**3GPP TSG SA WG4#129-e S4-241521**

**Online, 19th – 23rd Aug 2024 (revision of S4-241229)**

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|  | **26**.**804** | **CR** | **0007** | **rev** | **4** | **Current version:** | **18.1.0** |  |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network | **X** |

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| ***Title:*** | **[FS\_AMD] Key Issue #X: Improved QoS support for Media Streaming services** | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Huawei, HiSilicon | | | | | | | | | |
| ***Source to TSG:*** | S4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | FS\_AMD | | | | |  | ***Date:*** | | | 2024-05-14 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-19 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-10 (Release 10) Rel-11 (Release 11) Rel-12 (Release 12)* *Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)*  *Rel-17 (Release 17)*  *Rel-18 (Release 18)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | As agreed in SP-240514, how to improve the QoS support for Media Streaming services based on the QoS enhancements and the network information exposure is to be studied. Therefore, this paper proposes the Key Issue of "Improved QoS support for Media Streaming services". | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Proposal of KI#X: Improved QoS support for Media Streaming services. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | SI cannot be completed. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 3.3, 5.X | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  |  | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  |  | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  |  | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | | SA4#128:  1. Add clarifications on support of collaboration scenarios.  2. Add high-level call flow and corresponding procedure descriptions.  SA4#129-e:   1. Add the candidate solution for QoS monitoring mechanism in clause 5.X.6.Y. | | | | | | | | |

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

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

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\* \* \* \* Second change \* \* \* \*

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

CDN Content Delivery Network

DS Differentiated Service

EAS Edge Application Server

ECN Explicit Congestion Notification

EES Edge Enabler Server

FAR Forward Action Rule

L4S Low Latency, Low Loss and Scalable ThroughputMAR Multi-Access Rule

NRF Network Repository Function

PDR Packet Detection Rule

PDU Protocol Data Unit

PFCP Packet Forwarding Control Protocol

PSA PDU Session Anchor

PSDB PDU Set Delay Budget

PSER PDU Set Error Rate

PSIHI PDU Set Integrated Information

QER QoS Enforcement Rule

QLOG QUIC Logging

PHB Per-Hop Behaviour

PFD Packet Flow Description

SDF Service Data Flow

URL Uniform Resource Locator

URR Usage Reporting Rule

\* \* \* \* Third change (all new text)\* \* \* \*

## 5.23 Key Issue #X: Improved QoS support for Media Streaming services

### 5.23.1 Description

#### 5.23.1.1 General

Since Rel-16, QoS support for Media Streaming services has been introduced. For example, the dynamic policy feature is introduced to request specific QoS handling and the network assistance feature is introduced to get aware of the network status. New QoS enhancements and the network information exposure have been introduced in recent releases, which could be useful for Media Streaming services.

This Key Issue proposes to study whether and how to integrate the new features of 5GS to improve the QoS support for Media Streaming services.

#### 5.23.1.2 QoS enhancements and network information exposure in 5GS

Editor’s Note: Other candidate QoS features are FFS.

##### 5.23.1.2.1 Support of ECN marking for L4S

As described in IETF RFC 9330 [X1], IETF RFC 9331 [X2] and IETF RFC 9332 [X3], the purpose of ECN marking for L4S (Low Latency, Low Loss and Scalable Throughput) is to inform a recipient host at the earliest opportunity that an IP packet has experienced network congestion at some point in its routing path. It exposes congestion information by marking ECN bits in the IP header of the user IP packets between the UE and the application server. This early notification may be used by the receiving application to report the congestion to its sending peer using the acknowledgement mechanism in QUIC or TCP. Based on this feedback, the sender may behave adaptively, for example, by triggering application layer rate adaptation. To support this functionality, the recipient host needs to support L4S feedback as described in IETF RFC 9330 [X1].

