**3GPP TSG-WG SA2 Meeting #161**  ***S2-2403084***

**Athens, Greece, February 26 – March 1, 2024 (revision of S2-2400595)**

**Source: China Mobile, CATT, Xiaomi, Huawei, Nokia**

**Title: KI #1, New Sol: Alternative PDU Set QoS to support differentiated QoS handling for PDU Set**

**Document for: Approval**

**Agenda Item: 19.3**

**Work Item / Release: FS\_XRM\_Ph2 / Rel-19**

*Abstract: Propose a solution for alternative PDU Set QoS enhancement to support PDU Set level differentiated QoS handling related to KI #1 and KI #9.*

# 1. Introduction/Discussion

This solution is for the key issue#1 of PDU Set based QoS handling enhancement and key issue #9 of enhancement for XR related network information exposure.

In the 5GS, each frame/video slice of XR services is transmitted via multiple PDUs i.e. PDU Sets, where the frame or slice should be handled in an integrated manner. The PDU sets have different importance and service characteristics, e.g. the I-frame, which is used as basic frame, is irreplaceable and has higher importance than the P-frame, or a discardable frame has low importance. However the existing PDU Set based QoS handling binds to a single QoS flow with only one set of PDU Set QoS parameters, which is unable to meet the requirements of differentiated QoS handling for various types of PDU Sets.

The alternative QoS mechanism can be enhanced to support flexible QoS adjustment at PDU Set level with combination of PDU Set based QoS parameters, effectively adapting to the differentiated data rate or PDU Set Importance (PSI) in XR services. The requirements of QoS guarantees varies by importance level of PDU Set, e.g. I-frame requires stringent PDU Set based QoS handling to guarantee the data transmission.

To achieve dynamic QoS adjustment at PDU Set level, AF could provide the 5G network with the alternative PDU Set QoS Parameter sets in a prioritized order or the PDU Set QoS references, as well as the importance level for different PDU Sets from the application server. Each importance level of PDU set can be mapped to one set of PDU Set QoS parameters with specific priority or reference. When 5GS acquires the alternative PDU Set QoS Parameter sets and the mapping to the importance level of the PDU Set, 5GS could choose an appropriate alternative PDU Set QoS reference regarding corresponding importance level of each PDU set, which can promote the network resource scheduling based on XR service characteristics and improve the resource utilization efficiency of RAN side.

**Step 1**: AF provides 5GS with alternative PDU Set QoS parameters and the corresponding reference for each service flow, as well as the mapping relationship between alternative PDU Set QoS parameter sets and PDU Set Importance. The mapping relationship indicates the appropriate PDU Set QoS parameters for different PDU Sets with differentiated importance.

**Step 2**：5GS binds service flow to QoS flow and creates Alternative PDU Set QoS Profile with one-to-one mapping between one PDU Set QoS parameter set and one PDU Set Importance level, according to alternative PDU Set QoS parameters and the mapping relationship provided by AF.

**Step 3**：For different PDU Sets comprising the QoS flow, RAN chooses the PDU Set QoS Parameter set that corresponds to the specific PDU Set Importance to ensure the PDU Set based handling and schedules the radio resources based on the differentiated QoS requirements, when receiving the PDU Set with PSI marking from UPF.

This contribution proposes a solution for the enhanced alternative PDU Set QoS mechanism between AF and the 5GS and also QoS policy enhancement to support PDU Set level differentiated QoS handling. The solution applies to KI #1 and KI #9.

The update of this contribution merges the following contents of S2-2401980, S2-2402646, S2-2402741, S2-2402745 and S2-2402419:

* the enhanced exposure of QoS Notification Control via user plane in S2-2401980;
* the main idea of Alternative QoS Profiles with PDU Set QoS Parameters in S2-2402741;
* the exposure of Alternative QoS Profiles with PDU Set QoS Parameters via control plane in S2-2402745;
* the solution of enhancing the RAN to autonomously switch between QoS Profiles and Alternative QoS profiles based on media traffic change indication in S2-2402419.

And the main idea of S2-2402646 is the same as S2-2402741 and S2-2402745, which is not specifically marked.

# 2. Text Proposal

It is proposed to capture the following changes in TR 23.700-70.

