**3GPP TSG-SA4 Meeting #112e *S4-210134***

**Electronic meeting, Telco, Feb 01-10, 2021**

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| *CR-Form-v12.0* | | | | | | | | |
| **Draft CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **26.512** | **CR** | **-** | **rev** | **-** | **Current version:** | **16.1.0** |  |
|  | | | | | | | | |
| *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:*** | Corrections on Procedures and APIs for Downlink and Uplink Streaming | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Qualcomm Incorporated, BBC, Ericsson LM | | | | | | | | | |
| ***Source to TSG:*** | SA4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | 5GMS3 | | | | |  | ***Date:*** | | | 2020-12-14 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **F** |  | | | | | ***Release:*** | | | Rel-16 |
|  | *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-8 (Release 8) Rel-9 (Release 9) 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)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | There are a number of bugs in the terminology and description of the procedures and APIs for downlink and uplink streaming in various sections of TS 26.512. Notably, very little normative text is currently present in the document on uplink streaming related interface procedures and associated APIs. It can be shown that most of the procedures/APIs currrently attributed to downlink streaming are also applicable to uplink streaming, and can be quite easily adapted for that purpose. The focus of this CR is on the M1 and M5 interfaces and modifying the associated descriptions in clauses 4, 7 and 11. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Corrections of bugs and modifications to descriptions of existing downlink-specific interface procedures and APIs to also support uplink streaming. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Inaccuracies and missing descriptions in TS 26.512 on uplink streaming | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 3.3, 4, 4.1, 4.2, 4.3, 5.2, 6.4.4, 7, 8, 11 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
| ***56*** | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

1st CHANGE: Adding new references to clause 2

## 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".

*---- <snipped> ----*

[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".

END OF 1st CHANGE

2nd CHANGE: Adding new abbreviations to clause 3.3

## 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].

5GMS 5G Media Streaming

*---- <snipped> ----*

BMFF (ISO) Base Media File Format

*---- <snipped> ----*

CMAF Common Media Application Format

*---- <snipped> ----*

ISO International Organization for Standardization

*---- <snipped> ----*

END OF 2nd CHANGE

3rd CHANGE: Correction to clause 4 and its various sub-clauses

## 4 Common and Downlink Media Streaming procedures

## 4.1 General

This clause defines all procedures common for use in either Downlink Media Streaming or Uplink Media Streaming, as well as procedures specific only to Downlink Media Streaming, using the different 5G Media Streaming Reference Points.

## 4.2 APIs relevant to Downlink Media Streaming

Table 4.2‑1 summarises the APIs used to provision and use the various downlink media streaming features specified in TS 26.501 [2].

Table 4.2‑1: Summary of APIs relevant to downlink media streaming features

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 5GMSd feature | Abstract | Relevant APIs | | |
| Interface | API name | Clause |
| Content Hosting | Content is ingested, hosted and distributed by the 5GMSd AS according to a Content Hosting Configuration associated with a Provisioning Session. | M1 | Provisioning Sessions API | 7.2 |
| Server Certificates Provisioning API | 7.3 |
| Content Preparation Templates Provisioning API | 7.4 |
| Content Protocols Discovery API | 7.5 |
| Content Hosting Provisioning API | 7.6 |
| M2d | HTTP-pull based content ingest protocol | 8.2 |
| DASH-IF push based content ingest protocol | 8.3 |
| M4d | DASH [4] or 3GP [37] | 10 |
| M5 | Service Access Information API | 11.2 |
| Metrics reporting | The 5GMSd Client uploads metrics reports to the 5GMSd AF according to a provisioned Metrics Reporting Configuration it obtains from the Service Access Information for its Provisioning Session. | M1 | Provisioning Sessions API | 7.2 |
| Metrics Reporting Provisioning API | 7.8 |
| M5 | Service Access Information API | 11.2 |
| Metrics Reporting API | 11.4 |
| Consumption Reporting | The 5GMSd Client provides feedback reports on currently consumed content according to a provisioned Consumption Reporting Configuration it obtains from the Service Access Information for its Provisioning Session. | M1 | Provisioning Sessions API | 7.2 |
| Consumption Reporting Provisioning API | 7.7 |
| M5 | Service Access Information API | 11.2 |
| Consumption Reporting API | 11.3 |
| Dynamic Policy invocation | The 5GMSd Client activates different traffic treatment policies selected from a set of Policy Templates configured in its Provisioning Session. | M1 | Provisioning Sessions API | 7.2 |
| Policy Templates Provisioning API | 7.9 |
| M5 | Service Access Information API | 11.2 |
| Dynamic Policies API | 11.5 |
| Network Assistance | The 5GMSd Client requests bit rate recommendations and delivery boosts from the 5GMSd AF. | M5 | Service Access Information API | 11.2 |
| Network Assistance API | 11.6 |

## 4.3 Procedures of the M1 (5GMS Provisioning) interface

### 4.3.1 General

A 5GMS Application Provider may use the procedures in this clause to provision the network for media streaming sessions that are operated by that 5GMS Application Provider. For downlink media streaming, these sessions may be DASH streaming sessions, progressive download sessions, or any other type of media streaming or distribution (e.g. HLS) sessions. For uplink media streaming, the content format and delivery protocol are defined by the 5GMSu Application Provider, and may be either non-fully standardized or employ standardized HTTP-based streaming of ISO BMFF content fragments as profiled by CMAF [39].

