**3GPP TSG SA WG4#129e S4-241540**

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
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|  | **26**.**804** | **CR** | **0008** | **rev** | **3** | **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:*** | Ericsson |
| ***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 canbe 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:*** |  |
|  |  |
| ***Summary of change:*** | This CR suggests changes against the endorsed CR in S4-240806. |
|  |  |
| ***Consequences if not approved:*** | SI cannot be completed. |
|  |  |
| ***Clauses affected:*** |  |
|  |  |
|  | **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:*** | **S4-241269, S4-240921, S4-240921** |

\* \* \* \* 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 tex)\* \* \* \*

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

### 5.23.1 Description

#### 5.23.1.1 General

QoS support for Media Streaming services was introduced in Release 16. For example, the dynamic policy feature allows a 5GMSd Client to request specific QoS handling of its application flows, and the network assistance feature allows it to find out about the current 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 a suitable Layer 4 feedback mechanism. Based on this feedback, the sender should reduce the sending bit rate. In the context of adaptive segmented media delivery, application layer rate adaptation may be needed in addition. For example, a media player consuming a media presentation that receives an ECN-marked downlink packet from a streaming media server may induce a reduction in the sender’s bit rate by switching to a representation of a lower bit rate. 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 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 PDU Session Anchor (PSA) UPF (see clause 5.37.3.3 of TS 23.501[23]).

In the case of ECN marking for L4S by the 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 in the uplink and/or downlink directions via GTP-U header extension. Accordingly, the PSA UPF may mark the uplink and/or downlink direction packets as congested.

##### 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 that together form a logical access unit such as a video frame or a slice of a video frame.

The AF may provide a Protocol Description and PDU Set QoS Parameters 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 Protocol Description is used to assist UPF/UE in identifying PDUs that belong to a PDU Set. This may involve deep packet inspection of the PDU payload by the UPF (downlink PDUs) or by the UE (uplink PDUs).

- 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 handling in NG-RAN.

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 applies PDU Set QoS handling accordingly.

In the uplink direction, based on the PDU Set QoS parameters, the RAN configures the UE to apply QoS handling to 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 third-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

#### 5.23.2.1 Collaboration scenarios for L4S ECN marking

Collaboration scenarios for L4S ECN marking are depicted below. Both the Media AS and the 5GMSd Client make use of an L4S-enabled protocol stack. Figure 5.23.2.1-1 assumesthat the Media AS resides within the external DN, while figure 5.23.2.1-2 assumes the Media AS within the Trusted DN.



Figure 5.23.2.1-1: Media AS in External DN



Figure 5.23.2.1-1: Media AS in Trusted DN

### 5.23.3 Architecture mapping

Not applicable.

### 5.23.4 High-level call flow

Not applicable.

### 5.23.5 Gap analysis and requirements

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.Z Solution #Z: L4S on request

An Application Function may request L4S support from the 5G Network for a certain QoS Flow, e.g. by invoking the Nnef\_AfsessionWithQoS service. The concept of this solution is that an application only requests L4S support from the network when the application layer provides support. The activation leverages the existing 5GMS Dynamic Policy invocation API, allowing the 5GMS-Aware Application to request L4S support as and when it is needed.

A high-level call flow for this candidate solution is sketched in figure 5.23.6.Z-1 below. The following is assumed:

- The service here is a unicast downlink streaming service with dynamic policy support, as described in clause 5.7 of TS 26.501 [15].

- The Layer 4 protocol used for application flows is TCP and the TCP stack used supports L4S.

- The network supports L4S packet marking.

- The application has specifically requested ECN marking for its media delivery session.

- NG-RAN manipulaties the ECN bits (per clause 5.37.3.2 of TS 23.501 [23]). It is equally possible that the PSA-UPF manipulates the ECN bits (per clause 5.37.3.3 of [23]).



Figure 5.23.6.Z-1: Call flow for L4S on request

The steps are as follows:

0: *Policy Template Provisioning.* A Policy Template is provisioned with L4S capability.

1: *Dynamic Policy activation.* The Media Session Handler within the 5GMSd Client obtains Service Access Information and triggers a dynamic policy activation. The selected Policy Template is one configured with L4S capability.

2: QoS request. The 5GMSd AF requests QoS handling adding the L4S indication using e.g. the Nnef\_AfSessionWithQoS service or the Npcf\_PolicyAuthorization service. This indicates that the new QoS flow should be L4S-enabled. The new QoS flow with the L4S indication setting propagates through the 5G System.

3: The Media Player within the 5GMSd Client ensures that ECN is enabled within the used transport protocol.

NOTE: This step may happen implicitly by selecting an L4S supporting transport protocol stack.

4: The Media Player within the 5GMSd Client triggeres the establishment of a TCP connection. The ECT(1) codepoint is set in the IP header, indicating an L4S-Capable Transport, and the SDAP entity ensures that the packet is forwarded via the matching QoS flow.

5: The 5GMSd AS responds to the TCP connection establishment request. The 5GMSd AS sets ECT(1) in the IP headers, indicating an L4S-Capable Transport.

6: The UPF finds the matching QoS flow identifier for the downlink packet and sends the packet via the according QoS flow to the UE. TCP Connection setup continues, with one ECT bit set in all packets.

7. When the RAN detects an upcoming congestion (based on continuous congestion monitoring), the 5G System sets the CE (Congestion Experienced) codepoint in the IP header of the downlink packet.

8. The TCP protocol stack used by the Media Player in the 5GMSd Client reflects the Early Congestion Notification to the TCP sender by setting the ECN-Echo (ECE) flag in the TCP header of an uplink PDU of the same TCP connnection. The TCP sender reacts to the ECN-Echo accordingly (i.e., by reducing its sending congestion window).

NOTE 1: The ECN-Echo flag is also acknowledged by the TCP sender setting the Congestion Window Reduced (CWR) flag in an outgong TCP frame, but this acknowledgement is not illustrated in this call flow.

NOTE 2: Classic ECN [X6] requires an ECN signal to be treated as equivalent to a packet drop. L4S [X1] specifies a more fine-grained response and an early congestion signal triggers a less severe reaction. How TCP sender behaves “accordingly” is not in scope of the specification.

9. Based on the CE indication received in step 7, or by detecting a reduced bit rate in the downlink application flow, the Media Player in the 5GMSd Client reacts by, for example, changing the requested representation.

Intermediate summary for Solution #Z:

- L4S/ECN does not require modifications to the Media Player.

- The 5GMSd AF needs to explicitly request L4S handling of packets by the 5G System by interacting with the PCF at reference point N5 (or else via the NEF at reference poiont N33).

- The Policy Template structure needs to be extended to include an L4S enablementflag for .

- An L4S-capable transport protocol stack is required in both the 5GMSd Client and at the 5GMSd AS.

NOTE: When the transport protocol stack used on the UE or the Application Server does not support ECN marking, the ECT flags are set accordingly to explicitly indicate lack of support.

- Whether L4S requires explicit activation at session start is for further study.

### 5.23.7 Summary and conclusions

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