\* \* \* \* First change \* \* \* \*

## 6.0 Mapping of Solutions to Key Issues

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |
| --- | --- |
| Solutions | Key Issue # |
|  | <KI #1> | <KI#2> | <KI#3> | <KI#4> | <KI#5> | <KI#6> | <KI#7> | <KI#8> | <KI#9> |
| Solution #X: Alternative PDU Set QoS to support differentiated QoS handling | x |  |  |  |  |  |  |  | x |

\* \* \* \*Second change(all new) \* \* \* \*

6.X Solution #X: Alternative PDU Set QoS parameters to support differentiated QoS handling and information exposure

### 6.X.1 Key Issue mapping

This solution is for KI #1 PDU Set based QoS handling enhancement for XR/media services, and KI #9 enhancement for XR related network information exposure.

### 6.X.2 Description

This solution enhanced alternative QoS mechanism to support PDU Set QoS parameters between AF and the 5GS. The existing Alternative QoS profile could be enhanced to support alternative PDU Set QoS parameter Set(s) including PSDB, PSER and PSIHI. To achieve fine-granularity PDU Set based QoS handling in 5GS, the alternative PDU Set QoS parameters can be flexibly adjusted by RAN.

In Rel-18 clause 5.37.5.1, when the SMF receives the PCC rule, the SMF performs binding of the PCC rule to one QoS Flow as described in clause 6.1.3.2.4 of TS 23.503. If the PCC rule contains one or more PDU Set QoS Parameters (PSER, PSDB and PSIHI), the SMF adds these PDU Set QoS parameters to the QoS Profile of the QoS Flow as described in clause 6.2.2.4 of TS 23.503 [45].

In this solution, AF can additionally provide the PCF with one or more Requested Alternative PDU Set QoS Parameter Sets (including the PSDB, PSER, PSIHI), the corresponding reference of each alternative PDU Set QoS Parameter Set in a prioritized order, and the mapping relationship between PDU Set QoS reference and importance level of PDU Set (i.e. PSI value). NG-RAN fulfills proper Alternative PDU Set QoS profile that corresponds to the specific PDU Set Importance based on the mapping relationship, when receiving the PDU Set with PSI or QoS/Alt-QoS Indicator marking from UPF. The AF may also provide a mapping between Media Types, QoS/Alt-QoS Indicators and QoS / Alt-QoS requirements. If one PSI or QoS/Alt-QoS Indicator value is mapped to multiple PDU Set QoS references, NG-RAN will choose one suitable PDU Set QoS reference based on radio resources.

Editor’s NOTE: whether NG-RAN can fulfill the Alternative PDU Set QoS parameters which is corresponding to the PDU Set Importance or QoS/Alt-QoS Indicator should be check with RAN WGs and it is FFS.

The PCF generates the PCC rule containing alternative PDU set QoS parameter Set(s) and the mapping relationship. The SMF performs binding of the PCC rule to one QoS Flow, with generating the the QoS Profile, and Alternative PDU Set QoS Profiles, as well as the mapping relationship indication of PDU Set QoS references and the importance level of PDU Sets. At least one kind of the PDU Set QoS parameters (PSDB, PSER and PSIHI) should be in the Alternative PDU Set QoS Profiles.

Another way is the Alternative QoS Profiles enhanced with PDU set QoS Parameter(s), a prioritized order is used for the enhanced Alternative QoS Profiles.

The Alternative PDU Set QoS mechanism also support PDU Set QoS Notification Control (PQNC), which is notified from NG-RAN to SMF/PCF with including Alternative PDU set QoS reference or Alternative PDU set QoS parameters. Considering XR services, the application server can timely adjust the codec/traffic rate based on QoS information exposed by network. In order to support timely network information exposure, the PQNC mechanism can be enhanced to support expose the QoS related information (e.g. QoS profile/Alternative QoS profile/Alternative PDU set QoS reference or parameters) via user plane or control plane.

Besides current mechanism of NG-RAN fulfilling the alternative QoS profile, the NG-RAN can be enhanced to autonomously switch between QoS Profiles and Alternative QoS profiles when media traffic characteristics change dynamically. The change in traffic characteristics is identified by the UPF and an indication of the needed QoS/Alt-QoS is sent to the RAN by an additional “QoS/Alt-QoS Indicator” PDU Set Information parameter.

### 6.X.3 Procedures

#### 6.X.3.1 Procedures of alternative PDU Set QoS handling

The procedure of alternative PDU Set QoS handling is described in the Figure 6.X.3.1-1.