The M1 interface offers three different sets of procedures:

- For downlink media streaming, configuration of content ingest at M2d for onward distribution over M4d by the 5GMSd AS: designed as an API that is equivalent to the functionality of a public CDN. For uplink media streaming, configuration of content egest at M2u for the media content received by the 5GMSu AS from the 5GMSu Client over M4u. The resource types involved in content hosting configuration are provisioning session (see clause 4.3.2), content hosting procedures (see clause 4.3.3), ingest protocols (see clause 4.3.4), content preparation template (see clause 4.3.5), and server certificates (see clause 4.3.6).

- Configuration of dynamic policies: allows the configuration of Policy Templates at M5 that can be applied to M4 downlink/uplink media streaming sessions.

- Configuration of reporting: permits the MNO to collect, at M5, QoE metrics and consumption reports about M4 downlink sessions, as well as permits the MNO to collect, at M5, QoE metrics reports about M4 uplink sessions.

A 5GMS Application Provider may use any of these procedures, in any combination, to support its media streaming sessions.

### 4.3.2 Provisioning Session procedures

#### 4.3.2.1 General

Prior to configuring content hosting, dynamic policies, or reporting, the 5GMS Application Provider shall create a new Provisioning Session. The following CRUD operations are used to manage a provisioning session.

#### 4.3.2.2 Create Provisioning Session

This procedure is used by the 5GMS Application Provider to create a new Provisioning Session. The 5GMS Application Provider shall use the HTTP POST method to create a new Provisioning Session. Upon successful creation, the 5GMS AF shall respond with a 201 (Created) response message that includes the resource identifier of the newly created Provisioning Session in the body of the reply and the URL of the resource, including its resource identifier, shall be returned as part of the HTTP Location header field.

#### 4.3.2.3 Read Provisioning Session properties

This procedure is used by the 5GMS Application Provider to obtain the properties of the Provisioning Session from the 5GMS AF. The 5GMS Application Provider uses the GET method for this purpose.

#### 4.3.2.4 Update Provisioning Session properties

The Update operation is not allowed on Provisioning Sessions.

#### 4.3.2.5 Destroy Provisioning Session

This procedure is used by the 5GMS Application Provider to destroy a Provisioning Session. The 5GMS AF will release any associated resources, purge any cached data, delete all QoS and reporting configurations associated with this Provisioning Session. The 5GMS AF shall use the HTTP DELETE method for this purpose.

### 4.3.3 Content Hosting Provisioning procedures

#### 4.3.3.1 General

These procedures are used by the 5GMSd Application Provider and the 5GMSd AF on M1d to provision the content hosting feature for downlink streaming.

*---- <snipped> ----*

#### 4.3.3.5 Destroy Content Hosting Configuration

This operation is used by the 5GMS Application Provider to destroy a Content Hosting Configuration resource and to terminate the related distribution. The HTTP DELETE method shall be used for this purpose. As a result, the 5GMS AF will release any associated network resources, purge any cached content, and delete any corresponding configurations.

If the procedure is successful, the 5GMSd AF shall respond with a 200 (OK) response message.

If the procedure is not successful, the 5GMSd AF shall provide a response code as defined in clause 6.3.

### 4.3.4 Content Protocols Discovery procedures

#### 4.3.4.1 General

The set of downlink content ingest or uplink content egest protocols supported by the 5GMS AS at interface M2 is described by the ContentProtocols resource at M1, as specified in clause 7.5.3.1.

#### 4.3.4.2 Create Content Protocols

The Create operation is not permitted for the ContentProtocols resource.

#### 4.3.4.3 Read Content Protocols

This procedure is used by the 5GMS Application Provider to retrieve a list of content ingest protocols supported by the 5GMS AS. The HTTP GET method shall be used for this purpose.

If the procedure is successful, the 5GMS AF shall respond with a 200 (OK) response that includes a ContentProtocols resource in the response message body, as specified in clause 7.5.3.1. If the procedure is not successful, the 5GMS AF shall provide a response code as defined in clause 6.3.

#### 4.3.4.4 Update Ingest Protocols

The Update operation is not permitted for the ContentProtocols resource.

#### 4.3.4.5 Destroy Ingest Protocols

The Delete operation is not permitted for the ContentProtocols resource.

### 4.3.5 Content Preparation Template Provisioning procedures

#### 4.3.5.1 General

For downlink media streaming, the 5GMSd AS may be required to process content ingested at interface M2d before serving it on interface M4d. For uplink media streaming, the 5GMSu AS may be required to process content it receives from the 5GMSu Client before passing it to the 5GMSu Application Provider on the egest interface M2u. The content processing operations are specified in a Content Preparation Template resource, as specified in clause 7.4.2.

#### 4.3.5.2 Create Content Preparation Template

This procedure is used by the 5GMS Application Provider to register a new Content Preparation Template with a Provisioning Session. The 5GMS Application Provider shall use the HTTP POST method to upload a new Content Preparation Template resource. The MIME content type of the Content Preparation Template shall be supplied in the Content-Type HTTP request header.

