**3GPP TSG-S4 Meeting #133-e*****S4-251236***

**Electronic Meeting, 18th July – 25th July 2025** Revision of S4aI250103

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
|  |
|  | **26.512** | **CR** | **0087** | **rev** | **6** | **Current version:** | **18.6.0** |  |
|  |
| *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 | **X** | Radio Access Network |  | Core Network | **X** |

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| ***Title:***  |  |
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| ***Source to WG:*** | , Nokia |
| ***Source to TSG:*** |  |
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| ***Work item code:*** |  |  | ***Date:*** |  |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** |  |
|  | *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-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
|  |  |
| ***Reason for change:*** |  Generalize application configuration of transport parameters using Configuration API  |
|  |  |
| ***Summary of change:*** | Below changes are proposed to endorsed tdoc S4-251119 during Fukuoka, Japan meeting: * Editorial corrections
* Procedure description for multi-access media delivery for uplink streaming
* Generalizing parameters for application configuration of transport layer parameters to support multi-access media delivery

Changes highlighted in yellow are the changes on top of endorsed version S4-251119.  |
|  |  |
| ***Consequences if not approved:*** | Multi-access media delivery feature is incomplete |
| ***Q*** |  |
| ***Clauses affected:*** | 4.6.1, 4.6.2, 4.9, 4.9.3 (new), 5.1, 5.6, 6.2.1.2, 12.4, 13.2.4, 13.2.5, 13.2.6 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications |  |
| ***affected:*** |  | **X** |  Test specifications |  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications |  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | S4-250505: Version implementing normative recommendations documented in clause 7.3.3 on topic of multi-access media deliveryS4-250698: Corrections based on feedback received during presentation of S4-250505 in SA4#131-bis-e.S4-250698: Corrections during SA4#131-bis-eS4-250969: OpenAPI changes based on CR agreements from S4-250698S4-251097: Revisions after SA4#132 offline meeting. Includes editorial changes, removal of OpenAPI code, and refactoring to clarify on multipath and multi-access. S4-251119: Merge of S4-251094, and editorial correctionsS4aI250103: Generalizing transport parameters for application configuration using configuration API, and some editorial corrections S4-251236: Re-submission of S4aI250103 as it wasn’t treated during Post #132 meetings |

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

[3] DASH Industry Forum, "Specification of Live Media Ingest",
<https://dashif-documents.azurewebsites.net/Ingest/master/DASH-IF-Ingest.pdf>

[4] 3GPP TS 26.247: "Transparent end-to-end Packet-switched Streaming Service (PSS); Progressive Download and Dynamic Adaptive Streaming over HTTP (3GP-DASH)".

[5] Standard ECMA-262, 5.1 Edition: "ECMAScript Language Specification", June 2011.

[6] IETF RFC 6234: "US Secure Hash Algorithms (SHA and SHA-based HMAC and HKDF)".

[7] 3GPP TS 23.003: "Numbering, addressing and identification".

[8] ITU-T Recommendation X.509 (2005) | ISO/IEC 9594-8:2005: "Information Technology – Open Systems Interconnection – The Directory: Public-key and attribute certificate frameworks".

[9] Void

[10] IETF RFC 4648: "The Base16, Base32, and Base64 Data Encodings".

[11] IEEE Standard 1003.1™, Issue 7: "The Open Group Base Specifications", 2018.
<https://pubs.opengroup.org/onlinepubs/9699919799/>

[12] 3GPP TS 29.571: "Common Data Types for Service Based Interfaces; Stage 3".

[13] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification".

[14] 3GPP TS 36.321: "Evolved Universal Terrestrial Radio Access (E-UTRA); Medium Access Control (MAC) protocol specification".

[15] 3GPP TS 27.007: "AT Command set for User Equipment (UE)".

[16] Void[17] IETF RFC 7468: "Textual Encodings of PKIX, PKCS, and CMS Structures", April 2015.

[18] ISO 3166‑1: "Codes for the representation of names of countries and their subdivisions — Part 1: Country codes".

[19] ISO 3166‑2: "Codes for the representation of names of countries and their subdivisions — Part 2: Country subdivision code".

[20] IETF RFC 5280: "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile", May 2008.

[21] 3GPP TS 29.500: "5G System; Technical Realization of Service Based Architecture; Stage 3".

[22] 3GPP TS 29.501: "5G System; Principles and Guidelines for Services Definition; Stage 3".

[23] OpenAPI: "OpenAPI 3.0.0 Specification", <https://github.com/OAI/OpenAPI-Specification/blob/master/versions/3.0.0.md>.

