**3GPP TSG RAN2 #121bis-e R2-23xxxxx**

**Electronic, 17th – 26th April, 2023**

**Agenda Item:**  **XX.YY**

**Source: China Unicom (email rapporteur)**

**Title:** **[Post121][886][R17 SONMDT] New packet loss rate (China Unicom)**

**Document for: Discussion and Decision**

# 1 Introduction

This is the email report of [Post121][886]:

* **[Post121][886][R17 SON/MDT] New packet loss rate (China Unicom)**

Based on R2-2301855, Focus on the necessity of introducing the new packet loss rate and Figure out the proper method on when and how to introduce it if needed.

 Intended outcome: Report to the next meeting

 Deadline: 5th Apr, 10:00 UTC

Companies providing input to this email discussion are requested to leave contact information below.

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

## 2.1 Discussion on the necessity of introducing the new packet loss rate

In [1], two observations are provided:

**Observation 1: PER (packet error rate) is defined in TS 23.501 as a characteristic of a QoS Flow and it has different meanings for GBR QoS Flows with Delay-critical GBR resource type compared to other QoS Flows.**

**Observation 2: The numerator of the measurement for DL packet loss rate formula defined in TS 38.314 doesn’t contain the packets that are transmitted successfully but delayed, which is only suitable for QoS Flows with non-GBR resource type and GBR resource type, but not suitable for Qos Flows with delay-critical GBR resource type.**

Then, three conclusions are drawn:

* The existing measurement of packet loss rate in TS 38.314 is only suitable for QoS Flows with non-GBR resource type and GBR resource type which can’t cover all the types of QoS Flow.
* When it comes to QoS Flows with delay-critical GBR resource type, the measurement algorithm of packets loss rate doesn’t align with the definition of PER which is used as upper bound of the measurement.
* A new measurement needs to be introduced to meet the definition of PER for delay-critical GBR resource type which taking the delay threshold (AN-PDB, part of PDB as defined in TS23.501) into consideration.

In summary, for delay-critical GBR resource type (5QI value is 82~90 as defined in TS 23.501), the Packet Uu Loss Rate in the DL (as defined in section 4.2.1.5.1 in TS 38.314) does not contain the packets that are transmitted successfully but delayed above a threshold, and such packets have been reflected in TS 23.501, i.e. For GBR QoS Flows with Delay-critical GBR resource type, a packet which is delayed more than PDB is counted as lost, and included in the PER unless the data burst is exceeding the MDBV within the period of PDB or the QoS Flow is exceeding the GFBR.

**Q1: For GBR QoS Flows with Delay-critical GBR resource type, TS 23.501 has defined “a packet which is delayed more than PDB is counted as lost, and included in the PER”, however, the existing measurement packet loss packet has not taken such packets into account. Do companies agree with the issue?**

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| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | Yes | Firstly, we agree with the issue mentioned in Q1, and we also think the delay measurement is critical for centain services.Secondly, we think the terminology PDB (including CN PDB and 5G-AN PDB) has been defined in TS 25.501, but there are no concrete definitions. In other words, how PDB works in 3GPP network is implementation related.Thus, whether/how to use PDB as the threshold may need more technical considerations. |
| ZTE | Yes, and | Our understanding the measurement intends to address both packets loss in uu interface that has been transmitted but not successfully transmitted and packets that has been successfully received but with delay exceeding the intended delay requirement for air interface, while AN-PDB defined in TS 23501 inn our understanding intends for end-to-end packet delay, therefore how to implement the delay threshold (i.e., using AN-PDB) needs further discussion. |
| Ericsson | Yes |  |
| Nokia | Yes | We agree that the current measurement is not the same as the PER defined in 23.501 in case of Delay-critical GBR. Before doing this work, it would be good to ask SA2 and SA5 whether they think that this enhancement is needed. |
| CATT | Yes | Current TS 38.314 does not consider the Delay-critical GBR resource type, so the DL Packet Loss Rate is calculated only based on RLC ACK.But how to define the extended packet loss rate, especially the delay threshold parameter, requires careful consideration. |
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## 2.2 Discussion on possible methods

If the issue in Q1 is valid, the next question is to figure out possible methods.