Upon successful creation, the 5GMS AF shall respond with a 201 (Created) response message and the URL of the newly created resource, including its resource identifier, shall be returned as part of the HTTP Location header field.

If the MIME content type indicated in Content-Type is not understood by the 5GMS AF, the creation of the Content Preparation Template resource shall fail with HTTP error response status code 422 (Unprocessable entity).

If the 5GMS AF is unable to provision the resources indicated in the supplied Content Preparation Template, the creation operation shall fail with an HTTP response status code of 503 (Service Unavailable).

If the procedure is not successful, the 5GMS AF shall provide a response code as defined in clause 6.3.

#### 4.3.5.3 Read Content Preparation Template

This procedure is used by the 5GMS Application Provider to download a copy of a Content Preparation Template resource from the 5GMS AF. The 5GMS Application Provider shall use the GET method for this purpose.

If the procedure is successful, the 5GMS AF shall respond with 200 (OK) and shall provide the requested resource in the HTTP message response body. The Content-Type response header shall have the same value as that supplied when the Content Preparation Template resource was created.

If the procedure is not successful, the 5GMS AF shall provide a response code as defined in clause 6.3.

#### 4.3.5.4 Update Content Preparation Template

The update procedure is used by the 5GMS Application Provider to modify or replace an existing Content Preparation Template resource. The HTTP PATCH or HTTP PUT methods shall be used for the update operation.

If the procedure is successful, the 5GMS AF shall respond with a 200 (OK) and provide the content of the resource in the response, reflecting the successful update operation.

If the procedure is not successful, the 5GMS AF shall provide a response code as defined in clause 6.3.

#### 4.3.5.5 Destroy Content Preparation Template

This operation is used by the 5GMS Application Provider to destroy a Content Preparation Template resource. The HTTP DELETE method shall be used for this purpose.

If the procedure is successful, the 5GMS AF shall respond with a 200 (OK) response message.

If the procedure is not successful, the 5GMS AF shall provide a response code as defined in clause 6.3. If the Content Preparation Template is in use as part of a Content Hosting Configuration, the procedure shall fail with HTTP error response status code 409 (Conflict).

### 4.3.6 Server Certificate Provisioning procedures

*---- <snipped> ----*

#### 4.3.6.7 Destroy Server Certificate

This procedure is used to remove a Server Certificate resource from a Provisioning Session. The HTTP DELETE method shall be used for this purpose. On success, the HTTP response 200 (OK) or 204 (No content) shall be returned and afterwards the identifier of the Service Certificate resource is no longer valid.

Only the party that created (see clause 4.3.6.2) or reserved (see clause 4.3.6.3) the Server Certificate resource is permitted to destroy it. Any attempt by another party to destroy a Server Certificate resource shall elicit the HTTP response 405 (Method Not Allowed).

The HTTP response 409 (Conflict) shall be returned if an attempt is made to destroy a Server Certificate resource that is currently referenced by a Content Hosting Configuration resource.

Attempting to destroy a Server Certificate resource that has been reserved but never uploaded shall elicit a 200 (OK) HTTP response. In this case, the 5GMSd AF should release any resources associated with the reservation.

If the procedure is not successful, the 5GMSd AF shall provide a response code as defined in clause 6.3.

### 4.3.7 Dynamic Policy Provisioning procedures

#### 4.3.7.1 General

These procedures are used by the 5GMS Application Provider to configure the Policy Templates for streaming sessions of a particular Provisioning Session.

Figure 4.3.7.1‑1 below is a state diagram showing the life-cycle of a Policy Template resource.



Figure 4.3.7.1‑1: Policy Template Resource State Diagram

Since Policy Templates require 5GMS System operator verification, a Policy Template resource that is newly created cannot be used immediately. Upon creation, a Policy Template resource shall be in the pending state. Once all mandatory properties are provided, the 5GMS AF triggers validation. If the Policy Template is not deemed to be valid by the operator of the 5GMS System, it shall move to the invalid state, from where it can be updated to remedy the defect. Once it has been successfully validated by the 5GMS System operator, a Policy Template resource shall take the ready state, indicating that it may be applied to media streaming sessions. If it is subsequently updated by the 5GMS Application Provider, a Policy Template resource shall return to the pending state, awaiting revalidation by the operator of the 5GMS System. Finally, a Policy Template resource may be suspended by the 5GMS System operator, e.g. in case of a violation of the usage terms or for some other reasons, which renders it unusable. The update of any property moves the state into pending and triggers revalidation. A Policy Template resource may be destroyed when it is in any of the abovementioned states.

The 5GMS AF shall verify the status of a Policy Template resource prior to allowing a Dynamic Policy Instance to instantiate it. Only a Policy Template resource in the ready state is eligible to be instantiated in this way.

#### 4.3.7.2 Create Policy Template

This procedure is used by the 5GMS Application Provider to create a new Policy Template resource. The HTTP POST method shall be used for this purpose.