According to clause 6.1.3.22 of TS 23.503 [41], an Application Function may provide an explicit indication that the uplink and/or downlink path of a service data flow supports ECN marking for L4S by means of the Nnef\_AFsessionWithQoS service at reference point N33 or the Npcf\_PolicyAuthorization service at reference point N5. Based on AF input and/or local configuration, the PCF indicates to the SMF that ECN marking for L4S is enabled for that service data flow. The SMF accordingly configures ECN marking for the corresponding QoS Flow in the uplink and/or downlink direction. ECN marking for the L4S in the IP header is supported in either the NG-RAN (see clause 5.37.3.2 and TS 38.300 [X4]), or in the PDI Session Anchor (PSA) UPF (see clause 5.37.3.3 of TS 23.501[23]).

In the case of ECN marking for L4S by PSA UPF, the NG-RAN is instructed to perform congestion information monitoring and report to the PSA UPF the congestion information of the QoS Flow on UL and/or DL directions via GTP-U header extension to PSA UPF and accordingly, the PSA UPF may mark the UL and/or DL direction packets.

##### 5.23.1.2.2 Support of PDU Set handling

A PDU Set is comprised of one or more PDUs carrying an application layer payload such as a video frame or video slice.

AF may provide PDU Set QoS Parameters and the Protocol Description to the 5GC (i.e. PCF) by means of the Nnef\_AFsessionWithQoS service at reference point N33 or the Npcf\_PolicyAuthorization service at reference point N5. The PDU Set QoS parameters, including a PDU Set Integrated Handling Information (PSIHI), PDU Set Delay Budget (PSDB) and PDU Set Error Rate (PSER), are used to instruct the PDU Set based hanlding in NG-RAN. And the Protocol Description is used to assist UPF/UE for the PDU Set identification.

To support QoS handling of PDU Sets in the downlink direction, the PSA UPF identifies PDUs that belong to PDU Sets based on a protocol description (e.g. the RTP Header Extension defined in TS 26.522 [X5]) if available or else in an implementation-specific way), and determines the following PDU Set Information which it sends to the NG-RAN in the GTP-U header. The PDU Set information is used by the NG-RAN for QoS handling of PDU Sets as described above.

The PDU Set Information comprises:

- PDU Set Sequence Number.

- Indication of End PDU of the PDU Set.

- PDU Sequence Number within a PDU Set.

- PDU Set Size in bytes.

- PDU Set Importance, which identifies the relative importance of a PDU Set compared to other PDU Sets within a QoS Flow.

Based on the PDU Set QoS parameters provided by the 5GC and the PDU Set Information carried over the GTP-U header of downlink packets, the NG-RAN performs the PDU Set based QoS handling accordingly.

In the uplink direction, based on the PDU Set QoS parameters, the RAN configures the UE to enable QoS handling of PDU Sets. Uplink PDU Sets are identified by the UE based on the protocol description or else in an implementation-specific way.

##### 5.23.1.2.3 Support of QoS monitoring

QoS monitoring comprises of measurements of QoS monitoring parameters and reports of the measurement result for a service data flow (i.e., QoS Flow) and can be enabled based on 3rd party application requests and/or operator policies configured in the 5GC (i.e. PCF).

The AF may request measurements and subscribe to the event for one or more of the following QoS monitoring parameters by means of the Nnef\_AFsessionWithQoS service at reference point N33 or the Npcf\_PolicyAuthorization service at reference point N5, which may trigger QoS monitoring for service data flow(s):

- Uplink packet delay, downlink packet delay and round-trip packet delay for a service data flow (see clause 5.45.2 of TS 23.501 [23]).

- Congestion (see clause 5.45.3 of TS 23.501 [23]).

- Data Rate (see clause 5.45.4 of TS 23.501 [23]).

- Packet Delay Variation (see clause 5.37.7 of TS 23.501 [23]).

- Round-trip packet delay considering the uplink path of one service data flow and the downlink path of another service data flow (see clause 5.37.4 of TS 23.501 [23]).

Using the QoS monitoring mechansims of the 5G Core, the above parameters can be derived and further exposed to the AF via the PCF or the UPF (directly or further via NEF) as requested.

### 5.23.2 Collaboration scenarios

Editor’s Note: Collaboration scenarios between the 5G System and Application Provider are FFS.

