**3GPP TSG-SA5 Meeting #148e *S5-233503rev1***

Electronic meeting, Online, 17 -25 April 2023

**Source: China Unicom**

**Title: Add potential solution for Energy Efficiency KPI of URLLC Network Slice based on reliability**

**Document for: Approval**

**Agenda Item: 6.9.2**

# 1 Decision/action requested

***The group is asked to approve the proposal.***

# 2 References

[1] 3GPP TR 28.913 v0.3.0: “Study on new aspects of Energy Efficiency (EE) for 5G Phase 2”

[2] 3GPP TS 28.554 “Management and orchestration;5G end to end Key Performance Indicators (KPI)”

[3] 3GPP TR 28.832 v0.3.0: “Study on management aspects of URLLC”

[4] 3GPP TS 22.261 “Service requirements for the 5G system; Stage 1”

# 3 Rationale

As presented in TR 28.913 [1], “Energy Efficiency KPI of URLLC Network Slice based on its Reliability” has been introduced as key issue #6. It has been agreed that performance of a URLLC network slice can be its latency and reliability, while existing standardised solution (TS 28.554 [2], clause 6.7.2.3), determines Energy Efficiency (EE) for a URLLC slice only based on latency performance, reliability performance is not considered. Reliability performance is also an integral part of URLLC slice by nature. Hence, it is important that a variant of Energy Efficiency KPI should also consider reliability performance of a URLLC slice for comprehensive assessment of EE.

This contribution is to propose a potential solution to add a a variant of Energy Efficiency KPI of URLLC Network Slice based on reliability as solution #2.

# 4 Detailed proposal

This contribution proposes to make the following changes in [1].

### 4.6.2 Potential Solutions

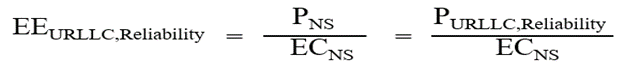
#### 4.6.2.1 Potential solution #1: Energy Efficiency KPI of URLLC Network Slice based on its Reliability when Reliability is in terms of PSR%

##### 4.6.2.1.1 Introduction

This potential solution focuses on the 'Ultra Reliable' (UR) characteristic of the URLLC network slice. The solution considers reliability of Network Slice as “percentage of successfully delivered packets within a time constraint” as defined in TS 22.261 [15] and TS 22.289 [16]. This enables CSPs/NOPs to have a robust and complete view of its URLLC slice’s EE KPI. The solution involves dividing the Reliability Performance of URLLC slice (based on percentage of successfully delivered packets within a time constraint) by the total amount of energy consumption of the URLLC slice in same time period.

##### 4.6.2.1.2 Description

Energy Efficiency KPI of a URLLC network slice based on its reliability performance is represented as EEURLLC,Reliability. Since generic EE KPI formula of a slice is the ratio of Performance of network slice to the Energy Consumption of network slice hence EEURLLC,Reliability is given as below:



, where PNS is the performance of a network slice. For a URLLC slice it can be both latency and reliability. Since the proposed solution is to establish EE KPI with respect to its reliability, thus here, performance of Network Slice is in terms of its reliability and hence PNS is actually denoted as PURLLC,Reliability. It is calculated for a considered time duration T1. ECNS is the Energy Consumption of the whole slice as specified in TS 28.554 [2] clause 6.7.3.3 and is calculated for the same time duration T1.

Reliability performance of URLLC slice i.e. PURLLC,Reliability can be judged by “Packet Success Rate percentage” (PSR%). The definition of reliability in TS 22.261 [15] says “Reliability is defined in the context of network layer packet transmissions, as percentage value of the packets successfully delivered to a given system entity within the time constraint required by the targeted service out of all the packets transmitted.”.

So, in this case, PURLLC,Reliability is denoted by PURLLC,Reliability,PSR and is defined as:



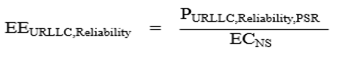
, where:

# PSR% is Packet Success Rate percentage and is calculated over different interfaces and direction (UL/DL) which is explained in sections below;

# X is the total number of packets sent over an interface in a URLLC slice, within the considered time frame T1.

If PURLLC,Reliability,PSR is divided by Energy Consumption of network slice (ECNS) which is measured for the same time period T1, then we get EE KPI i.e. EEURLLC,Reliability. Ittells that “with an evaluated reliability (PSR%), how many packets can be successfully sent per Joule of energy in a URLLC slice in a given time frame constraint”.

So, in this case, EE KPI is given by:



PURLLC,Reliability,PSR can be calculated independently for DL and UL directions. With PSR% based approach the EEURLLC,Reliability of a URLLC slice has the unit of packets or bits per Joule. EEURLLC,Reliability can be calculated per interface and per DL and UL direction.

Throughout the slice, the same or different PSR% might exist on different interfaces.