If the procedure is successful, the 5GMS AF shall generate a resource identifier to uniquely identify the newly created Policy Template resource. In that case, it shall respond with a 201 (Created) HTTP response message and provide the URL to the newly created resource in the Location header field.

If the procedure is not successful, the 5GMS AF shall provide a response code as defined in clause 6.3.

The default state of a newly created Policy Template resource is pending. If all mandatory property values have been provided, the Policy Template resource is eligible for validation.

#### 4.3.7.3 Read Policy Template

This procedure is used by the 5GMS Application Provider and other 5GMS AFs to query the properties of an existing Policy Template resource from the 5GMS AF. The HTTP GET method shall be used for this purpose.

If the procedure is successful, the 5GMS AF shall respond with a 200 (OK) response that includes a copy of the Policy Template resource in the response message body.

If the procedure is not successful, the 5GMS AF shall provide a response code as defined in clause 6.3.

#### 4.3.7.4 Update Policy Template

The update operation is invoked by the 5GMS Application Provider to modify the properties of an existing Policy Template resource. All available properties except state may be updated. The HTTP PATCH or HTTP PUT methods shall be used for the update operation.

Any update to the Policy Template resource will change its state back to pending, which makes it temporarily unusable. If all mandatory property values have been provided, the Policy Template is eligible for revalidation.

If the procedure is successful, the 5GMS AF shall respond with a 200 (OK) response message that includes a copy of the Policy Template resource in the response message body. Modifications to read-only properties, such as changes to the state of a Policy Template, shall be rejected with a 403 (Forbidden) HTTP response.

If the procedure is not successful, the 5GMS AF shall provide a response code as defined in clause 6.3.

#### 4.3.7.5 Destroy Policy Template

This operation is used by the 5GMS Application Provider to destroy a Policy Template resource. The HTTP DELETE method shall be used for this purpose. As a result, the 5GMS AF will remove the Policy Template from any Provisioning Sessions that reference it.

Currently active media streaming sessions using the destroyed Policy Template, if any exist, shall be stopped by the removal of the Policy Template.

If the procedure is successful, the 5GMS AF shall respond with a 200 (OK) response message.

If the procedure is not successful, the 5GMS AF shall provide a response code as defined in clause 6.3.

*---- <snipped> ----*

### 4.3.9 Metrics Reporting Provisioning procedures

#### 4.3.9.1 General

These procedures are used by the 5GMS Application Provider to configure QoE metrics reporting functionality associated with downlink or uplink media streaming. This clause defines the basic procedures. More details are provided in clause 7.8.

A given instance of a Metrics Reporting Configuration resource is identified by the metricsReportingConfigurationId property of the MetricsReportingConfiguration resource, The properties of that resource, as described in clause 7.8.3.1, pertain to metrics collection and reporting by the Media Session Handler to the 5GMS AF.

#### 4.3.9.2 Create Metrics Reporting Configuration

This procedure is used by the 5GMS Application Provider to create a Metrics Reporting Configuration resource for a particular Provisioning Session. The 5GMS Application Provider shall use the HTTP POST method for this purpose and the request message body may include a MetricsReportingConfiguration resource, as specified in clause 7.8.3.1. Upon successful operation, the 5GMS AF shall respond with a 201 (Created) response message and the resource URL for the newly-created Metrics Reporting Configuration resource shall be returned in the Location header field. If the procedure is unsuccessful, the 5GMS AF shall provide a response code as defined in clause 6.3.

This procedure may be perfomed multiple times to provision different Metrics Reporting Configurations in the scope of a particular Provisioning Session. Each such configuration resource is represented by a different value of metricsReportingConfigurationId.

#### 4.3.9.3 Read Metrics Reporting Configuration

This procedure is used by the 5GMS Application Provider to obtain the properties of an existing Metrics Reporting Configuration resource from the 5GMS AF. The 5GMS Application Provider shall use the GET method for this purpose. If successful, the 5GMS AF shall respond with a 200 (OK) and the requested MetricsReportingConfiguration resource (see clause 7.8.3.1) shall be returned in the body of the HTTP response message. If the procedure is unsuccessful, the 5GMS AF shall provide a response code as defined in clause 6.3.

#### 4.3.9.4 Update Metrics Reporting Configuration

The update operation is invoked by the 5GMS Application Provider to initially upload the Metrics Reporting Configuration resource, or in the case of an existing Metrics Reporting Configuration resource, to entirely replace or modify certain properties of that resource. All available properties may be updated. The HTTP PATCH or HTTP PUT methods shall be used for the update operation.

If the procedure is successful, the 5GMS AF shall respond with a 200 (OK) reflecting the successful update operation. If the procedure is unsuccessful, the 5GMS AF shall provide a response code as defined in clause 6.3.

#### 4.3.9.5 Destroy Metrics Reporting Configuration

This operation is used by the 5GMS Application Provider to destroy a Metrics Reporting Configuration resource and to terminate the related metrics reporting procedure. The HTTP DELETE method shall be used for this purpose. As a result, the 5GMS AF should release any associated resources, discard any pending metrics reports, and delete any corresponding configurations.

If the procedure is successful, the 5GMS AF shall respond with a 200 (OK) response message. If the procedure is unsuccessful, the 5GMS AF shall provide a response code as defined in clause 6.3.

