are made separately in two contributions:

* Proposal 3: For split bearer, the M5 measurement results of MN and SN can be calculated in the DU respectively.[4] CATT
* Proposal 4 For the throughput measurements (M5) in split bearer configurations, the throughput is computed at individual DUs and sent to TCE.[5] Ericsson

Considering how to provide measurements is more within RAN3 scope, the OAM/TCE related part were deleted from the original proposals, and the modified proposals are given as below:

* **Proposal a: For split bearers, MN and SN can calculate M5 measurement in the DU respectively.**

**Question 3: Based on above analysis, do you agree with proposal as given below? Please add your comments if any.**

* **Proposal a: For split bearers, MN and SN can calculate M5 measurement in the DU respectively.**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm | Disagree (not sufficient) | Consider a simple scenario in the above figure, where around 100 KB data burst is sent over MN from 0 – 100 ms and 500 KB data burst is sent over SN from 25 – 100 ms. In this example, the throughput calculated by MN and SN are respectively:By MN: $\frac{0.1}{0.1}=1 MBps$By SN: $\frac{0.5}{0.075}=6.66 MBps$While the actual thoughput is:Actual UE throughput = $\frac{0.6}{0.1}=6MBps$Even in this simplest above example, it is difficult (practically impossible) to obtain accurate throughput without burst level information. I.E. just the information whether the packet duplication is used together with DU throughput measurement is not sufficient (the inaccuracy in the computed throughput can be significantly high).  |
| Huawei, HiSilicon | Disagree | We think that the independent M5 measurement cannot reflect the actual throughput, and the overload for the signalling interaction should be considered.If needed, the CU or MCE can get the throughput based on the following formula:$$\frac{sum of the total data in MCG and SCG legs}{transmission duration time in MCG or SCG}$$ |
| Ericsson | Agree (See comments, the contents of the comments are important for further discussion in our opinion) | The measurement performed at the DU is a simplistic solution. As only the DU is aware of which packets have been successfully transmitted/received to/from the UE, DU is the only network entity that can correctly compute the throughput. Such a measurement reflect the throughput over each leg independently. **This measurement should also be reported as part of M5 measurement as it reflects per leg throughput.**However, this could lead to some inaccuracies in the overall throughput computation. If we are to resolve such an issue, one could take different approaches.1. Option-1: Let the UE report the DL and UL throughput measurement as the UE is aware of this metric.
2. Option-2: Compute the overall throughput at the CU-UP
	1. Compute the simplistic throughput at CU-UP i.e., the CU-UP calculates the total number of packets sent to the UE (either via MCG or via SCG or both) and this metric does not take into account if the UE has received these packets from the respective DUs or not.
	2. Introduce new indications from the DU to the CU to include the measurements mentioned in 5b, 5c and 5d.

The option 2b is too complex in a split gNB implementation. This is not acceptable to us.We are open to discuss the option-1 (very accurate) or option-2a (not accurate just like DU based throughpout measurement) listed above. **We prefer the option 1 (UE to report throughput measurement) if the target is to achieve the accurate metric to represent the throughput**.  |
| Nokia | Agree | Obtaining the average value from the measurements at DU (at PDCP level) should be sufficient for Immediate MDT purposes and DC observability. |
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**Part II: How MN and SN collects M7 measurements in split bearer**

M7 measurements includes DL/UL packet loss rate over uu interface and over F1-U interface, where packet loss rate over F1-U interface is within RAN3 scope, thus will not be discussed in this section. Moreover, considering the UL PDCP SDU Packet loss rate is measured at CU-UP which won’t be impact by bearer types, therefore no further discussion is needed also. The remaining part is how to support DL packet loss rate over uu interface of M7 measurement in split bearers.

Similar to M5, since PDCP cannot know the number of RLC SDU transmitted and acknowledged, it is unable to compute DL packet loss rate over uu interface at PDCP level. Moreover, considering DL packet loss rate over uu interface of M7 measurement is calculated at RLC level by DU, it is simpler to reuse the measurement for split bearers, where MN and SN can calculates DL packet loss rate over uu interface separately. Based on above observations, following proposals are made separately in two contributions:

* Proposal 5 For split bearer, the MN DU and the SN DU send the results of M7 measurement to OAM respectively. [4] CATT
* Proposal 6 Packet Loss rate measurements (M7) are performed at DUs and sent to TCE. [5] Ericsson

Considering how to provide measurements is more within RAN3 scope, the OAM/TCE related part were deleted from the original proposals, and the modified proposals are given as below:

* Proposal b: For split bearers, MN and SN can calculate the DL packet loss rate over uu interface as part of M7 measurement in the DU respectively.