In [1], one method is provided. Details are copied as below. The principle of the method is that the following packets are counted as loss packets:

1. Packets that are not positively acknowledged
2. Or, positively acknowledged but the DL delay of the RLC SDU is more than corresponding 5G-AN PDB

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4.2.1.5.x Packet Uu Loss Rate with delay threshold in the DL per DRB per UE

The objective of this measurement is to measure the DL packets loss including any packets not successfully transmitted or delayed more than a delay threshold at Uu transmission, for OAM performance observability or for QoS verification of MDT.

Protocol Layer: RLC

**Table 4.2.1.5.x-1: Definition for Packet Uu Loss Rate with delay threshold in the DL per DRB per UE**

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| Definition | Uu Packet Loss Rate with daley threshold in the DL per DRB per UE: One packet corresponds to one RLC SDU. The measurement is done separately per DRB.Detailed definition:$$M\\_dt(T,drbid)=\left⌊\frac{[Dloss\left(T,drbid\right)+Dexd\left(T, drbid\right)]\*1000000}{N\\_dt\left(T,drbid\right)+Dloss\left(T,drbid\right)+Dexd\left(T, drbid\right)}\right⌋$$ Where explanations can be found in the table 4.2.1.5.x-2 below. |

NOTE 1: Packet loss rate with delay threshold can be used when the resource type of corresponding QoS Flow is Delay-critical GBR. It is expected to be upper bounded by the PER (packet error rate, as defined in TS 23.501[4]) of the DRB which takes values between 10-6 and 10-2. The statistical accuracy of an individual packet loss rate measurement result is dependent on how many packets have been received, and thus the time for the measurement.

NOTE 2: Delay threshold of this measurement is determined by 5G-AN PDB defined in TS 23.501.

NOTE 3: The granularity for Packet loss rate measurement is per DRB per UE, as defined in TS 28.552 [2].

**Table 4.2.1.5.x-2: Parameter description for Packet Uu Loss Rate with delay threshold in the DL per DRB per UE**

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| --- | --- |
| $$M\\_dt(T,drbid)$$ | Packet Loss Rate with delay threshold in the DL per DRB per UE. Unit: number of lost packets per transmitted packets per DRB \* 106, Integer. Lost packets here means the packets that delayed more than delay threshold or not successfully transmitted. |
| $$Dloss(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, for which at least a part has been transmitted over the air but not positively acknowledged, and it was decided during time period $T$ that no more transmission attempts will be done. If transmission of a packet might continue in another cell, it shall not be included in this count. |
| $$Dexd(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, for which is transmitted over air interface and positively acknowledged but the DL delay of the RLC SDU is more than corresponding 5G-AN PDB during time period T.The DL delay of a RLC SDU is calculated as defined in clause 5.1.1.1 in TS 28.552. |
| $$N\\_dt(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, which has been transmitted over the air and positively acknowledged and delayed no more than the threshold, 5G-AN PDB, during time period $T$.  |
| $$T$$ | Time Period during which the measurement is performed, Unit: minutes. |
| $$drbid$$ | The identity of the measured DRB. |

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**Q2: In order to solve the issue mentioned in Q1, do companies agree with the proposed method in [1] (also shown above)?**