*---- <snipped> ----*

## 4.7 Procedures of the M5 (Media Session Handling) interface

### 4.7.1 Introduction

The M5 APIs are used by a Media Session Handler within a 5GMS Client to invoke services relating to downlink or uplink media streaming at the 5GMS AF.

### 4.7.2 Procedures for Service Access Information

#### 4.7.2.1 General

Service Access Information is the set of parameters and addresses needed by the 5GMSd Client to activate reception of a downlink media streaming session or to activate an uplink media streaming session for contribution. Typically, the 5GMSd Client receives via M8 a media entry point (e.g. a URL to a DASH MPD or a URL to a progressive download file) that can be consumed by the Media Player and is handed to the Media Player through M7. In addition, the media entry point URL may trigger the Media Session Handler to fetch the Service Access information from the 5GMS AF for this media streaming session.

This clause specifies the procedures whereby the 5GMS Client fetches the Service Access Information from the 5GMS AF.

#### 4.7.2.2 Create Service Access Information

The Create operation is not allowed on Service Access Information.

#### 4.7.2.3 Read Service Access Information properties

This procedure shall be used by the Media Session Handler to acquire Service Access Information from the 5GMS AF. The Media Session Handler uses the GET method for this purpose.

The downlink or uplink media streaming session for which the Media Session Handler is requesting data is identified by a unique reference contained in the path of the URL, as specified in clause 11.2.2.

Once it has obtained an initial set of Service Access Information, the Media Session Handler shall periodically check for updated Service Access Information by issuing a conditional HTTP GET request containing either:

* an If-None-Match request header with the value of the entity tag (ETag) that was returned with the most recently acquired ServiceAccessInformation resource; or else
* an If-Modified-Since request header with the Last-Modified value of that most recently acquired resource.

The periodicity of polling for updated Service Access Information shall be guided by the value of the Expires and/or Cache-control: max-age headers that shall be included along with every response message for this procedure.

#### 4.7.2.4 Update Service Access Information properties

The Update operation is not allowed on Service Access Information.

#### 4.7.2.5 Destroy Service Access Information properties

The Destroy operation is not allowed on Service Access Information.

### 4.7.3 Procedures for dynamic policy invocation

This procedure is used by a Media Session Handler to manage Dynamic Policy Instance resources via the M5 interface. A dynamic policy invocation consists of a Policy Template Id, flow description(s), a 5GMS Application Service Configuration Id and potentially other parameters, according to TS 26.501 clause 5.7.

A Policy Template Id identifies the desired Policy Template to be applied to an application flow. A Policy Template includes properties such as specific QoS (e.g. background data) or different charging treatments. The 5GMS AF combines the information from the Policy Template with dynamic information from the Media Session Handler to gather a complete set of parameters to invoke the N33 or N5 API call. The Policy Template may contain for example the AF identifier.

The flow description allows the identification and classification of the media traffic, such as the packet filter sets given in clause 5.7.6 of [2].

In order to instantiate a new dynamic policy, the Media Session Handler shall first create a resource for the Dynamic Policy Instance on the 5GMS AF. When the Media Session Handler needs several dynamic policies, it repeats the step as often as needed.

The Media Session Handler creates a new Dynamic Policy Instance by sending an HTTP POST message to the 5GMS AF. The body of the HTTP POST message shall include a Provisioning Session Id, the Policy Template Id and the traffic descriptor. The traffic descriptor identifies the actual application flow(s) to be policed according to the Policy Template. If the operation is successful, the 5GMS AF creates a new resource URL representing the Dynamic Policy Instance. In this case, the 5GMS AF shall respond to the Media Session Handler with a 201 Created HTTP response message, including the URL for the newly created Dynamic Policy Instance resource as the value of the Location header field.

Editor's Note: At minimum, the N5 and N33 API requires the UE IP Address at time of API invocation. The full Flow Description is an optional element, when more fine-grained traffic flow identification is required. It needs to be studied, how to enable usage of other traffic filtering parameters, such as an application id.

The Media Session Handler can modify the parameters of an existing Dynamic Policy Instance resource using either the HTTP PUT or PATCH methods, as appropriate to the desired update. The 5GMS AF shall trigger the appropriate actions towards other Network Functions like PCF or NEF when all information is set.

Editor's Note: It is not clear what triggers the 5GMS AF to start the PCF/NEF interactions.

The Media Session Handler can destroy a Dynamic Policy Instance resource using the HTTP DELETE method. As a result, the 5GMS AF shall trigger the appropriate actions towards other Network Functions like PCF or NEF to remove the associated PCC rule.

Editor's Note: Notification subscription will be added in the next version of the pCR.

*---- <snipped> ----*

### 4.7.5 Procedures for metrics reporting

The M5 procedures for QoE metrics reporting pertain to the combination of the provisioning of metrics collection and reporting in the Media Session Handler using relevant Service Access Information, and the sending of collected metrics by the Media Session Handler to the 5GMS AF in accordance with the configured metrics scheme(s). A metrics scheme may be 3GPP-defined or non-3GPP-defined.