[24] IETF RFC 9112: "HTTP/1.1", June 2022.

[25] IETF RFC 9110: "HTTP Semantics", June 2022.

[26] Void

[27] Void

[28] IETF RFC 9111: "HTTP Caching", June 2022.

[29] Void

[30] IETF RFC 8446: "The Transport Layer Security (TLS) Protocol Version 1.3", August 2018.

[31] IETF RFC 9113: "HTTP/2", June 2022.

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

[33] 3GPP TS 23.503: "Policy and charging control framework for the 5G System (5GS); Stage 2".

[34] 3GPP TS 29.514: "5G System; Policy Authorization Service; Stage 3".

[35] 3GPP TS 26.511: "5G Media Streaming (5GMS); Profiles, codecs and formats".

[36] Void.

[37] 3GPP TS 26.244: "Transparent end-to-end packet switched streaming service (PSS); 3GPP file format (3GP)".

[38] IETF RFC 8259: "The JavaScript Object Notation (JSON) Data Interchange Format", December 2017.

[39] ISO 14496-12: "Information technology – Coding of audio-visual objects – Part 12: ISO base media file format".

[40] ISO 23000-19: "Information technology – Coding of audio-visual objects – Part 19: Common media application format (CMAF) for segmented media".

[41] IETF RFC 3986: "URI Generic Syntax".

[42] 3GPP TS 26.118: "Virtual Reality (VR) profiles for streaming applications".

[43] 3GPP TS 24.558: "Enabling Edge Applications; Protocol specification".

[44] 3GPP TS 29.558: "Enabling Edge Applications; Application Programming Interface (API) specification; Stage 3".

[45] 3GPP TS 23.502: "Procedures for the 5G System (5GS); Stage 2".

[46] 3GPP TS 29.517: "5G System; Application Function Event Exposure Service; Stage 3".

[47] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[48] 3GPP TS 26.531: "Data Collection and Reporting; General Description and Architecture".

[49] 3GPP TS 26.532: "Data Collection and Reporting; Protocols and Formats".

[50] 3GPP TS 29.522: "5G System. Network Exposure Function Northbound APIs; Stage 3".

[51] 3GPP TS 26.346: "Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs".

[52] 3GPP TS 26.347: "Multimedia Broadcast/Multicast Service (MBMS); Application Programming Interface and URL".

[53] IETF draft-bhutton-json-schema-validation: "JSON Schema Validation: A Vocabulary for Structural Validation of JSON", June 2022.

[54] IETF RFC 3339: "Date and Time on the Internet: Timestamps", July 2002.

[55] 3GPP 29.591: "Network Exposure Function Southbound Services; Stage 3".

[56] 3GPP TS 26.510: "Media delivery; interactions and APIs for provisioning and media session handling".

[57] IETF RFC 2045: "Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies".

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

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

[60] IETF RFC 9114: "HTTP/3", June 2022.

[61] IETF RFC 8673: "HTTP Random Access and Live Content", November 2019.

[62] Consumer Technology Association CTA-5005-A: "Web Application Video Ecosystem – DASH-HLS Interoperability Specification".

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

[64] 3GPP TS 26.517: "5G Multicast-Broadcast User Services; Protocols and Formats".

[65] Consumer Technology Association CTA‑5004: "Web Application Video Ecosystem – Common Media Client Data", September 2020,
https://cdn.cta.tech/cta/media/media/resources/standards/pdfs/cta-5004-final.pdf.

[66] IETF RFC 4122: "A Universally Unique IDentifier (UUID) URN Namespace", July 2005.

[TCP] IETF RFC 9293: "Transmission Control Protocol (TCP)", August 2022.

[MPTCP] IETF RFC 8684: "TCP Extensions for Multipath Operation with Multiple Addresses".

[MPQUIC] IETF Draft: "Multipath Extension for QUIC", draft-ietf-quic-multipath-15, July 2025.

Media streaming procedures (M4d)

### 4.6.1 Procedures for DASH Session

This procedure is used by a 5GMSd Client to establish a DASH session via the M4d interface. In order to establish such a session, the 5GMSd AS shall host an MPD as defined in ISO/IEC 23009-1 [32] or TS 26.247 [4] and the MPD URL is known to the 5GMSd Client typically using M8d.

The Media Player may use a multipath transport protocol supported by the UE as specified in clause 6.2.1.2 to connect to a reference point M4d service location on the 5GMSd AS.

NOTE: The different multipath transport connection subflows/paths may span one or more access networks available to the UE.