**Question 4: Based on above analysis, do you agree with proposal as given below? Please add your comments if any.**

* **Proposal b: For split bearers, MN and SN can calculate the DL packet loss rate over uu interface as part of M7 measurement in the DU respectively.**

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| **Company name** | **Agree/Disagree** | **Comments** |
| Qualcomm  | Disagree | * Indication of duplication together with Uu packet loss computed by DUs is not sufficient
	+ For example, If 10 packets are sent over MN and SN in duplication scenario and let us assume sequence numbers 2,3, and 4 lost over MN but successfully delivered over SN, and 6,7, and 8 lost over SN but successfully delivered over MN
		- Then packet loss is zero

In the above example, DL packet loss rate over uu interface as part of M7 meaasurements in the DUs are not sufficient.The inaccuracy in the measurements can be significantly high.  |
| Huawei, HiSilicon | Disagree | We think that the independent M7 measurement cannot reflect the actual packet loss rate, and the overload for the signalling interaction should be considered.If needed, we think the following method can be considered to get an approximate result. For example:* For duplication case, M7 could be: MIN (M7 in leg1, M7 in leg2)
* For non-duplication case, M7 could be:

$$\frac{number of loss packets in leg1+number of loss packets in leg2}{number of packets in leg1+number of packets in leg2}$$ |
| Ericsson | Agree ( see further comments, the contents of the comments are important for further discussion in our opinion) | MDT provides an average measurement and computing the average packet loss rate on MN side and average packet loss rate on the SN side should suffice to know what is the average packet loss rate that can be expected in this scenario.We also agree with Huawei regarding the overall packet loss rate measurement computation. In our contribution (R2-2108305), we had the following proposal.1. Introduce new layer-2 measurements to be performed by the CU-UP in association to M5, M6 and M7 measurements in split bearer scenarios.

1) Number of duplicated packets during the measurement period2) Number of non-duplicated packets sent over MCG during the measurement period3) Number of non-duplicated packets sent over SCG during the measurement periodUsing the above listed measurements and the packet loss rate sent by the DU, the OAM should be able to compute the overall packet loss rate.Again, if this is not acceptable, **we propose a UE based reporting of the packet loss rate measurement as the UE should be able to compute this (both in UL and DL)** without much overhead compared to the network side where there is a large coordination is needed between MN and SN nodes and also the impact of the split gNB deployment needs to be handled.  |
| Nokia | Agree | Individual metrics by MN and SN serve the purpose and they can be used to deliver “averaged” result. |
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**Part III: Enhancements to M5/M7 measurements in split bearer**

It is discussed in [4][5] that in case of duplication , packets has been received before will be discarded which will have an impact on M5 and M7 measurements, thus it is proposed to provide following information during M5/M7 measurement period in split bearer:

* Information to indicate duplicate status during M5/M7 measurement period

In [7] , the importance of more accurate M5 and M7 measurements are further stressed. It is argued in the contribution that duplication indicator is insufficient for accurate M5/M7 measurements, and additional measurements as shown below can be provided separately from MN and SN in case of split bearers to assist more accurateM5/M7 measurements calculation:

* Burst Size of data transmitted over SN (taking multiple transmission slots)
* The point in time when the transmission is started for the first data in the data burst over SN
* The point in time when the data until the second last piece of data burst TX over SN has been successfully received at the UE
* The RLC SDU sequence number of packets lost over the Uu interface
* The RLC SDU sequence number of the packet discard at the RLC or MAC for traffic management for which part is transmitted over the air.

It is noticed that similar enhancements in[7] has been discussed in RAN2#113-e in summary R2-2104441[8], and there was only one companies supporting this enhancements while there were three NW vendors not convinced with these enhancements and one NW vendors showed concerns on the additional overhead and extra complexity in implementation.

Considering in [7] some new observations are given and alternative is provided to address the concerns on the overhead, rapporteur suggest to check one last time companies’ opinions on necessity of those enhancements raised, to see if there are enough support for further enhancements on M5/M7.

Based on above analysis, please indicate in the table which information/measurements you consider is needed for M5/M7 measurement in split bearers.

**Question 5: Which of the following parameter/measurements you consider are needed for M5/M7 measurement in split bearers (none is also one option):**

1. **Information to indicate duplicate status during M5/M7 measurement period**
2. **Burst Size of data transmitted over SN (taking multiple transmission slots)**
3. **The point in time when the transmission is started for the first data in the data burst over SN**
4. **The point in time when the data until the second last piece of data burst TX over SN has been successfully received at the UE**
5. **The RLC SDU sequence number of packets lost over the Uu interface**
6. **The RLC SDU sequence number of the packet discard at the RLC or MAC for traffic management for which part is transmitted over the air.**

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| **Company name** | **a/b/.../f/None** | **Comments** |
| Qualcomm | All (proponent) | Needed for accurately obtaining M5/M7 measurments. |
| Huawei, HiSilicon | M5: a/b, and the transmission duration time M7: a, the number of loss packets and the number of packets | If TCE is to calculate the final M5/M7 results, the mapping information between UEs and M5/M7 information should be provided from RAN to TCE.For M5, we think each DU can send the total data size and the transmission duration time to the CU or MCE.For M7, we think each DU can send the number of loss packets and the number of packets to the CU or MCE. |
| Ericsson | No to b, c, d, e, fFor a see comments | As indicated in R2-2108305, we believe the following measurements are required at the TCE for computing M5 and M7 measurements.1. Introduce new layer-2 measurements to be performed by the CU-UP in association to M5, M6 and M7 measurements in split bearer scenarios.