When the metrics collection and reporting feature is activated for a downlink media streaming session, one or more metrics configuration sets, each associated with a metrics scheme, may be provided to the 5GMS Client. A given metrics configuration set contains information such as the 5GMS AF address(es) to which metrics are to be sent by the Media Session Handler, metrics reporting interval, target percentage of media streaming sessions for which reports should be sent, and the set of metrics to be collected and reported. See TS 26.501 [2] for additional details.

For progressive download and DASH streaming services, the listed metrics in a given metrics configuration set are associated with the 3GPP metrics scheme and shall correspond to one or more of the metrics as specified in clauses 10.3 and 10.4, respectively, of TS 26.247 [4].

Details of the metrics reporting API are provided in clause 11.4, and for 3GP-DASH based downlink media streaming services, the 3GPP-defined metrics reporting scheme and metrics report format are defined in clause 11.4.3.

### 4.7.6 Procedures for network assistance

This procedure is used by the 5GMS Client to request Network Assistance from the 5GMSd AF.

The 5GMS Client first creates a Network Assistance Session. It provides information that will be used by the Network Assistance function to request QoS from the PCF and to recommend a bit rate to the 5GMS Client.

The 5GMS Client may also request a delivery boost to be provided.

After the Network Assistance Session resource is provisioned, the 5GMS Client uses the Network Assistance Session identifier when requesting a bit rate recommendation.

In order to terminate a Network Assistance Session, the 5GMS Client deletes the Network Assistance session resource.

END OF 3rd CHANGE

4th CHANGE: Corrections to clause 5 and its sub-clauses

# 5 Uplink Media Streaming procedures

## 5.1 General

Uplink media streaming functional entities in the 5GMS System include the 5GMSu Application Provider, 5GMSu AF, 5GMSu AS and the UE. To make use of these other entities, the UE includes a 5GMSu-Aware Application that is provided by the 5GMS Application Provider and a 5GMSu Client comprising the Media Session Handler and the Media Streamer.

The M1 Provisioning API enables the 5GMSu Application Provider to establish and manage the uplink media session handling and streaming options of the 5GMSu system.

The M2u Egest interface enables uplink media streaming content sent by the 5GMSu Client to the 5GMSu AS over interface M4u to be subsequently delivered to the 5GMSu Application Provider. Uplink media streaming media transfer from the 5GMSu AS to the 5GMSu Application Provider may be either pull-based and initiated by the 5GMSu Application Provider using the HTTP GET method, or push-based and initiated by the 5GMSu AS using the HTTP PUT method. The resource identifier of the 5GMSu Application Provider for push-based streaming content delivery is provided to the 5GMSu AS by the 5GMSu AF over the M3u interface, as part of the M1 Provisioning Session.

The 5GMSu AF, having acquired M1 Provisioning information, sets up the M5 interface that the 5GMSu Client can use for uplink media streaming session management, remote control, metrics reporting, network assistance and request for policy and/or charging treatment. Certain types of configuration and policy information accessed over M5 by the Media Session Handler, such as uplink metrics reporting, QoS policy, or support for AF-based network assistance are further passed to the Media Streamer via the M7u API.

Based on the configuration information received on M5 and a request from the Media Streamer received over the M6u interface, the Media Session Handler sets up an uplink media streaming session with the 5GMSu AF. Upon successful session establishment, the Media Session Handler triggers the Media Streamer to begin uplink streaming of media content to the 5GMSu AS over the M4u interface.

Subscription to status and other event notification services are offered by the Media Session Handler to the 5GMSu-Aware Application and to the Media Streamer via the M6u APIs exposed by the Media Session Handler.

Subscription to status and other event notification services are also offered by the Media Streamer to the 5GMSu-Aware Application and to the Media Session Handler via the M7u APIs exposed by the Media Player.

## 5.2 APIs relevant to Uplink Media Streaming

Table 5.2‑1 summarises the APIs used to provision and use the various uplink media streaming features as specified in TS 26.501 [2]. These are in addition to the procedures applicable to both downlink and uplink media streaming: Provisioning Session (clause 4.3.2), Content Protocols Discovery (clause 4.3.4), Content Preparation Template Provisioning (clause 4.3.5), Dynamic Policy Provisioning (clause 4.3.7) and Metrics Reporting Provisioning (clause 4.3.9).

Table 5.2‑1: Summary of APIs relevant to uplink media streaming features

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 5GMSu feature | Abstract | Relevant APIs | | |
| Interface | API name | Clause |
| Content Preparation | Supports manipulation by 5GMSu AS of streaming media content uploaded by 5GMSu Client over M4u, prior to egest of the manipulated content over M2u. | M1 | Content Preparation Templates Provisioning API | 7.4 |
| Content Protocols Discovery | Used by 5GMSu Application Provider to determine which content egest protocols are supported by 5GMSu AS(s). | M1 | Content Protocols Discovery API | 7.5 |
| Metrics Reporting | The 5GMSu Client uploads metrics reports to the 5GMSu AF according to a provisioned Metrics Reporting Configuration it obtains from the Service Access Information for its Provisioning Session. | M1 | Provisioning Sessions API | 7.2 |
| Metrics Reporting Provisioning API | 7.8 |
| M5 | Service Access Information API | 11.2 |
| Metrics Reporting API | 11.4 |
| Dynamic Policy invocation | The 5GMSu Client activates different traffic treatment policies selected from a set of Policy Templates configured in its Provisioning Session. | M1 | Provisioning Sessions API | 7.2 |
| Policy Templates Provisioning API | 7.9 |
| M5 | Service Access Information API | 11.2 |
| Dynamic Policies API | 11.5 |
| Network Assistance | The 5GMSu Client requests bit rate recommendations and delivery boosts from the 5GMSu AF. | M5 | Service Access Information API | 11.2 |
| Network Assistance API | 11.6 |