The Media Player receives an MPD URL from the 5GMSd-Aware Application through M7d by methods defined in clause 13. The Media Player shall send an HTTP GET message to the 5GMSd AS including the URL of the MPD resource. On success, the 5GMSd AS shall respond with a *200 (OK)* message that includes the requested MPD resource.

Additional procedures for reactions to different HTTP status codes are provided in TS 26.247 [4], clause A.7 and ISO/IEC 23009-1 [32] clause A.7.

Additional procedures for handling partial file responses are provided in TS 26.247 [4], clause A.9.

This information is provided through M7d to the application for selection. In addition, the currently used service description parameters are provided as status information through M7d in order for the Media Session Handler to make use of this information, for example for Dynamic Policy and Network Assistance.

The detailed handling of service description information is documented in clause 13.2 of the present document.

### 4.6.2 Procedures for Progressive Download Session

This procedure is used by a 5GMSd Client to establish a Progressive Download session at reference point M4d . In order to establish such a session, the 5GMSd AS shall host an 3GP/MP4 file as defined in TS 26.247 [4]. The 3GP/MP4 URL is known to the Media Player (in this case a progressive download player), typically by using M8d.

The Media Player may use a multipath transport protocol supported by the UE as specified in clause 6.2.1.2 to connect to a reference point M4d service location on the 5GMSd AS.

NOTE: The different multipath transport connection subflows/paths may span one or more access networks available to the UE.

The Media Player receives a URL from the 5GMSd-Aware Application through M7d by methods defined in clause 13. The Media Player shall send an HTTP GET message to the 5GMSd AS including the URL of the 3GP/MP4 resource. On success, the 5GMSd AS shall respond with a 200 (OK) message that includes the requested 3GP/MP4 resource.

Additional procedures for reactions to different HTTP status codes are provided in TS 26.247 [4].

Media Player Client API procedures (M7d/M11d)

## 4.9 Procedures of the M7d/M11d (UE Media Player) interface

### 4.9.3 Multipath media delivery procedures

To facilitate multipath media delivery at reference point M4d (see clause 4.6.1), the 5GMSd-Aware Application and the Media Session Handler may configure multipath transport protocol parameters at the Media Player via reference points M7d and M11d respectively. The multipath transport protocol parameters for downlink media streaming are specified in clause 13.2.4 of the present document.

The Media Player may inform the 5GMSd-Aware Application and the Media Session Handler via reference points M7d and M11d respectively about the status of reference point M4d transport connections as specified in clauses 13.2.5 and 13.2.6 of the present document. The 5GMSd-Aware Application and the Media Session Handler may make use of this information, for example to re-configure multipath media delivery connection properties, or to disable multipath media delivery altogether, using the configuration and settings API specified in clause 13.2.4.

NOTE 1: The different multipath transport connection subflows/paths may span one or more access networks available to the UE, supporting multi-access media delivery at reference point M4d.

NOTE 2: The specification of the client API to support multi-access media delivery for downlink media streaming is not complete in this release and is for further study.

PRocedurEs for Uplink Media Streaming

## 5.6 Procedures of the M4u (Media Streaming) interface

### 5.6.x Multipath media delivery

To facilitate multipath media delivery at reference point M4u (see clause 5.6), the 5GMSu-Aware Application and the Media Session Handler may configure multipath transport protocol parameters at the Media Streamer via reference points M7u and M11u respectively. The multipath transport protocol parameters for uplink media streaming are not specified in this version of the present document.

The Media Streamer may inform the 5GMSu-Aware Application and the Media Session Handler via reference points M7u and M11u respectively about the status of reference point M4u transport connections. (These notifications are not further specified in this version of the present document.) The 5GMSd-Aware Application and the Media Session Handler may make use of this information, for example to re-configure multipath media delivery connection properties, or to disable multipath media delivery altogether, using a configuration and settings API not specified in this version of the present document.

NOTE 1: The different multipath transport connection subflows/paths may span one or more access networks available to the UE, supporting multi-access media delivery at reference point M4u.

NOTE 2: The specification of the client API to support multi-access media delivery for uplink media streaming is for further study.

HTTP Protocol Version

#### 6.2.1.2 5GMS AS

Implementations of the 5GMS AS shall expose HTTP/1.1 [24] endpoints at reference points M2 and M4 and may additionally expose HTTP/2 [31] endpoints at these reference points. In both protocol versions, TLS [16] shall be supported and HTTPS interactions should be used in preference to cleartext HTTP. Multipath TCP per RFC 8684 [MPTCP] may be used as the underlying transport protocol at these two reference points.