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| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | Yes, but comments | As provided by the email rapporteur, the principle of the proposed method is shown as below:The principle of the method is that the following packets are counted as loss packets:Packets that are not positively acknowledgedOr, positively acknowledged but the DL delay of the RLC SDU is more than corresponding 5G-AN PDBWe are fine with the 1st bullet, as it has been reflected by the existing measurement “4.2.1.5.1 Packet Uu Loss Rate in the DL per DRB per UE” in TS 38.314.For the 2nd bullet, we have the following comments:**Firstly**, for Q1, the typical service is GBR QoS Flows with Delay-critical GBR resource type, and then RLC UM is suitable (no strong needs to have RLC re-transmission for such services).**Secondly**, we think it is sufficient to only consider Tx delay in MAC at gNB side. In the figure below, here is our understanding on how it works.For one RLC SDU, there may be segmentations in RLC layer and each segment corresponds to a MAC SDU. The transmission delay of one RLC SDU packet can be defined:For RLC UM mode, point in time when the last part of the RLC SDU packet was sent to the UE which was consequently confirmed by reception of HARQ ACK from UE, minus time when the corresponding MAC SDU was received at MAC layer.**Thirdly**, as we pointed out in Q1, it is important to understand how PDB works in 3GPP networks before using it in specs. It is our understanding that PDB is implementation related, and thus it seems hard to directly couple it with an existing delay measuremnt. Our understanding is that this threshold can be configurable (e.g. by OAM), and one implementation is that AN PDB can be referenced.So our suggestion is:Clarify “… is more than corresponding 5G-AN PDB” into “… is more than a threshold (can be configured by OAM)”.In summary, we suggest to modify the principle a bit:(1) Packets that are not positively acknowledged(2) Or, ~~positively acknowledged but the DL delay of the RLC SDU is more than corresponding 5G-AN PDB~~ for one RLC SDU for RLC UM mode, if the last part of the RLC SDU packet has been successfully transmitted to the UE and the transmission delay is more than a threshold (can be configured by OAM). The transmission delay is defined as below:point in time when the last part of the RLC SDU packet was sent to the UE which was consequently confirmed by reception of HARQ ACK from UE, minus time when the corresponding MAC SDU was received at MAC layer.[Huawei2] If there are interests on RLC AM for GBR QoS Flows with Delay-critical GBR resource type, we are also open.For “The DL delay of a RLC SDU is calculated as defined in clause 5.1.1.1 in TS 28.552.”, we find that there are couple of delay measurements, e.g. 5.1.1.1.1, 5.1.1.1.2. We think the “D1 (DL delay in over-the-air interface), referring to Average delay DL air-interface in TS 28.552 [2] 5.1.1.1.1.” is close to the requirement, so it can be clarified here. For example,Clarify “The DL delay of a RLC SDU is calculated as defined in clause 5.1.1.1 in TS 28.552.” into:“The DL delay of a RLC SDU is calculated as defined in clause 5.1.1.1.1 in TS 28.552.” |
| ZTE | See comments | As commented in Q1, using AN-PDB as the delay threshold to count the additional “packets loss” might not be inappropriate since AN-PDB is considered to be requirement for end-to-end delay, which is calculated from PDCP layer to PDCP layer as specified in TS 38.314. Similar to what’s proposed in huawei’s proposal a configurable delay threshold can be used to address this use case. However, considering the delay requirement could be varied among different vendor implementation considering different service and difference deployment scenarios, it is suggested to leave the detailed threshold configuration up to NW implementation. Regarding the use case, I guess another typical use case is URLLC service where both delay and reliability counts, therefore we tend to think both UM and AM mode can be considered. Therefore for Huawei’s proposed principle in the second bullet, we think the packet delay can reuse the DL delay defined in 5.1.1.1 in TS 28.552, which covers both UM and AM mode. |
| Ericsson | Yes, with some changes | We think instead of merging the existing packet loss rate with the packet drop rate, it is more appropriate to define packet drop rate as a separate measurement for delay critical type of services. Packet loss rate formulated in the TS 38.314 represents the impact of the coverage and the Uu radio link quality on data delivery while the packet stems from the queuing delay e.g., impact of scheduling on queuing delay (although it might be affected by poor radio coverage as well).Separating the packet loss rate measurement from packet drop rate enables pinpointing the potential issues in a better way. Needless to say that the total lost packets can be easily calculated by sum of the existing packet loss rate and the new packet drop rate. In addition, we agree with ZTE that the threshold needs to be left to implementation. Therefore, we propose the following changes to the suggested solution:4.2.1.5.x Packet Uu Drop Rate with delay threshold in the DL per DRB per UEThe objective of this measurement is to measure the DL packets drop including any packets delayed more than a delay threshold at Uu transmission, for OAM performance observability or for QoS verification of MDT.Protocol Layer: RLC**Table 4.2.1.5.x-1: Definition for Packet Uu Drop Rate with delay threshold in the DL per DRB per UE**

