**3GPP TSG-SA WG2 Meeting #143E S2-200XXX**

**February 24 – March 9, 2021, Elbonia**

**Source: Xiaomi**

**Title: Discussion on 5QI due to satellite access and/or satellite backhaul**

**Document for: Approval**

**Agenda Item: 8.11**

**Work Item / Release: 5GSAT\_Arch / Rel-17**

*Abstract of the contribution: This contribution proposes to analyse how to support satellite backhaul.*

# 1 Background

S2-2008952 CN PDB for slow backhaul links tries to propose dynamic CN PDB instead of statistic CN PDB due to satellite backhaul. This paper do analysis on the additional delay introduced by satellite access and/or satellite backhaul for Conversational Voice and Conversational Video services since Conversational Voice and Conversational Video are the most important service that should be provided by satellite access 5G system. The results shows that additional 5QIs have to be introduced and dynamic CN PDB doesn’t solve the problem due to additional delay introduced by satellite access and/or satellite backhaul.

# 2 Discussion

First, let’s discuss on additional delay introduced by satellite access.

PDU retransmission is used to get less Packet Error Rate (PER) to counteract poor physical link. If the PDU is not received by receiver correctly, retransmission will be needed to maintain a certain PER (such as 10-2 PER for Conversational Voice and 10-3 for Conversational Video). One time retransmission will introduce additional 2 times one-way propagation delay. N times retransmission will need additional 2\*N times one-way propagation delay. So the delay contributed to packet delay due to satellite access is 2\*N+1 times one-way propagation delay.

AN Packet Delay (PD) = 2\*N+1 times one-way propagation delay + AN processing delay.

Total Packet Delay (PD) = 2\*N+1 times one-way propagation delay + AN processing delay + CN Packet Delay (PD)

**Observation 1: If the PDU is not received by the receiver correctly, retransmission will be needed. One time retransmission will need 2 times additional one-way propagation delay. N times retransmission will need additional 2\*N times one-way propagation delay. Total PD = 2\*N+1 times one-way propagation delay + AN processing delay + CN PD.**

TS 22.261 chapter 7.4.1 defines One-Way Max propagation delay for LEO, MEO and GEO as below

-----------------------------------------The text below abstracted from TS 22.261--------------------------------------------

## 7.4 KPIs for a 5G system with satellite access

### 7.4.1 Description

Satellite access networks are based on infrastructures integrated on a minimum of satellites that can be placed in either GEO, MEO or LEO.

The propagation delay associated with these orbit ranges, for the UE to the satellite path, can be summarized in Table 7.4.1-1:

Table 7.4.1-1: UE to satellite propagation delay

|  |  |  |
| --- | --- | --- |
|  | UE to satellite Delay [ms] | One-Way Max propagation delay [ms] |
|  | Min | Max |
| LEO | 3 | 15 | 30 |
| MEO | 27 | 43 | 90 |
| GEO | 120 | 140 | 280 |

-----------------------------------------End of text abstracted from TS 22.261--------------------------------------------

PD for LEO, MEO and GEO could be calculated in worst case (One-Way Max propagation delay applied) as below,

|  |  |  |  |
| --- | --- | --- | --- |
|  | One-Way Max propagation delay [ms] | PD with no retransmissionin worst case [ms] | PD with N retransmission in worst case [ms] |
|  |
| LEO | 30 | 30+AN processing delay + CN Packet Delay | 30\*(2N+1)+AN processing delay + CN Packet Delay |
| MEO | 90 | 90+AN processing delay + CN Packet Delay | 90\*(2N+1)+AN processing delay + CN Packet Delay |
| GEO | 280 | 280+AN processing delay + CN Packet Delay | 280\*(2N+1)+AN processing delay + CN Packet Delay |

The PDB defined in 23.501 for Conversational Voice and Conversational Video which are 100ms and 150ms respectively. And we know that Conversational Voice and Conversational Video are the most important service that have to be provided by satellite access 5G system.

It is noted in the Table 5.7.4-1: Standardized 5QI to QoS characteristics mapping of TS 23.501 chapter 5.7.4 that a static value of 20ms for the delay between a UPF terminating N6 and a 5G-AN of 20ms (i.e. CN PDB) should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface for Conversational Voice and Conversational Video services.

It is also noted in the Table 5.7.4-1: Standardized 5QI to QoS characteristics mapping that a static value of of 1ms, 2ms, 5ms and 20 ms as well as a dynamic value for the delay between a UPF terminating N6 and a 5G-AN (i.e. CN PDB) should be subtracted from a given PDB to derive the packet delay budget that applies to the radio interface for other services.

The table below gives the analysis whether LEO, MEO and GEO based satellite access network can provide Conversational Voice and Conversational Video services and how many PDU retransitions are allowed according the PDB defined in 23.501 for Conversational Voice and Conversational Video which are 100ms and 150ms with assume CN PDB = 20ms. If we apply less value for CN PDB, some improvements could be reached as highlighted in the following table as well.

|  |  |  |  |
| --- | --- | --- | --- |
|  | One-Way Max propagation delay [ms] | Conversational VoicePDB=100ms | Conversational VideoPDB=150ms |
|  |
| LEO | 30 | Can be supported with no retransmission assuming CN PDB = 20ms & AN processing delay + CN Packet Delay <= 70ms.Can be improved with 1 time retransmission if AN processing delay + CN Packet Delay <= 10ms. | Can be supported with 1 time retransmission assuming CN PDB =20ms & AN processing delay + CN Packet Delay <= 60ms.No further improvement even with less CN PDB |
| MEO | 90 | Cannot be supported with if assuming CN PDB =20ms.Can be improved with no retransmission if AN processing delay + CN Packet Delay<= 10ms. | Can be supported with no retransmission if assuming CN PDB = 20ms & AN processing delay + CN Packet Delay <= 60ms.No further improvement even with less CN PDB |
| GEO | 280 | Cannot be supported since One-Way Max propagation delay 280ms > Conversational Voice PDB 70ms. | Cannot be supported since One-Way Max propagation delay 280ms > Conversational Video PDB 150ms. |

**Observation 2: The table above could be observed.**

Since it is impossible to support Conversational Voice and Conversational Video which are most important services for 5GC with current 5QI, we propose to define new 5QI for Conversational Voice and Conversational Video.

**Proposal 1：New 5QI should be defined for** **Conversational Voice and Conversational Video services due to satellite access 5G network**.

When satellite backhaul is used , in order to reach the required packet error rate (PER), retransmission mechanism has to be used for the satellite link, so the analysis of additioanl delay introduced by the satellite access still valid the additional dealy introduced satellite backhaul (the addition delay is moved from AN packet delay to CN packet Delay, but the contribtuin to total delay keeps the same).

**Obervation 3: Additional delay introduced by satellite backhaul is the same as additional delay introduced by satellite access since retransmission mechanism aslo need to be used for satellite backhaul.**

**Proposal 2：New 5QI should be defined for Conversational Voice and Conversational Video services due to satellite backhaul**.

# 3 Proposal

It is proposed to endorse the following proposal as general:

**New 5QI should be defined for Conversational Voice and Conversational Video services due to satellite access and satellite backhaul.**