For pull-based content ingest, the 5GMS Application Provider shall expose an HTTP/1.1-based origin endpoint to the 5GMSd AS at reference point M2 and may additionally expose HTTP/2- and/or HTTP/3-based origin endpoints.

For push-based content ingest, the 5GMS Application Provider may use any supported HTTP protocol version at reference point M2.

Implementations of the 5GMS AS should expose HTTP/3 [60] endpoints at reference point M4. In HTTP/3, the QUIC protocol [58] or its multipath variant [MPQUIC] may be used for transport, and in both cases TLS [59] is used for the initial handshake and key exchange.

The 5GMS AF may use any supported HTTP protocol version at reference point M3.

The Media Stream Handler (Media Player or Media Streamer) may use any supported HTTP protocol version at reference point M4. The Media Stream Handler may use multipath TCP per RFC 8684 [MPTCP] as the underlying transport protocol for HTTP/1.1 [24] or HTTP/2 [31] at this reference point. The Media Stream Handler may use multipath QUIC [MPQUIC] to support HTTP/3 [60] connections at this reference point.

## 12.4 3GPP Service URL for 5G Media Streaming

The 3GPP Service URL for 5G Media Streaming is based on the generic 3GPP Service URL defined in clause 6 of TS 26.510 [56].

If the service type discriminator service in the URL indicates ms, then the target service is a 5G Media Streaming service.

The parameters of the 3GPP Service URL for 5G Media Streaming are defined in table 12.4-1.

Table 12.4-1: 3GPP Service URL parameters for 5G Media Streaming

|  |  |  |
| --- | --- | --- |
| Path element | Cardinality | Description |
| service\_id | 1 | An External Service Identifier that resolves to a Provisioning Session in the 5GMS System. |
| Query parameter | Cardinality | Description |
| af-host-address | 0..\* | The Fully Qualified Domain Name and optional port number of a 5GMS AF endpoint to be used by the Media Session Handler at reference point M5 with the format hostname[:port].More than one occurrence of this parameter may be present in the Service URL to indicate alternative host endpoint addresses. Any of these may be used by the Media Session Handler at reference point M5.Supplied by the invoking 5GMS-Aware Application when the 5GMS AF is deployed in an External DN. The endpoint address(es) may, for example, have been passed to the 5GMS-Aware Application via reference point M8.If omitted, the Media Session Handler assumes the default 5GMS AF host endpoint address ms.af.3gppservices.org:443 is to be used at reference point M5. |
| access-token | 0..1 | A token that is presented by the Media Session Handler to the 5GMS AF at reference point M5 that asserts its right to invoke the media session handling operations exposed by the 5GMS AF. |
| service-operation-point | 0..1 | A reference to the target Service Operation Point of the 5G Media Streaming session.Overrides any default Service Operation Point signalled in the resource pointed to by media-entry-point. |
| estimated-volume | 0..1 | An estimate of the volume of media data to be transferred between the 5GMS Client and the 5GMS AS at reference point M4 during the 5G Media Streaming session.Required if service-operation-point or media-entry-point refers to a Policy Template with an associated Background Data Transfer policy. |
| media-entry-point | 0..1 | A Media Entry Point reference expressed as a fully qualified URL per RFC 3986 [41], suitable for presentation to a 5GMS AS at reference point M4.If supplied, used by the Media Session Handler to launch the Media Stream Handler (Media Player or Media Streamer) after successfully initiating media session handling. |
| multipath-protocol | 0..\* | A multipath transport protocol to be used by the Media Stream Handler (Media Player or Media Streamer) for media delivery at reference point M4.- The value MPTCP indicates the use of the protocol specified in RFC 8684 [MPTCPMPTCP].- The value MPQUIC indicates the use of the protocol specified in [MPQUIC]. |
| max-paths | 0..1 | The maximum number of transport protocol subflows/paths to be used for multipath media delivery at reference point M4.If omitted, there is no restriction on the number of paths.Ignored if multipath-protocol is omitted. |
| content-type | 0..\* | A MIME content type string conforming to section 5 of RFC 2045 [57] identifying a type of Media Entry Point that is acceptable to the Media Stream Handler (Media Player or Media Streamer).More than one occurrence of this parameter may be present in the Service URL to indicate that more than one type of Media Entry Point is acceptable.Used by the Media Session Handler to eliminate unacceptable Media Entry Points from those listed in the Service Access Information.It is an error to supply this parameter if an explicit Media Entry Point is specified using media-entry-point. |
| profile | 0..\* | A fully-qualified term identifier from a controlled vocabulary specified outside the scope of the present document identifying a profile of Media Entry Point that is acceptable to the Media Stream Handler (Media Player or Media Streamer). The term identifier shall be formatted as a URI according to RFC 3986 [41].More than one occurrence of this parameter may be present in the Service URL to indicate that more than one type of Media Entry Point is acceptable.Used by the Media Session Handler to eliminate unacceptable Media Entry Points from those listed in the Service Access Information.It is an error to supply this parameter if an explicit Media Entry Point is specified using media-entry-point. |