END OF 4th CHANGE

5th CHANGE: Additional enumerated data type under clause 6.4.4

### 6.4.4 Enumerated data types

#### 6.4.4.1 CellIdentifierType enumeration

The data model for the *CellIdentifierType* enumeration which indicates the type of cell identifier as defined in TS 23.003 [7], is specified in Table 6.4.4.1-1 below:

Table 6.4.4.1‑1: Definition of CellIdentifierType enumeration

|  |  |
| --- | --- |
| Enumeration value | Description |
| CGI | Cell Global Identification. |
| ECGI | E-UTRAN Cell Global Identification. |
| NCGI | NR Cell Global Identity. |

#### 6.4.4.2 SdfMethod enumeration

The data model for the SdfMethod enumeration is specified in Table 6.4.4.2-1 below:

Table 6.4.4.2‑1: Definition of SdfMethod enumeration

|  |  |
| --- | --- |
| Enumeration value | Description |
| 5Tuple | The Media Session Handler shall use 5-Tuples for Service Data Flow descriptions. The 5‑Tuple shall not contain a wildcard. |
| 2Tuple | The Media Session Handler shall use a 2-Tuple of UE IP and Server IP as Service Data Flow Description. |
| typeOfServiceMarking | The Media Session Handler shall apply Type of Service (ToS) marking to the Service Data Flow. |
| flowLabel | The Media Session Handler shall apply IPv6 flow label marking and provide the IPv6 flow label of the Service Data Flow. |
| domainName | The Media Session Handler shall provide the domain name of the 5GMSd AS. |

#### 6.4.4.3 ProvisioningSessionType enumeration

The data model for the ProvisioningSessionType enumeration is specified in Table 6.4.4.3-1 below:

Table 6.4.4.3‑1: Definition of ProvisioningSessionType enumeration

|  |  |
| --- | --- |
| Enumeration value | Description |
| downlink | Downlink media streaming |
| uplink | Uplink media streaming |

END OF 5th CHANGE

6th CHANGE: Corrections to sub-clauses of clause 7

# 7 Provisioning (M1) APIs

## 7.1 General

This clause defines the provisioning API used by a 5GMS Application Provider to configure downlink or uplink 5G Media Streaming services.

## 7.2 Provisioning Sessions API

### 7.2.1 Overview

The Provisioning Sessions API is used by the 5GMS Application Provider to instantiate and manipulate Provisioning Sessions in the 5GMS System, as described in clause 4.3.2. Having created a Provisioning Session, the 5GMS Application Provider can then go on to provision other 5GMS features in the context of that Provisioning Session, using the APIs specified in clause 7.3 *et seq*. Certain of these features are only applicable to the type of Provisioning Session created.

### 7.2.2 Resource structure

The Provisioning Sessions API is accessible through the following URL base path:

{apiRoot}/3gpp-m1/v1/provisioning-sessions/

Table 7.4.2‑1 specifies the operations and the corresponding HTTP methods that are supported by this API. In each case, the sub-resource path specified in the second column of the table shall be appended to the above URL base path.

Table 7.2.2‑1: Operations supported by the Provisioning Sessions API

|  |  |  |  |
| --- | --- | --- | --- |
| Operation | Sub‑resource path | Allowed HTTP method(s) | Description |
| Create Provisioning Session |  | POST | Used to create a new Provisioning Session resource.  If the operation succeeds, the URL of the created Provisioning Session resource shall be returned in the Location header of the response. |
| Retrieve Provisioning Session | {provisioningSessionId} | GET | Used to retrieve a Provisioning Session resource for inspection. |
| Destroy Provisioning Session | DELETE | Used to destroy an existing Provisioning Session resource. |

### 7.2.3 Data model

#### 7.2.3.1 ProvisioningSession resource

The data model for the ProvisioningSession resource is specified in Table 7.2.3.1-1 below. Different properties are present in the resource depending on the type of Provisioning Session indicated in the provisioningSessionType property, and this is specified in the *Applicability* column.