# If it is same, the PSR % (thus reliability) of a slice can be calculated at any one segment of network i.e between UE and gNB or between gNB and UPF;

# In case, if it is not same, the implementations may choose to calculate the PSR% of a URLLC slice at any interface deemed appropriate for the operator e.g. N3 or can consider combined reliability of all the interfaces (e.g. multiplying all interfaces reliability). This is illustrated with following example:

Consider that from above equations, in uplink, RAN domain and Core domain reliability, i.e. PSRUL,Uu & PSRUL,N3, is known to the operator.

Now operator wants to know if X number of packets are transmitted by UE then out of X, how many packets can be successfully received in UPF i.e. what is its End to End Reliability.

This can be calculated as in equation below:

End to End PSR % = [{(X×PSRUL,Uu) × (PSRUL,N3)} ÷ X] × 100

Suppose X = 1000000 packets, PSRUL,Uu = 99.98% , PSRUL,N3 = 99.99% , then

End to End PSR % = [{(1000000 × .9998) × (.9999)} ÷ 1000000] × 100

= [{(999800) × (.9999)} ÷ 1000000] × 100

= [{999700} ÷ 1000000] × 100

= [.999700] × 100

= 99.97 %

Explanation of above calculation: out of 1 million packets sent by UE, 999800 packets are successfully received in gNB because reliability between UE and gNB is 99.98%.

Now these 999800 packets will be sent over N3 interface as GTP-U packets towards UPF. Since PSR% between gNB and UPF is 99.99% so based on that, out of 999800 packets sent over N3 interface, 999700 packets are successfully received in UPF. So out of 1 million packets sent by UE, finally 999700 packets are received successfully in UPF, hence E2E PSR% is 99.97 %.

Following are the possible options and related calculations:

**# Reliability calculation for uplink over Uu interface** – PURLLC,Reliability,PSR is obtained for Uu interface by using PSR% calculated in equation below:

PSRUL,Uu = ULRelPSR\_Uu.SNSSAI

, where PSRUL,Uu is equal to ULRelPSR\_Uu.SNSSAI which is PSR% in UL for Uu interface per SNSSAI as defined in TS 28.554 [2] clause 6.8.1.2.

**# Reliability calculation for downlink over Uu interface**: PURLLC,Reliability,PSR is obtained for Uu interface by using corresponding PSR% as calculated in equation below.

PSRDL,Uu = DLRelPSR\_Uu.SNSSAI

, where PSRDL,Uu is equal to DLRelPSR\_Uu.SNSSAI which is PSR% in DL for Uu interface per SNSSAI as defined in TS 28.554 [2] clause 6.8.1.1.

**Reliability calculation over N3 interface in uplink**: PURLLC,Reliability,PSR is obtained for N3 interface by using PSR% calculated in equation below. It is based on number of GTP data packets measurement.

PSRUL,N3 = ULRelPSR\_N3.SNSSAI

, where PSRUL,N3 is equal to ULRelPSR\_N3.SNSSAI which is PSR% in UL for N3 interface per SNSSAI as defined in TS 28.554 [2] clause 6.8.1.4.

**Reliability calculation over N3 interface in downlink**: PURLLC,Reliability,PSR is obtained for N3 interface by using PSR% calculated in equation below. It is based on number of GTP data packets measurement.

PSRDL,N3 = DLRelPSR\_N3.SNSSAI

, where PSRDL,N3 is equal to DLRelPSR\_N3.SNSSAI which is PSR% in DL for N3 interface per SNSSAI as defined in TS 28.554 [2] clause 6.8.1.3.

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| **1st Change** |

#### 4.6.2.X Potential solution #X: Energy Efficiency KPI of URLLC Network Slice based on reliability

##### 4.6.2.X.1 Introduction

In this potential solution #X, it is proposed to define a variant of Energy Efficiency KPI that considers reliability performance of a URLLC slice for comprehensive assessment of EE. Specifically, some of KPI and parameters refer to definitions in TS 28.554.

4.6.2.X.2 Description

###### 4.6.2.X.2.1 Based on reliability of the network slice

a) A KPI that shows the energy efficiency of network slices of type URLLC based on reliability. The Pns for a network slice of type URLLC is the end-to-end packet transmission reliability of the network slice [2]. In this KPI variant, reliability is the factor considered for evaluating the performance of network slice.

b)

,where

‘Network slice E2E reliability’ is defined as the end-to-end packet transmission reliability of the network slice, and where the end-to-end packet transmission reliability of the network slice from for one S-NSSAI is defined by:

,Where

and are defined according to clause 6.8.1 in TS 28.554.

and are defined as downlink reliability and uplink reliability in RAN.

The unit of this KPI is (0.1ms \* J)-1.

c)

d) The KPI object is network slice.

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| **End of changes** |