The service\_id path element, and the af-host-address and access-token query parameters correspond to the baseline Service Access Information for downlink media streaming specified in clause 4.2.3 of TS 26.501 [2] and the baseline parameters of the 3GPP Service URL for 5G Media Streaming defined in clause 4.10.2 of [2]. Together, they enable a full set of Service Access Information to be retrieved by the Media Session Handler from the 5GMS AF using the Service Access Information API at reference point M5 specified in clause 11.2 of the present document.

The service-operation-point parameter is used to support the procedure where the desired Service Operation Point is known *a priori* to the invoker and/or is not encoded in the Media Entry Point.

The estimated-volume parameter is used to support the procedure where the invoker intends the launched 5G Media Streaming session to be used for the purpose of Background Data Transfer.

The media-entry-point query parameter is used to support the procedure where the Media Session Handler launches media playback in the Media Stream Handler (Media Player or Media Streamer) after successfully retrieving a full set of Service Access Information via reference point M5 (if needed) and after successfully initiating media session handling.

The multipath-protocol parameter is used to support the use of multipath transport protocols for media delivery, as specified in clauses 4.6.1 and 4.9.3. When multiple instances of this parameter exist in the URL, the Media Stream Handler (Media Player or Media Streamer) shall sequentially attempt each specified protocol in their URL appearance order until establishing a successful multipath connection. If all multipath connection attempts fail, the Media Stream Handler (Media Player or Media Streamer) shall fall back to using a single-path transport connection.

The max-paths parameter specifies the maximum number of subflows/paths to be used on each reference point M4 transport connection when the transport protocol supports multipath operation.

The remaining query parameters are used for client-side filtering of Media Entry Point information provided in the Service Access Information and selection of one Media Entry Point by the Media Session Handler. (They are mutually exclusive with the media-entry-point parameter.) In this case, media playback by the Media Stream Handler (Media Player or Media Streamer) is launched by the Media Session Handler with its chosen Media Entry Point.

If the 5GMS-Aware Application prefers to launch media streaming itself (rather than have the Media Session Handler launch media streaming on its behalf), the media-entry-point query parameter and all client-side filtering parameters shall be omitted from the 3GPP Service URL. In this case, the Media Session Handler initiates only media session handling for the 5GMS Provisioning Session identified by the External Service Identifier.

DASH Media Player APIs and functions

### 13.2.4 Configurations and settings API

DASH streaming for a particular downlink media delivery session may be configured by the 5GMSd-Aware Application at reference point M7d or by the Media Session Handler at reference point M11d with the parameters provided in table 13.2.4-1. Note that these parameters may be set and they may also be observed.

Table 13.2.4-1: Media Player Configuration API

|  |  |  |
| --- | --- | --- |
| Status | Type | Definition |
| sessionId | string | A media delivery session identifier for the downlink media streaming session that has been initialised using the method specified in clause 13.2.3.2. |
| capabilities | array(enum) | A read-only list of Media Player capabilities.See table 13.2.4‑2. |
| source | Object | Provides the MPD and all contained information. |
| consumptionMode | Enum | Defines two modes:live: in this case the target latency is maintained, if specified in the service description, according to the parametersvod: in this case the latency is set by the application and the latency settings are ignored. |
| maxBufferTime | Integer | Maximum buffer time in milliseconds for the service.  |
| serviceDescriptionId | id | Selects a service description by selecting an identifier. |
| serviceDescriptions[] | Service description parameters | Configures a service description as defined in annex K of ISO/IEC 23009-1 [32]. This allows the application to define additional service descriptions beyond those defined in the MPD. |
|  | id | id | Sets a service description identifier different from the ones available in the service descriptions in the MPD or modifies existing service descriptions. |
|  | serviceLatency | Object | Sets service description parameters for the service latency, as defined in table K.1 of ISO/IEC 23009-1 [32]. |
|  | playBackRate | Object | Sets service description parameters for the playback rate, as defined in table K.2 of ISO/IEC 23009-1 [32] when the service is consumed in live mode. |
|  | operatingQuality | Object | Sets service description parameters for the operating quality, as defined in table K.3 of ISO/IEC 23009-1 [32]. |
|  | operatingBandwidth | Object | Sets service description parameters for the operating bandwidth, as defined in table K.4 of ISO/IEC 23009-1 [32]. |
| mediaSettings[] | Media type audio, video, subtitle | Sets the selected Adaptation Set based on the available Adaptation Sets for each media type. |
| metricsConfiguration[ ] | Object | Zero or more sets of settings for collecting metrics in relation to the downlink media streaming session. |
| desired‌Transport‌Connection‌Configuration | Object | Desired configuration of transport connection at reference point M4d. |
|  | transportProtocols | array(Enumeration) | A non-empty array of enumerated values from table 13.2.4‑3 to be used by the Media Player for multipath media delivery at reference point M4d. |
|  | maxPaths | Integer | Maximum number of subflows/paths to be used by the Media Player for multipath media delivery at reference point M4d.If omitted, there is no restriction on the number of paths. |