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| --- | --- |
| Definition | Uu Packet Drop Rate with delay threshold in the DL per DRB per UE: One packet corresponds to one RLC SDU. The measurement is done separately per DRB.Detailed definition:$$M\\_dt(T,drbid)=\left⌊\frac{\left(\right)Dexd\left(T, drbid\right)]\*1000000}{N\\_dt\left(T,drbid\right)\left(\right)+Dexd\left(T, drbid\right)}\right⌋$$ Where explanations can be found in the table 4.2.1.5.x-2 below. |

NOTE 1: Packet drop rate with delay threshold can be used when the resource type of corresponding QoS Flow is Delay-critical GBR. It is expected to be upper bounded by the PER (packet error rate, as defined in TS 23.501[4]) of the DRB which takes values between 10-6 and 10-2. The statistical accuracy of an individual packet drop rate measurement result is dependent on how many packets have been received, and thus the time for the measurement.NOTE 2: Delay threshold of this measurement is determined by network implementation.NOTE 3: The granularity for Packet drop rate measurement is per DRB per UE.**Table 4.2.1.5.x-2: Parameter description for Packet Uu Drop Rate with delay threshold in the DL per DRB per UE**

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| $$M\\_dt(T,drbid)$$ | Packet Drop Rate with delay threshold in the DL per DRB per UE. Unit: number of lost packets at upper layers per transmitted packets per DRB \* 106, Integer. Lost packets here means the packets that delayed more than delay threshold. |
|  |  |
| $$Dexd(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, for which is transmitted over air interface and positively acknowledged but the DL delay of the RLC SDU is more than corresponding the delay threshold during time period T. The delay threshold is defined in Note 2.The DL delay of a RLC SDU is calculated as defined in clause 5.1.1.1 in TS 28.552. |
| $$N\\_dt(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, which has been transmitted over the air and positively acknowledged and delayed no more than the threshold, during time period $T$. The delay threshold is defined in Note 2. |
| $$T$$ | Time Period during which the measurement is performed, Unit: minutes. |
| $$drbid$$ | The identity of the measured DRB. |

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| Nokia | Comment | Based on the above comments some more discussion is needed on the solution.In the 23.501 there is an additional condition: “unless the data burst is exceeding the MDBV within the period of PDB or the QoS Flow is exceeding the GFBR”. Note that it is quite probable that a data burst may lead to increased packet delays, which with the proposed solution will show increased measurement results, even if the actual QoS requirements are met. |
| CATT | Yes, with comment | For the TSC QoS Flow, the 5G-AN PDB is set to value of 5QI PDB minus the CN PDB. No matter the dynamic or static CN PDB, the gNB can always calculate the AN PDB. But to compare with the AN PDB, the termination point of the measured delay should be the high layer in the gNB, e.g. PDCP layer. So to compare the delay over air interface, AN PDB seems not appropriate.We agree with Huawei that the threshold can be configured by OAM, which can be a value smaller than the AN PDB. |
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**Q3: In order to solve the issue mentioned in Q1, do companies have other methods? If yes, please provide short descriptions on the method and also possible specification impacts.**

