**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:*** | | **S4aI240102, 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*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] Akamai Blog, "A QUICk Introduction to HTTP/3", April 2020, <https://developer.akamai.com/blog/2020/04/14/quick-introduction-http3>

[3] Fielding, R., Nottingham, M., and J. Reschke, "HTTP/1.1", Work in Progress, Internet-Draft, draft-ietf-httpbis-messaging-13, 14 December 2020, http://www.ietf.org/internet-drafts/draft-ietf-httpbis-messaging-13.txt

[4] Belshe, M., Peon, R., and M. Thomson, Ed., "Hypertext Transfer Protocol Version 2 (HTTP/2)", RFC 7540, May 2015, https://www.rfc-editor.org/info/rfc7540

[5] RFC 9114, "Hypertext Transfer Protocol Version 3 (HTTP/3)", June 2022

[6] D. Bhat, A. Rizk, and M. Zink, "Not so QUIC: A Performance Study of DASH over QUIC," NOSSDAV'17: Proceedings of the 27th Workshop on Network and Operating Systems Support for Digital Audio and VideoJune 2017 Pages 13–18 https://doi.org/10.1145/3083165.3083175

[7] AWS: "Achieving Great Video Quality Without Breaking the Bank", Streaming Media June 2019, [[https://pages.awscloud.com/rs/112-TZM-766/images/GEN elemental-wp-achieving-great-video-quality-without-breaking-the-bank.pdf](https://pages.awscloud.com/rs/112-TZM-766/images/GEN%20elemental-wp-achieving-great-video-quality-without-breaking-the-bank.pdf)](https://pages.awscloud.com/rs/112-TZM-766/images/GEN%20elemental-wp-achieving-great-video-quality-without-breaking-the-bank.pdf)

[8] Netflix, "Optimized shot-based encodes: Now Streaming!", Netflix Blog, May 2018, https://netflixtechblog.com/optimized-shot-based-encodes-now-streaming-4b9464204830

[9] DASH-IF/DVB: "Report on Low-Latency Live Service with DASH", July 2017, available here: <https://dash-industry-forum.github.io/docs/Report%20on%20Low%20Latency%20DASH.pdf>

[10] DASH-IF: "IOP Guidelines v5, Low-latency Modes for DASH", available here: <https://dash-industry-forum.github.io/docs/CR-Low-Latency-Live-r8.pdf>

[11] ISO/IEC 23009-1: "Information technology — Dynamic adaptive streaming over HTTP (DASH) — Part 1: Media presentation description and segment formats".

[12] IETF RFC 8673: "HTTP Random Access and Live Content".

[13] 3GPP TR 26.939: "Guidelines on the Framework for Live Uplink Streaming (FLUS)".

[14] 3GPP TS 26.238: "Uplink Streaming".

[15] 3GPP TS 26.501: "5G Media Streaming (5GMS); General description and architecture".

[16] 3GPP TS 26.512: "5G Media Streaming (5GMS); Protocols".

[17] ISO/IEC 13818-1:2019: "Information technology — Generic coding of moving pictures and associated audio information — Part 1: Systems".

[18] SCTE 35 2020: "Digital Program Insertion Cueing Message", <https://www.scte.org/pdf-redirect/?url=https://scte-cms-resource-storage.s3.amazonaws.com/SCTE-35-2020_notice-1609861286512.pdf>

[19] ISO/IEC 23000-19:2020: "Information technology — Multimedia application format (MPEG-A) —Part 19: Common media application format (CMAF) for segmented media".

[20] ISO/IEC 23009-1:2019/DAMD1: "Information technology — Dynamic adaptive streaming over HTTP (DASH) — Part 1: Media presentation description and segment formats — Amendment 1: CMAF support, events processing model and other extensions".

[21] VSF TR-06-01:2020, "RIST Simple Profile", https://vsf.tv/download/technical\_recommendations/VSF\_TR-06-1\_2020\_06\_25.pdf

[22] VSF TR-06-02: "RIST Main Profile", <https://www.videoservicesforum.org/download/technical_recommendations/VSF_TR-06-2_2020_03_24.pdf>

[23] 3GPP TS 23.501: "System architecture for the 5G System (5GS)".

[24] 3GPP TS 23.502: "Procedures for the 5G System (5GS)".

[25] 3GPP TS 29.517: "5G System; Application Function Event Exposure Service; Stage 3".

[26] 3GPP TS 29.244: "Interface between the Control Plane and the User Plane nodes; Stage 3".

[27] IETF RFC 6733: "Diameter Base Protocol".

[28] 3GPP TS 29.514: "5G System; Policy and Charging Control over Rx reference point; Stage 3".

[29] IETF RFC 7657: "Differentiated Services (Diffserv) and Real-Time Communication", November 1995.