**Table 13.2.4-2: Media Player capabilities enumeration**

|  |  |
| --- | --- |
| **Value** | **Definition** |
| CAPABILITY\_TRANSPORT\_PROTOCOL\_UNKNOWN | The Media Player is not aware of which multipath protocols (if any) it is capable of using. |
| CAPABILITY\_TRANSPORT\_PROTOCOL\_MPTCP | The Media Player has a protocol stack capable of handling multipath TCP connections as specified in RFC 8684 [MPTCP]. |
| CAPABILITY\_TRANSPORT\_PROTOCOL\_MPQUIC | The Media Player has a protocol stack capable of handling multipath QUIC connections as specified in [MPQUIC]. |

Table 13.2.4-3: Transport Protocols enumeration

|  |  |
| --- | --- |
| Value | Definition |
| TRANSPORT\_PROTOCOL\_TCP | TCP as specified in RFC 9293 [TCP] |
| TRANSPORT\_PROTOCOL\_QUIC | QUIC as specified in RFC 9000 [58] |
| TRANSPORT\_PROTOCOL\_MPTCP | Multipath TCP as specified in RFC 8684 [MPTCP]. |
| TRANSPORT\_PROTOCOL\_MPQUIC | Multipath QUIC as specified in [MPQUIC]. |

### 13.2.5 Notifications and error events

Table 13.2.5-1 provides a list of notification events that are provided by the Media Player to 5GMSd-Aware Applications at reference point M7d and to the Media Session Handler at reference point M11d. Every notification and error event is disambiguated by a media delivery session identifier.