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| **Company** | **Comments** |
| ZTE | As replied in previous comments a new measurement specific for packet loss due to exceeding delay requirement for air interface can be introduced, which also avoids impact on existing measurements. An example of the measurements could be as below:4.2.1.5.x Packet Uu Loss Rate with delay threshold in the DL per DRB per UEThe objective of this measurement is to measure the DL packets loss at uu transmission with consideration on delay threshold, which includes any packets not successfully transmitted at Uu transmission or packets that are successfully received but are delayed more than a delay threshold, for OAM performance observability or for QoS verification of MDT.Protocol Layer: RLC**Table 4.2.1.5.x-1: Definition for Packet Uu Loss Rate with delay threshold in the DL per DRB per UE**

|  |  |
| --- | --- |
| Definition | Uu Packet Loss Rate with delay threshold in the DL per DRB per UE. One packet corresponds to one RLC RLC SDU. The measurement is done separately per DRB.Detailed definition:$$M\\_dt(T,drbid)=\left⌊\frac{[Dloss\left(T,drbid\right)+Dexd\left(T, drbid\right)]\*1000000}{N\\_dt\left(T,drbid\right)+Dloss\left(T,drbid\right)+Dexd\left(T, drbid\right)}\right⌋$$ Where explanations can be found in the table 4.2.1.5.x-2 below. |

NOTE 1: Packet loss rate with delay threshold can be used when the resource type of corresponding QoS Flow is Delay-critical GBR. It is expected to be upper bounded by the PER (packet error rate, as defined in TS 23.501[4]) of the DRB which takes values between 10-6 and 10-2. The statistical accuracy of an individual packet loss rate measurement result is dependent on how many packets have been received, and thus the time for the measurement.NOTE 2: Delay threshold of this measurement is determined by NW implementation..NOTE 3: The granularity for Packet loss rate measurement with delay threshold is per DRB per UE, as defined in TS 28.552 [2].**Table 4.2.1.5.x-2: Parameter description for Packet Uu Loss Rate with delay threshold in the DL per DRB per UE**

|  |  |
| --- | --- |
| $$M\\_dt(T,drbid)$$ | Packet Loss Rate with delay threshold in the DL per DRB per UE. Unit: number of lost packets per transmitted packets per DRB \* 106, Integer. Lost packets here means the packets that are successfully received but are delayed more than delay threshold or not successfully transmitted. |
| $$Dloss(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, for which at least a part has been transmitted over the air but not positively acknowledged, and it was decided during time period $T$ that no more transmission attempts will be done. If transmission of a packet might continue in another cell, it shall not be included in this count. |
| $$Dexd(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, for which is transmitted over air interface and positively acknowledged but the DL delay of the RLC SDU is more than corresponding delay threshold during time period T.The DL delay of a RLC SDU is calculated as defined in clause 5.1.1.1 in TS 28.552. The delay threshold is as defined in Note 2. |
| $$N\\_dt(T,drbid)$$ | Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, which has been transmitted over the air and positively acknowledged and delayed no more than the threshold, during time period $T$. The delay threshold is as defined in Note 2. |
| $$T$$ | Time Period during which the measurement is performed, Unit: minutes. |
| $$drbid$$ | The identity of the measured DRB. |

One additional comments for above measurement definition is that for simplicity we can keep the the original definition of $N\\_dt(T,drbid)$ in the denominator, i.e., Number of DL packets, of a data radio bearer with DRB Identity = $drbid$, which has been transmitted over the air and positively acknowledged during time period $T$, since the packets received with delay exceeding thresholds plus packets received with delay not exceeding thresholds equal to packets successfully received. |
| Ericsson | We think the delay threshold based packet drop rate at RAN does not reflect the actual dropped packets at the upper layers as it cannot count the delay at the PDCP, or F1 interface i.e., a packet may be counted as successfully delivered (i.e., delay < delay threshold) but the packet is dropped at the upper layer since the sum of the delay in PDCP, F1 and DU is greater than the PDB. Therefore, the measurement provided by the new L2 measurements is a lower bound for the actual dropped packets occurring at the upper layers. Therefore, in order to have a more comprehensive picture of the dropped packets due to delay at the upper layers, it would be beneficial to collet such measurements in terms of RVQoE reports provided by application layer. |
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For the scope of this email discussion, it mentions “figure out the proper method on when and how to introduce it if needed”. During online discussions at RAN2#121, some companies thought that Rel-17 SONMDT has been completed, and thus any enhancements have to be discussed in Rel-18 or later release. So it is proposed to collect companies’ views on the proper release.

