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

**Online, 19. – 23. August 2024 revision of S4aI240102**

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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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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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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 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:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***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**  **SA4#129e: merged 1521 Clause 2, 5.23.1, 1531** | | | | | | | | |

\* \* \* \* 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

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

As described in RFC 9330 [X1], RFC 9331 [X2] and 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 RFC 9330 [X1].

L4S is based on the idea that delay is mainly caused by the classic congestion control algorithms introduced with TCP. L4S replaces these traditional congestion control algorithms with a class of scalable congestion control algorithms.

The L4S architecture relies on 3 components to operate:

- A scalable congestion control algorithm,

- A modified ECN marking behaviour,

- An active queue management algorithm that isolates L4S traffic

An example of a scalable congestion control algorithm that is widely deployed today is TCP Prague. In TCP Prague the congestion window is adjusted proportionally to the probability of receiving an ECN mark.

, where p is the probability of receiving an ECN mark, and is a constant

TCP Prague further adjust the congestion window to implement an RTT independence, which is crucial to not overly react to RTT variations. The additive increase part of the algorithm is also adjusted to ensure that flows with short RTT are not penalized by a slow increase.

Another popular scalable congestion control algorithm is BBRv2, which stands for Bottleneck Bandwidth and Round-trip propagation time. BBRv2 continuously estimates the bottleneck bandwidth of the connection and the RTT. It then uses the 2 parameters to adjust its congestion window as follows:

, where BtlBW is the estimated bottleneck bandwidth and RTprop is the estimated minimum round-trip propagation time. The algorithm’s reaction to packet loss and ECN marks is also modified to be less aggressive, compared to classic congestion control algorithms. To accurately estimate the bottleneck bandwidth, BBRv2 periodically sends data at a high rate (thank the estimated bottleneck bandwidth) to probe the network for the maximum throughput. BBRv2 also tracks the data that is sent and received during a RTT cycle.

The ECN mechanism is also modified in L4S. The default reaction to an ECN mark is to treat it as an equivalent to a packet loss. This is no more the case in L4S, which allows the network to signal the start of congestion more frequently without the risk of messing up the connection’s bandwidth. This change requires the identification of L4S connections by the network. The ECT code point is used for this purpose. When set to 1, the network identifies the sender as L4S capable and deploys the fine-tuned congestion notification mechanism.

Finally, the queue management approach closes the loop for L4S. RFC9332 [X3] defines one such management approach, the Dual Queue Coupled Active Queue Management, which in essence separates the L4S and non-L4S traffic into two separate queues for differentiated latency treatment and ECN marking. The available bandwidth is still shared among both queues though through the coupling mechanism.

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. The indication is supported at MediaComponent and MediaSubComponent levels, which provides high flexibility on its usage. 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.

#### 5.23.1.3 Key Issue objectives

##### 5.23.1.3.1 QoS enhancements and network information exposure

Regarding the features 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.

##### 5.23.1.3.2 Support of QoS monitoring

Regarding the features described in clause 5.23.1.3, it is proposed to study:

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