Table 13.2.5-1: Media Player Notification events

|  |  |  |
| --- | --- | --- |
| Status | Definition | Payload |
| AST\_IN\_FUTURE | Triggered when playback will not start yet as the MPD's availabilityStartTime is in the future. | Media delivery session identifier, Time before playback will start. |
| AVAILABLE\_MEDIA\_CHANGED | The list of available media has changed. | Media delivery session identifier, Media type:- video- audio- subtitle- all |
| BUFFER\_EMPTY | Triggered when the media playback platform's buffer state changes to stalled. | Media delivery session identifier, Media Type |
| BUFFER\_LOADED | Triggered when the media playback platform's buffer state changes to loaded. | Media delivery session identifier, Media Type |
| CAN\_PLAY | Sent when enough data is available that the media can be played. | Media delivery session identifier |
| MANIFEST\_LOADED | Triggered when the manifest load is complete | Media delivery session identifier |
| METRIC\_ADDED | Triggered every time a new metric is added. | Media delivery session identifier |
| METRIC\_CHANGED | Triggered every time a metric value changes. | Media delivery session identifier,Metric identifier |
| METRIC\_UPDATED | Triggered when the configuration of a metric is updated. | Media delivery session identifier,Metric identifier |
| METRICS\_CHANGED | Triggered whenever there is a change to the overall metrics. | Media delivery session identifier |
| OPERATION\_POINT\_CHANGED | Triggered whenever there is a change of a Service Operation Point parameter. | Media delivery session identifier,External reference identifier of currently selected Service Operation Point. |
| PLAYBACK\_ENDED | Sent when media playback completes normally. | Media delivery session identifier |
| PLAYBACK\_ERROR | Sent when an error occurs during media playback. The element's error attribute contains more information. | Media delivery session identifier,Error reason (see table 13.2.5‑2). |
| PLAYBACK\_PAUSED | Sent when media playback is paused. | Media delivery session identifier |
| PLAYBACK\_PLAYING | Sent when the media begins to play (either for the first time, after having been paused, or after ending and then restarting). | Media delivery session identifier |
| PLAYBACK\_SEEKED | Sent when a media playback seek operation completes. | Media delivery session identifier |
| PLAYBACK\_SEEKING | Sent when a media playback seek operation begins. | Media delivery session identifier |
| PLAYBACK\_STALLED | Sent when the media playback platform reports stalled. | Media delivery session identifier |
| PLAYBACK\_STARTED | Sent when playback of the media starts after having been paused; that is, when playback is resumed after a prior pause event. | Media delivery session identifier |
| PLAYBACK\_WAITING | Sent when the media playback has stopped because of a temporary lack of data. | Media delivery session identifier |
| SERVICE\_DESCRIPTION\_SELECTED | sent when the DASH client has selected a service description. | Media delivery session identifier |
| SERVICE\_DESCRIPTION\_CHANGED | Sent when the DASH client has changed a service description. | Media delivery session identifier |
| SERVICE\_DESCRIPTION\_VIOLATED | Provides notification that the service description parameters are currently not met. | Media delivery session identifier,Parameters of service description that are not met |
| SOURCE\_INITIALIZED | Triggered when the source is set up and ready. | Media delivery session identifier |
| DOWNLOAD\_STARTED | Sent when a non-real-time content download begins. | Media delivery session identifier |
| DOWNLOAD\_COMPLETED | Sent when a non-real-time content download is complete. | Media delivery session identifier |
| DOWNLOAD\_ERROR | Send when an error occurs during non-real-time content download | Media delivery session identifier,Error reason (see table 13.2.5‑2). |
| MULTIPATH\_DELIVERY\_ESTABLISHED | Triggered when a multipath transport connection is set up and ready for media delivery at reference point M4d. | Media delivery session identifier,Transport connection status information (see table 13.2.6-3). |
| TRANSPORT\_CONNECTION\_STATUS\_CHANGED | Triggered when the status of an established media transport connection changes. | Media delivery session identifier,Transport connection status information (see table 13.2.6-3). |

Table 13.2.5-2 provides a list of error reasons that are indicated for notifications of type PLAYBACK\_ERROR and DOWNLOAD\_ERROR.

Table 13.2.5-2: Media Player Error reasons

|  |  |
| --- | --- |
| Error reason | Definition |
| ERROR\_MEDIA\_ENTRY\_NOT\_FOUND | The Media Entry Point resource requested by the Media Player could not be located. |
| ERROR\_CONTENT\_NOT\_FOUND | Other content requested by the Media Player could not be located. |
| ERROR\_MEDIA\_PLAYBACK | There is an error from the media playback platform buffer. |
| ERROR\_INVALID\_MEDIA\_ENTRY | The Media Entry Point resource supplied is not syntactically valid. |
| ERROR\_INACCESSIBLE\_MEDIA\_TIME | The media time requested in a seek operation is not accessible in the current media presentation. |
| ERROR\_UNSUPPORTED\_PROFILE | The profile of the media presentation described by the Media Entry Point resource is not supported by the media playback platform. |
| ERROR\_DOWNLOAD\_DEADLINE\_MISSED | The download of content did not complete before the requested deadline and the incomplete download has been discarded. |
| ERROR\_MULTIPATH\_‌DELIVERY\_‌UNAVAILABLE | The configured multipath delivery (see clause 13.2.4) is not supported by the Media Player and/or the 5GMSd AS. |

### 13.2.6 Dynamic Status Information

Table 13.2.6-1 provides a list of dynamically changing status information that can be obtained from the Media Player via reference point M7d or M11d. A separate set of Dynamic Status Information is provided for each active downlink media streaming session, indexed by its media delivery session identifier initialised per clause 13.2.3.2.