**Q4: If a measurement of packet loss rate is needed, which release is suitable for introducing the measurement, e.g. Rel-17/Rel-18?**

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| **Company** | **Rel-17/Rel-18** | **Comments** |
| Huawei, HiSilicon | Rel-17 | For the solution mentioned in Q2, we think it only impacts network sides (mainly about gNB), so it is ok to consider introducing it in Rel-17 for TS 38.314. |
| ZTE | R18 | Since R17 has already been frozen, the new measurement is more suitable to be discussed in R18. |
| Ericsson | R18 | Agree with ZTE |
| Nokia | R18 | Agree with ZTE |
| CATT | R17 | To introduce this extended packet loss rate does not have air-interface impact, only the gNB measurement and statistic is added. |
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In TS 38.314 the following sentence has been defined in the scope:

*Only the differences relative to TS 28.552 v16.2.0 [2] are specified in this specification.*

In Rel-16, it was agreed that TS 38.314 and TS 28.552 should avoid duplicate definitions or conflicts, so the email rapporteur thinks that it seems sufficient to only impact TS 38.314 due to new measurements, and thus there should be no impacts to other WGs (e.g. SA5). It is suggested to collect companies’ views on possible impacts to other WGs.

**Q5: Do companies observe any impacts to WGs other than RAN2?**

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| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | Depends | In TS 28.552, the following use case has been defined. For now, we observe that the proposed solution in RAN2 is per DRB, and if operators may want to have counters per QoS Level and/or per S-NSSAI, we may contact SA5 for further work (otherwise no need to involve other WGs).\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*A.2 Monitoring of UL and DL packet loss in NG-RANKeeping track of UL and DL packet loss in the NG-RAN is essential, since for certain services packets that are lost along the way through the system may have a noticeable impact on the end user. UL and DL packet loss measurements can be useful for evaluation, optimization and for performance assurance within the integrity area (user plane connection quality). Subcounters per QoS Level as well as per supported S-NSSAI is helpful for operator to pinpoint the reason for high packet loss rate.UL packet loss is a measure of packets dropped in the UE and the packets lost on the interfaces (air interface and F1-U interface). If parts of the gNB are deployed in a virtualized environment, it is important to measure also the F1-U UL interface packet loss in a separate measurement, to be able to pinpoint the reason for high packet loss.\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* |
| ZTE | Only from RAN2 perspective | We can only confirm there is no other RAN2 specs impact except for 38.314. RAN3 and SA5 shall be informed, and they can discuss whether there is any further specs impact. . |
| Ericsson |  | Depends on the solution it might or might not affect other WGs. For the time being we can focus on the solution in RAN2.  |
| Nokia | Comment | We think that RAN2 cannot decide the impacts, therefore RAN3 and SA5 shall be asked if they see any impacts for their specifications |
| CATT | - | Since in TS38.314 only the DL Packet Loss Rate is defined, the additional measurement for Delay-critical GBR resource type can be extended only in TS38.314 without other WGs impact, if only DL direction is concerned. |
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# 3 Conclusion

[To be added]

# 4 References

[1] R2-2301855 Introduction of packet loss rate with delay threshold China Unicom, CMCC, CATT discussion Rel-17 NR\_ENDC\_SON\_MDT\_enh-Core

[2] R2-2301858 38.314 CR for the introduction of packet loss rate with delay threshold China Unicom, CMCC, CATT CR Rel-17 38.314 17.2.0 0026 - B NR\_ENDC\_SON\_MDT\_enh-Core