[30] IETF RFC 3168: "The Addition of Explicit Congestion Notification (ECN) to IP", September 2001.

[31] IETF RFC 9204: "QPACK: Field Compression for HTTP/3", June 2022.

[32] IETF RFC 9000: "QUIC: A UDP-Based Multiplexed and Secure Transport", May 2021.

[33] IETF RFC 9001: "Using TLS to Secure QUIC", May 2021.

[34] IETF RFC 9002: "QUIC Loss Detection and Congestion Control", May 2021.

[35] IETF RFC 5681: "TCP Congestion Control".

[36] M. Kuehlewind and B. Trammell, draft-ietf-quic-manageability-11, "Manageability of the QUIC Transport Protocol", Work in Progress, Internet-Draft, 30 June 2021.

[37] N. Cardwell et. al. "BBR Updates: Internal Deployment, Code, Draft Plans", 9 March 2021, https://datatracker.ietf.org/meeting/110/materials/slides-110-iccrg-bbr-updates-00.pdf

[38] ETSI TS 103 799: "Publicly Available Specification (PAS); DASH-IF Content Protection Information Exchange Format".

[39] ISO/IEC JTC1/SC29/WG11/N19062 23090‑8 FDIS: "MPEG-I: Network-based Media Processing — Network-Based Media Processing Specification".

[40] 3GPP TS 26.247: "Transparent end-to-end Packet-switched Streaming Service (PSS); Progressive Download and Dynamic Adaptive Streaming over HTTP (3GP-DASH)".

[41] 3GPP TS 23.503: "Policy and charging control framework for the 5G System (5GS); Stage 2".

[42] 3GPP TS 29.514: "5G System; Policy Authorization Service; Stage 3".

[43] 3GPP TS 29.522: "5G System; Network Exposure Function Northbound APIs; Stage 3".

[44] 3GPP TS 29.122: "T8 reference point for Northbound APIs".

[45] 3GPP TS 29.512: "5G System; Session Management Policy Control Service; Stage 3".

[46] 3GPP TS 26.803: "5G Media Streaming (5GMS); Architecture extensions".

[47] 3GPP TS 23.558: "Architecture for enabling Edge Applications (EA)".

[48] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[49] Tdoc S4-210723: "Generic architecture for data collection and reporting", submission from BBC, Dolby Laboratories Inc., LM Ericsson and Qualcomm Incorporated to SA4#114-e, May 19-28, 2021.

[50] Tdoc S2-2103267: "Extension of Naf\_EventExposure for observed service experience data collection from UEs", CR from InterDigital to SA2#144e, Apr 12-16, 2021.

[51] 3GPP TS 26.114: "IP Multimedia Subsystem (IMS); Multimedia telephony; Media handling and interaction".

[52] Tdoc S2-2104496: "Extension of Naf\_EventExposure for observed service experience data collection from UEs", CR from Qualcomm Incorporated to SA2#145e, May 17-28, 2021.

[53] 3GPP TS 26.118: "Virtual Reality (VR) profiles for streaming applications".

[54] 3GPP TS 26.346: "Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs".

[55] 3GPP TS 29.554: "Background Data Transfer Policy Control Service; Stage 3".

[56] 3GPP TS 28.530: "Management and orchestration; Concepts, use cases and requirements".

[57] 3GPP TS 28.531: "Management and orchestration; Provisioning".

[58] 3GPP TS 28.532: "Management and orchestration; Generic management services".

[59] 3GPP TS 28.533: "Management and orchestration; Architecture framework".

[60] 3GPP TS 28.540: "Management and orchestration; 5G Network Resource Model (NRM); Stage 1".

[61] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".

[62] 3GPP TS 28.542: "Management and orchestration of networks and network slicing; 5G Core Network (5GC) Network Resource Model (NRM); Stage 1".

[63] 3GPP TS 28.543: "Management and orchestration of networks and network slicing; 5G Core Network (5GC) Network Resource Model (NRM); Stage 2 and stage 3".

[64] 3GPP TS 28.545: "Management and orchestration; Fault Supervision (FS)".

[65] 3GPP TS 28.546: "Management and orchestration of networks and network slicing; Fault Supervision (FS); Stage 2 and stage 3".

[66] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[67] 3GPP TS 28.554: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)".

[68] 3GPP TS 23.434: " Service Enabler Architecture Layer for Verticals (SEAL); Functional architecture and information flows ".

[69] 3GPP TS 23.700‑99: " Study in Network slice capability exposure for application layer enablement (NSCALE)".

[70] 3GPP TS 29.520: " 5G System; Network Data Analytics Services; Stage 3".

[71] 3GPP TR 23.700-40: "Study on enhancement of network slicing; Phase 2".