Figure 6.X.3.1-1: High level procedure of alternative PDU Set QoS handling

1. The AF provides Alternative Service Requirements to the NEF using Nnef\_AFsessionWithQoS\_Create request, including one or more Requested Alternative PDU Set QoS Parameter sets in a prioritized order, or the PDU Set QoS reference, and the mapping relationship of PDU Set QoS Parameters Sets and the PDU Set importance (PSI) values or QoS/Alt-QoS Indicators (e.g. one-to-one or many-to-one mapping). The mapping relationship includes importance levels of PDU Sets QoS/Alt-QoS Indicators, each of which is mapped to one or more corresponding PDU Set QoS references or PDU Set QoS Parameter sets. Another way is the Alternative QoS Profiles enhanced with PDU set QoS Parameter(s), a prioritized order is used for the enhanced Alternative QoS Profiles.

The AF may also provide a mapping between Media Types, QoS/Alt-QoS Indicators and QoS / Alt-QoS requirements.

2. The NEF performs authorization of the AF request. If the request is authorized, the NEF provides the Alternative Service Requirements to PCF by invoking the Npcf\_PolicyAuthorization\_Create request. Otherwise, NEF responses to AF that the request is not authorized and the procedure stops.

3. Based on the Alternative Service Requirements from AF, the PCF generates one or more alternative PDU Set QoS Parameter Sets for QoS flows. Besides, the mapping relationship of PDU Set QoS references and the importance level of PDU Sets or the QoS/Alt-QoS Indicators is generated for the target XRM service, which may indicate one-to-one or many-to-one mapping relationship.

4. The PCF sends the PCC rules to SMF together with the alternative PDU Set QoS parameters. SMF generates the Alternative PDU Set QoS Profiles and the mapping relationship of PDU Set QoS Parameter sets and PDU Set Importance values or QoS/Alt-QoS Indicators and then sends them to RAN.

In another way, the PCF derive Alternative QoS Parameter Sets for PCC rule based on the requested Alternative QoS Parameter Sets in the enhanced Alternative Service Requirements. The SMF provides a prioritized list of enhanced Alternative QoS Profile(s) with PDU Set QoS parameters to the NG-RAN.

The SMF sends the RAN mapping relationship that associates “QoS/Alt-QoS Indicators ” with QoS/Alt-QoS profiles.

1. NG-RAN fulfills proper Alternative PDU Set QoS profile that corresponds to the specific PDU Set Importance based on the the mapping relationship, when receiving the PDU Set with PSI marking from UPF. If one PSI value is mapped to multiple PDU Set QoS references, NG-RAN will choose one suitable PDU Set QoS reference for that PSI based on radio status. When NG-RAN cannot fulfill Alternative PDU Set QoS requirement, the PDU Set QoS Notification Control indication is sent from NG-RAN. SMF shall also provide to the PCF the reference to the Alternative PDU set QoS parameter set corresponding to the Alternative PDU set QoS Profile referenced by NG-RAN.

UPF identifies the Media Type and determines PDU Set Information for the PDU, including the “QoS/Alt-QoS Indicator” parameter, and sends the expanded PDU Set Information to the RAN via the GTP-U header extension. The NG-RAN adapts between QoS/Alt QoS profiles based on the “QoS/Alt-QoS Indicator” PDU Set Information received in the GTP-U header and the mapping relationship that associates the QoS/Alt-QoS Indicator with a QoS or Alt QoS Profile.

#### 6.X.3.2 Procedures of network information exposure via user plane

The procedure of network information exposure via user plane is described in the Figure 6.X.3.2-1.



Figure 6.X.3.2-1: Network information exposure via user plane

1. The AF provides Alternative Service Requirements to the NEF using Nnef\_AFsessionWithQoS\_Create request, including one or more Requested Alternative QoS Parameter sets in a prioritized order which may additionally include PDU Set QoS parameters, or the QoS reference. The Alternative Service Requirements may also include the requested Alternative PDU Set QoS Parameter sets or the reference. And the AF may subscribe to receive QoS notifications from UPF via user plane when the QoS targets can no longer (or can again) be fulfilled. AF may provide Direct Exposure Indication, which indicates to exposure the QNC with reference to the matching Alternative QoS Profile with the highest priority via UPF directly.

2. The NEF performs authorization of the AF request. If the request is authorized, the NEF provides the Alternative Service Requirements to PCF by invoking the Npcf\_PolicyAuthorization\_Create request. Otherwise, NEF responses to AF that the request is not authorized and the procedure stops.