Collaboration scenarios 2–11 and 13–15 from TS 26.501 [15] are potential points of departure for improved QoS handling support with the following additions:

1. Similar to the Network Assistance feature in TS 26.501 [15], the network status of the 5G System may be exposed to media delivery sessions using the *QoS monitoring* feature and the *ECN marking for L4S* feature. The network status, including the data rate, latency, congestion, etc. may be used by the Media Delivery System for bit rate adaptation and/or congestion control.

The PDU Set handling feature may be used to label PDUs belonging to a video frame or video slice as members of the same PDU Set.

NOTE: Whether the concept of PDU Set is feasible for video segment in a segment-based streaming service is not clear.

2. In the case of network congestion, the NG-RAN may consider the PDU Set Importance for PDU Set level packet discarding. This is not expected for segment-based devliery where the TCP or QUIC transport connection used to carry the media streaming service requests reliable transmission.

Editor’s Note: Whether PDU Set feature is beneficial for Media Streaming services is FFS.

### 5.23.3 Architecture mapping

Editor’s Note: Based on existing architectures, one or more deployment architectures that address the key topics and the collaboration models are FFS.

### 5.23.4 High-level call flow

Editor’s Note: The high-level call flows are FFS.

The high-level call flow for integrating the QoS monitoring and/or ECN marking for L4S is shown below as well as the corresponding procedures.

It is assumed that the MNO and the 5GMS Application Provider have negotiated a Service Level Agreement that allows the 5GMS Application Provider to enable the ECN marking for L4S and QoS monitoring in the 5G System for media delivery.



Figure 5.23.4-1: Potential call flow for improved QoS handling support

Prerequisites:

- The 5GMS Application Provider has agreed an SLA with the Network Operator to allow the usage of network assistance for Media Streaming service.

Steps:

1. The 5GMS Application Provider provisions the 5G Media Streaming System configures content ingest. **A Network Assistance configuration is provided to allow the usage of ECN marking for L4S and/or QoS monitoring to notify the 5GMS Client of the latest network status.**

Editor’s Note: Whether to introduce the feature of "Improved QoS Support" or reuse the "Network Assistance" feature is FFS.

2. When the 5GMS-Aware Application starts, the Media Session Handler retrieves the Service Access Informaiton via M5 or M8. The 5GMS AF address that offers the network assistance is provided in the Service Access Information **and the options for QoS monitoring and/or ECN marking are also present**.

3. The Media Session Handler invokes the **Enhanced** Network Assistance API on the 5GMS AF **to find out about the latest network status. For instance, the 5GMS Media Session Handler may subscribe to the periodic congestion status report from 5GMS AF.**

4. 5GMS AF interacts with PCF or NEF to enable QoS monitoring and/or ECN marking for L4S in the 5G System via the Npcf\_PolicyAuthorization service at reference point N5 or the Nnef\_AFsessionWithQoS service at reference point N33.

5. In the case of QoS monitoring, the 5GMS AF can receive the notifications from PCF or NEF via the Npcf\_PolicyAuthorization\_Notify at reference point N5 or the Nnef\_AFsessionWithQoS\_Notify at reference point N33.

6. Alternatively, in the case of QoS monitoring, the 5GMS AF may receive the notifications from the UPF or NEF via the *Nupf\_EventExposure\_Notify* or the Nnef\_EventExposure\_Notify at reference point N33. This is beneficial when the 5GMS AF is deployed close to the users and the SMF/PCF is generally deployed remotely in a central way.

6. The 5GMS AF further sends the notifications exposed by the network to the Media Session Handler using the MQTT notification channel for the Provisioning Session. The 5GMS Client may take this into account for rate adaptaion, congestion/flow control.

### 5.23.5 Gap analysis and requirements

Editor’s Note: Other issues that need to be solved are FFS.

Regarding the features (i.e., QoS enhancements and network information exposure) described in clause 5.23.1.2, it is proposed to study:

- whether these features of the 5G System can be beneficial and valid for the Media Delivery System in the context of segemented media delivery (i.e., 5G Media Streaming):

- Whether ECN marking for L4S can be beneficial and valid.

- Whether PDU Set handling can be beneficial and valid.

- Whether QoS monitoring can be beneficial and valid.