1) Number of duplicated packets during the measurement period2) Number of non-duplicated packets sent over MCG during the measurement period3) Number of non-duplicated packets sent over SCG during the measurement period |
| Nokia | none | We believe averaged metrics per leg are sufficient for Immediate MDT purposes |
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####  Discussion on IDC detected during immediate MDT

**2.3.1 Background**

RAN3 sent an LS in [9] to inform SA5 and RAN2 that they has discussed the issue of immediate MDT measurement pollution, i.e., the case when measurements collected for MDT are subject to errors due to UE internal reasons. And IDC has been agreed to be included in this use case. In respond to RAN3’s LS[9], SA5 has discussed the corresponding issues and agreed to add the measurement pollution requirement and indication (i.e., IDC indication) in immediate MDT results as attached in [10]. RAN2 is asked to discuss relevant topic taking above information into consideration.

**2.3.2 Analysis**

Based on the LS received from SA5 and RAN3, two companies has submitted papers under this topic.

In [11] , it is observed that UE will initiate UE Assistance information (UAI) procedure when IDC is detected or resolved during RRC\_CONNECTED state, thus NW can know derive whether IDC problem exists by the time immediate MDT measurements is logged, no further enhancements are needed.

Moreover, in [6], it is stressed that in LTE the reporting of MDT measurements are not affected by IDC for immediate MDT(i.e., immediate MDT will not be suspend when IDC is detected), and it is NW’s responsibility to take care of IDC problem detected during immediate MDT collection period, which is aligned with the solution agreed by RAN3 and SA5.

Based on above analysis, it can be observed that both contributions consider that the requirement of immediate MDT pollution situation situation can be handled at NW’s side, no enhancements is needed in RAN2 aspects to support IDC tagging during immediate MDT. Therefore, following proposal has been made:

**Proposal c: The same as LTE, reporting of immediate MDT results won’t be impact by IDC.**

**Proposal d: No enhancement is needed in RAN2 signalling to support IDC tagging in immediate MDT results.**

**Question 6: Based on above analysis, do you agree with the proposals as shown below? Please add your comments if any.**

**Proposal c: The same as LTE, reporting of immediate MDT results won’t be impact by IDC.**

**Proposal d: No enhancement is needed in RAN2 signalling to support IDC tagging in immediate MDT results.**

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| **Company name** | **Agreed proposals** | **Comments** |
| Qualcomm | Agree.  | IDC is reporting in UAI. Further enhancement in immediate MDT is not needed.  |
| Huawei, HiSilicon | Agree |  |
| Ericsson | Agree |  |
| Nokia | Agree | We confirm Qualcomm observation |
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The intention of this email is to progress on the open issues in 8.13.3.1 (RAN2#115-e minutes), and if something is missing, please provide your comments in the table below.

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| **Company name** | **Comments** |
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### 3 Conclusion

[To be added]

### 4 References

1. [R2-2101956](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101956.zip) Report from SOM/MDT session Session chair (CMCC)

1. [R2-2104306](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2104306.zip) Report from SON/MDT session Session chair (CMCC)
2. R2-2109021 Summary on agenda item 8.13.3.1 Immediate MDT Huawei discussion Rel-17 NR\_ENDC\_SON\_MDT\_enh-Core
3. R2-2107826 Further Considerations on Immediate MDT Enhancements CATT discussion
4. R2-2108302 On Immediate MDT Enhancements Ericsson discussion
5. R2-2108565 Discussion on immediate MDT enhancements Huawei, HiSilicon discussion
6. R2-2108349 On accurate M5 and M7 measurements QUALCOMM INCORPORATED discussion
7. R2-2104441 Report of [AT113b-e][803][NR/R17 SON/MDT] IMM MDT Huawei
8. R3-211334 LS on the details of logging forms reported by the gNB-CU-CP, gNB-CU-UP and gNB-DU under measurement pollution conditions Source: RAN3 To: SA5, RAN2
9. S5-213499 Reply LS on the details of logging forms reported by the gNB-CU-CP, gNB-CU-UP and gNB-DU under measurement pollution conditions (Reply to R3-211334) Source: SA5 To: RAN3
10. R2-2108356 Consideration on immediate MDT aspects ZTE Corporation, Sanechips discussion
11. TS 38.331 v16.7.0
12. TS 28.552 V16.7.0
13. TS 38.314 v16.4.0