3. Based on the Alternative Service Requirements from AF, the PCF generates one or more alternative QoS Parameter Sets and/or alternative PDU Set QoS Parameter Sets for QoS flows and QoS notification control policy, which may configure the QoS information exposure via user plane.

4. The PCF sends the PCC rules to SMF together with the alternative QoS requirements and QoS Notification Control parameter which may request to expose the QoS information via user plane. SMF generates the Alternative QoS Profiles and/or Alternative PDU Set QoS Profiles, and the corresponding Notification control parameter, and then sends them to the NG-RAN.

5. SMF instructs the UPF by N4 session modification request to detect the notification(s) in the GTP-U header of UL packets and expose the notifications received by RAN to AF.

1. Based on the received Alternative QoS Profiles, if Notification control is enabled in the NG-RAN, the NG-RAN will indicate the QoS related information, e.g. QoS parameters or PDU Set QoS parameter in QoS Profile, the reference of Alternative QoS profile or the reference of PDU Set QoS parameters that can no longer (or can again) be fulfilled, towards UPF via user plane if requested. If the NG-RAN determines that the GFBR, the PDB/PSDB or the PER/PSER of the QoS profile cannot be fulfilled, RAN sends the notifications to UPF via the UL GTP-U header together with the reference to the matching Alternative QoS Profile with the highest priority.
2. UPF receives the QoS notification from NG-RAN, and send the information to AF/AS. UPF exposes the Notification that "GFBR can no longer be guaranteed" to AF together with the reference to the matching Alternative QoS Profile with the highest priority via the Nupf\_EventExposure service API.
3. Editor's note: RAN3 confirmation on impacts on NG-RAN from this procedure is required.

#### 6.X.3.3 Procedures of network information exposure via control plane

The NG-RAN may also send the Notification together with the reference to the SMF via control plane. Alternatively, after receiving the Notification together with the reference from the RAN, the UPF may be instructed to send them to the SMF via the N4 interface. The SMF provides the Notification to PCF, then the PCF will exposure to the AF based on the notification received.

### 6.X.4 Impacts on services, entities and interfaces

AF

* Provides the QoS requirements which include additional one or more Requested Alternative PDU Set QoS Parameter Sets (e.g. PSDB, PSER, PSIHI), the corresponding reference to each PDU Set QoS Parameter Set, and the mapping relationship of PDU Set QoS Parameters Sets and the PDU Set importance (PSI) values of different PDU Sets (e.g. one-to-one or many-to-one mapping).
* Subscribes to receive QoS notifications via user plane when the QoS targets can no longer (or can again) be fulfilled, and provides the Direct Exposure Indication to trigger exposure of QNC via the user plane.
* Provides mapping relationship between Media Types, QoS/Alt-QoS Indicator and QoS/Alt-QoS requirements.

PCF

* Generates a PCC, which derives one or more Alternative PDU Set QoS Parameter Sets for this PCC rule based on the PDU Set QoS Reference parameters or the Requested Alternative PDU Set QoS Parameter Sets in the Alternative Service Requirements. In addition, this PCC rule provides the mapping relationship of PDU Set QoS references and the PDU Set importance (PSI) values or QoS/Alt-QoS Indicators. For QoS notification control, The PCC rule also includes the QoS notification control parameter which may request network exposure via user plane.
* Send the PCC rules to SMF together with the Alternative PDU Set QoS requirements, the mapping relationship, and the QoS notification control parameter.

SMF

* Provides the Alternative PDU Set QoS Profiles and the mapping relationship of PDU Set QoS Parameter set and PDU Set Importance or QoS/Alt-QoS Indicator value to RAN.
* Enables the Notification control if requested, and sends the Notification control parameter to RAN.
* Sends the Notification control information to PCF.
* Instruct UPFs for the direct reporting.

RAN

* Chooses the proper PDU Set QoS profile for PDU Set received from UPF according to the PDU set information (i.e. PSI value) or QoS/Alt-QoS Indicator and radio status.
* PDU Set level differentiated QoS handling.
* Performs QoS monitoring and sends the notification of QoS information to the UPF via user plane or control plane.

UPF

* Enable the QoS related information report via user plane: detect QoS information from uplink data's header and report the network information to AF/AS.
* Identifies the Media Type of a PDU and adds “QoS/Alt-QoS Indicator” PDU Set Parameter to GTP-U header.

\* \* \* \* End of changes \* \* \* \*