- How to apply these features to the Media Delivery System:

- How to integrate the ECN marking for L4S feature into the Media Delivery System.

- How to integrate the PDU Set handling feature into the Media Delivery System.

- How to integrate the QoS monitoring feature into the Media Delivery System.

### 5.23.6 Candidate solutions

Editor’s Note: Candidate solutions including call flows, protocols and APIs for identified issues are FFS.

#### 5.23.6.Y QoS monitoring for Media Streaming



Figure 5.X.6-1: Call flow for QoS monitoring for Media Streaming

1. 5GMS Application Provider provisions the 5GMS AF with the **Network Assistance configuration** as described in step 1 of clause 5.23.4. The **Network Assistance configuration** contains the configuration of QoS monitoring, including the parameters to be monitored, reporting frequency (event triggered, periodic), optionally target entity of reporting and optionally the notification via UPF.

NOTE: In case the 5GMS AS are deployed locally, which is close to the users, a local UPF can also be inserted for local access to the 5GMS AF and 5GMS AS. In order to reduce the latency used for exposure of the QoS monitoring results, the local UPF is expected to provide the notifications of network status directly to the 5GMS AF and 5GMS AS, or via a locally deployed NEF as defined in clause 5.8.2.17 of TS 23.501 [23].

1. The Media Session Handler retrieves Service Access Information with the configuration of QoS monitoring provided inside the client Network Assistance configuration.
2. If the Media Session Handler is interested in understanding the network status (e.g., congestion status, packet latency) the it creates an enhanced Network Assistance Session **that includes the requested QoS montoring configuration** on the 5GMS AF at reference point M5.
3. Based on the QoS monitoring configuration received in the previous step, the 5GMS AF interacts with the PCF (or NEF) to enable QoS monitoring via the Npcf\_PolicyAuthorization service at reference point N5 or the Nnef\_AFsessionWithQoS service at reference point N33.

Besides, based on the provisioning from the 5GMS Application Provider, the 5GMS AF believes that nQoS monitoring is required to 5GMS AS for traffic control, e.g. congestion control, bit rate adaptation for progressive download, the 5GMS AF may also request the PCF or NEF to enable the QoS monitoring.

In the case where the 5GMS AS are deployed in the Edge DN, the 5GMS AF may additionaly indicate the PCF or NEF to enable the exposure of QoS montoring results via the local UPF or local NEF.

1. The 5GMS AF invokes the Npcf\_PolicyAuthorization service or the Nnef\_AFsessionWithQoS service **with the requested QoS monitoring configurations**.
2. The PCF accepts the request and enables QoS monitoring within the 5G System, i.e., by configuring the RAN and/or the UPF for monitoring and reporting of target QoS parameters.
3. Following the QoS monitoring request(s), the PCF exposes the QoS monitoring results to the 5GMS AF periocially or by event triggers.
4. **Alternatively, the QoS monitoring results can be exposed to the 5GMS AF by the UPF directly via *Nupf\_EventExposure\_Notify* service or via a locally deployed NEF via** ***Nnef\_EventExposure\_Notify* service at reference point N33.**
5. If QoS monitoring was requested by the Media Session Handler, **the 5GMS AF sends the notifications of the QoS monitoring results to the Media Session Handler** via the MQTT notification channel at reference point M5 associated with the Network Assistance Session.
6. **The Media Session Handler further provides the QoS monitoring results to the Media Stream Handler at reference point M11.**
7. **The Media Stream Handler may use the notified QoS monitoring results to modify its behaviour.**

For example, in the case of downlink media streaming, the Media Player may use the monitored packet latency to determine when to request the next media segment, and/or to change the bit rate of the next media segemtn based on the monitored congestion status.

1. If QoS monitoring for the 5GMS AS is provisioned, **the 5GMS AF provides QoS monitoring notifications to the 5GMS AS via reference point M3**.

NOTE: How the 5GMS AS receives notifications via reference point M3 is for further study.

1. The 5GMS AS may use the notified QoS monitoring results to modify its behaviour.

For example, the 5GMS AS may use the monitored packet latency, congestion status to adjust the congestion window.

### 5.X.7 Summary and conclusions

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