Table 13.2.6-1: Media Player Dynamic Status information

|  |  |  |  |
| --- | --- | --- | --- |
| Status | Type | Parameter | Definition |
| state | Enumeration |  | An enumerated value from table 13.2.2‑1 indicating the current state of the Media Player. |
| averageThroughput | float | none | Current average throughput computed in the ABR logic in bit/s. |
| bufferLength | float | MediaType"video", "audio" and "subtitle" | Current length of the buffer for a given media type, in seconds. If no type is passed in, then the minimum of video, audio and subtitle buffer length is returned. NaN is returned if an invalid type is requested, the presentation does not contain that type, or if no arguments are passed and the presentation does not include any adaption sets of valid media type. |
| liveLatency | float | none | Current live stream latency in seconds based on the latency measurement. |
| mediaSetting[ ] | MPDAdaptationSet | MediaType"video", "audio" and "subtitle" | Current media settings for each media type based on the CMAF Header and the MPD information based on the selected Adaptation Set for this media type. |
| mediaTime | float | None | Current media playback time from media playback platform. The media time is in seconds and is relative to the start of the playback and provides the media that is actually rendered. |
| playbackRate | float | None | The current rate of playback. For a video that is playing twice as fast as the default playback, the playbackRate value should be 2.00. |
| availableServiceDescriptions[ ] | Array of service descriptions |  | Provides the list of available selectable service descriptions with an id to select from. Those are either configured ones or the ones in the MPD. |
| availableMediaOptions[ ] | List of Adaptation Set or Preselection ids | MediaType"video", "audio" "subtitle""all" | Provides the list of available media options that can be selected by the application based on the capability discovery and the subset information. |
| service‌Operation‌Points | array(Service‌Operation‌Point) |  | The set of Service Operation Points declared in the presentation manifest (e.g. DASH MPD) of the current media presentation. See table 13.2.6-2. |
| operative‌Service‌Operation‌Point | integer |  | A zero-based index into the service‌Operation‌Points array indicating the Service Operation Point currently operative in the playback session.Set to -1 if the array is empty. |
| pathmetrics[ ][ ] | Metrics |  | A data blob of metrics for each configured metrics collecting scheme. |
| transportConnectionStatuses[ ] | array(Transport‌Connection‌Status) |  | Status information about the current set of reference point M4d transport connection(s) for media delivery. See table 13.2.6-3. |

Table 13.2.6-2 provides a list of configured operation point information that can be obtained from the client. Any change to a parameter below shall be announced with a notification OPERATION\_POINT\_CHANGED as specified in table 13.2.5‑1.

Table 13.2.6-2: Media Player Service Operation Point Information

|  |  |  |
| --- | --- | --- |
| Parameter | Type | Definition |
| ServiceOperationPoint | Object | The currently configured Service Operation Point parameters according to which the DASH client is operating. |
|  | externalIdentifier | String | The external identifier uniquely identifying this Service Operation Point in the presentation manifest (e.g. DASH MPD). |
|  | mode | Enum | The following operation modes are defined:live: The DASH client operates to maintain configured target latencies using playback rate adjustments and possibly resync.vod: The DASH client operates without latency requirements and rebuffering may result in additional latencies |
|  | maxBufferTime | Integer | maximum buffer time in milliseconds for the service. |
|  | switchBufferTime | Integer | buffer time threshold below which the DASH clients attempt to switch Representations. |
|  | latency | Object | Defines the latency parameters used by the DASH client when operating in live mode. |
|  |  | target | Integer | The target latency for the service in milliseconds. |
|  |  | max | Integer | The maximum latency for the service in milliseconds. |
|  |  | min | Integer | The maximum latency for the service in milliseconds. |
|  | playbackRate | MediaTypeaudio, video, all | Defines the playback rate parameters used by the DASH client for catchup mode and deceleration to avoid buffer underruns and maintaining target latencies. |
|  |  | max | Real | The maximum playback rate for the purposes of automatically adjusting playback latency and buffer occupancy during normal playback, where 1.0 is normal playback speed. |
|  |  | min | Real | The minimum playback rate for the purposes of automatically adjusting playback latency and buffer occupancy during normal playback, where 1.0 is normal playback speed. |
|  | bitRate |  | Defines the operating bit rate parameters used by the DASH client used for a specific media type or aggregated. The values are on IP level. |
|  |  | target | Integer | The target bit rate for the service in bit/s that the client is configured to consume. |
|  |  | max | Integer | The maximum bit rate for the service in bit/s that the client is configured to consume. |
|  |  | min | Integer | The minimum bit rate for the service in bit/s that the client is configured to consume. |
|  | playerSpecificParameters |  | Player-specific parameters may be provided, for example about the used algorithm, etc. |

Table 13.2.6-3 specifies the transport connection status parameters. Any change to a parameter below shall be announced with a notification TRANSPORT\_CONNECTION\_STATUS\_CHANGED as specified in table 13.2.5‑1.

Table 13.2.6-3: Transport connection status information

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter | Type | Parameter | Definition |
| TransportConnectionStatus | Object |  | Status information of transport connection for media delivery. |
|  | transportProtocol | Enumeration |  | An enumerated value from table 13.2.4-2 indicating the transport protocol used for media delivery. |
|  | numberOfActivePaths | Integer |  | The current number of active transport connection subflows/paths at reference point M4d. |

end of CHANGEs