[72] 3GPP TS 26.531: “Data Collection and Reporting; General Description and Architecture”.

[73] 3GPP TR 26.802: "Multicast Architecture Enhancement for 5G Media Streaming".

[74] IETF RFC 822: "STANDARD FOR THE FORMAT OF ARPA INTERNET TEXT MESSAGES", August 13, 1982.

[75] IETF RFC 1521: "MIME (Multipurpose Internet Mail Extensions)", September 1993.

[76] IETF RFC 2474: "Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers".

[77] IETF RFC 2475: "An Architecture for Differentiated Services".

[78] IETF RFC 3246: "An Expedited Forwarding PHB (Per-Hop Behavior)".

[79] IETF RFC 2597: "Assured Forwarding PHB Group".

[80] S. Hurst, draft-hurst-quic-rtp-tunnelling: "QRT: QUIC RTP Tunnelling", Internet-Draft, Work in Progress.

[81] J. Ott and M. Engelbart, draft-engelbart-rtp-over-quic: "RTP over QUIC", Internet-Draft, Work in Progress.

[82] SRT Alliance, “Secure Reliable Transport (SRT) Protocol”, https://github.com/Haivision/srt

[83] M.P. Sharabayko and M.A. Sharabayko, draft-sharabayko-srt-over-quic-00 ,“Tunnelling SRT over QUIC”, Internet-Draft, Work in Progress, 28 July 2021.

[84] Robin Marx, Luca Niccolini, Marten Seemann, draft-ietf-quic-qlog-main-schema-01, "Main logging schema for qlog", Internet-Draft, Work in Progress, 25 October 2021.

[85] Robin Marx, Luca Niccolini, Marten Seemann, draft-ietf-quic-qlog-h3-events-00, "HTTP/3 and QPACK event definitions for qlog", Internet-Draft, Work in Progress, 10 June 2021.

[86] Robin Marx, Luca Niccolini, Marten Seemann, draft-ietf-quic-qlog-quic-events-00, "QUIC event definitions for qlog", Internet-Draft, Work in Progress, 10 June 2021.

[87] Roger Pantos and William May, Jr., "HTTP Live Streaming", RFC 8216, August 2017.

[88] 3GPP TR 26.925: "Typical traffic characteristics of media services on 3GPP networks".

[89] 3GPP TR 26.917: "Multimedia Broadcast Multicast Services (MBMS) and Packet-switchedStreaming Service (PSS) enhancements to support television services".

[90] "DASH-IF WebRTC-based Streaming", https://dashif.org/news/webrtc/

[91] IETF RFC 6749: "The OAuth 2.0 Authorization Framework".

[92] IETF RFC 6750: "The OAuth 2.0 Authorization Framework: Bearer Token Usage".

[93] 3GPP TS 33.501: "Security architecture and procedures for 5G System".

[94] 3GPP TS 26.531: "Data Collection and Reporting; General Description and Architecture".

[95] 3GPP TS 26.532: "Data Collection and Reporting; Protocols and Formats".

[96] 3GPP TS 26.511: "5G Media Streaming (5GMS); Profiles, codecs and formats".

[97] ETSI TS 103 770: "Digital Video Broadcasting (DVB); Service Discovery and Programme Metadata for DVB-I".

[98] Android Developer Documentation: "Handling Android App Links",  
<https://developer.android.com/training/app-links>

[99] 3GPP TS 26.347: "Multimedia Broadcast/Multicast Service (MBMS); Application Programming Interface and URL".

[100] ETSI TS 103 769: "Digital Video Broadcasting (DVB); Adaptive media streaming over IP multicast".

[101] 3GPP TS 23.247: "Architectural enhancements for 5G multicast-broadcast services".

[102] 3GPP TS 29.558: "Enabling Edge Applications; Application Programming Interface (API) specification; Stage 3".

[103] IETF RFC 2045: "Multipurpose Internet Mail Extensions Part One: Format of Internet Message Bodies".

[104] IETF RFC 3986: "Uniform Resource Identifier (URI): Generic Syntax".

[X1] IETF RFC 9330:"Low Latency, Low Loss, Scalable Throughput (L4S) Internet Service: Architecture".

[X2] IETF RFC 9331: "Explicit Congestion Notification (ECN) Protocol for Very Low Queuing Delay (L4S)".

[X3] IETF RFC 9332: "Dual-Queue Coupled Active Queue Management (AQM) for Low Latency, Low Loss, and Scalable Throughput (L4S)".

[X4] 3GPP TS 38.300: "NR; NR and NG-RAN Overall Description".

[X5] 3GPP TS 26.522: "5G Real-time Media Transport Protocol Configurations".

[X6] IETF RFC 3168: "The Addition of Explicit Congestion Notification (ECN) to IP".

\* \* \* \* 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 \* \* \* \*