Table 7.2.3.1‑1: Definition of ProvisioningSession resource

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Property name | Type | Cardinality | Usage | Description | Applicability |
| provisioningSessionId | String | 1..1 | C: R  R: RO | A unique identifier for this Provisioning Session. | All types. |
| provisioningSession‌Type | Provisioning‌Session‌Type | 1..1 | C: RW R: RO  U: – | The type of Provisioning Session. | All types. |
| aspId | AspId | 0..1 | C: W  R: RO | The identity of the Application Service Provider responsible for this Provisioning Session, as specified in clause 5.6.2.3 of TS 29.514 [34]. | All types. |
| serverCertificateIds | Array(String) | 0..1 | C: –  R: RO | A list of Server Certificate identifiers currently associated with this Provisioning Session. | downlink |
| contentPreparation‌TemplateIds | Array(String) | 0..1 | C: –  R: RO | A list of Content Preparation Template identifiers currently associated with this Provisioning Session. | downlink,  *uplink* |
| contentProtocols | String | 1..1 | C: R  R: RO | The Content Protocols resource identifier.  Fixed value specified as the sub-resource path in table 7.5.2‑1. | downlink,  uplink |
| contentHosting‌ConfigurationId | String | 0..1 | C: –  R: RO | The Content Hosting Configuration identifier currently associated with this Provisioning Session, if any. | downlink |
| consumptionReporting‌ConfigurationId | String | 0..1 | C: –  R: RO | The Consumption Reporting Configuration identifier currently associated with this Provisioning Session, if any. | downlink |
| metricsReporting‌ConfigurationIds | Array(String) | 0..1 | C: –  R: RO | A list of Metrics Reporting Configuration identifiers currently associated with this Provisioning Session. | downlink,  uplink |
| policyTemplateIds | Array(String) | 0..1 | C: –  R: RO | A list of Policy Template identifiers currently associated with this Provisioning Session. | downlink,  uplink |

*---- <snipped> ----*

## 7.3 Server Certificates Provisioning API

### 7.3.1 Overview

The Server Certificates Provisioning API is used to provision X.509 [8] server certificates that can be referenced by a Content Hosting Configuration and subsequently presented by the 5GMSd AS when it distributes content to 5GMSd Clients at interface M4d using Transport Layer Security [12]. Server Certificate resources are provisioned within the scope of an enclosing Provisioning Session.

### 7.3.2 Resource structure

The Server Certificates Provisioning API is accessible through the following URL base path:

{apiRoot}/3gpp-m1/v1/provisioning-sessions/{provisioningSessionId}/

Table 7.3.2‑1 specifies the operations and the corresponding HTTP methods that are supported by this API. In each case, the Provisioning Session identifier shall be substituted into {provisioningSessionId} in the above URL template and the sub-resource path specified in the second column shall be appended to the URL base path.

*---- <snipped> ----*

## 7.4 Content Preparation Templates Provisioning API

### 7.4.1 Overview

Content Preparation Templates are used to specify manipulations applied by a 5GMS AS to downlink media resources ingested at interface M2d for distribution at interface M4d, or to uplink media resources contributed at interface M4u for egest at interface M2u. The Content Preparation Templates Provisioning API is used to provision a Content Preparation Template within the scope of a Provisioning Session that can subsequently be referenced from a Content Hosting Configuration.

### 7.4.2 Resource structure

The Content Preparation Templates Provisioning API is accessible through the following URL base path:

{apiRoot}/3gpp-m1/v1/provisioning-sessions/{provisioningSessionId}/

Table 7.4.2‑1 specifies the operations and the corresponding HTTP methods that are supported by this API. In each case, the Provisioning Session identifier shall be substituted into {provisioningSessionId} in the above URL template and the sub-resource path specified in the second column shall be appended to the URL base path.

Table 7.4.2‑1: Operations supported by the Content Preparation Templates Provisioning API

|  |  |  |  |
| --- | --- | --- | --- |
| Operation | Sub‑resource path | Allowed HTTP method(s) | Description |
| Create Content Preparation Template | content-preparation-templates | POST | Invoked on a Content Preparation Templates collection when supplying a new Content Preparation Template resource.  If the operation succeeds, the URL of the newly created Content Preparation Template resource shall be returned in the Location header of the response and this shall comply with the sub-resource path specified below for manipulating Content Preparation Templates. |
| Retrieve Content Preparation Template | content‑preparation‑templates/‌{contentPreparationTemplateId} | GET | Used to retrieve a Content Preparation Template resource. |
| Update Content Preparation Template | PUT,  PATCH | Used to modify an existing Content Preparation Template resource. |
| Destroy Content Preparation Template | DELETE | Used to destroy an existing Content Preparation Template resource. |

### 7.4.3 Data model

The data model of the Content Preparation Template resource shall be determined by its MIME content type.

### 7.4.4 Operations

The operations shall be determined by the MIME content type of the Content Preparation Template resource.

## 7.5 Content Protocols Discovery API

### 7.5.1 Overview

The Content Protocols Discovery API is used by a 5GMS Application Provider to find out which content ingest or egest protocols are supported by the 5GMS AS(s) associated with a 5GMS AF. One of the supported ingest protocols is subsequently indicated in a Content Hosting Configuration for downlink media streaming.

### 7.5.2 Resource structure

The Content Protocols Discovery API is accessible through the following URL base path:

{apiRoot}/3gpp-m1/v1/provisioning-sessions/{provisioningSessionId}/

Table 7.5.2‑1 below specifies the operations and the corresponding HTTP methods that are supported by this API. In each case, the Provisioning Session identifier shall be substituted into {provisioningSessionId} in the above URL template and the sub-resource path specified in the second column of the table shall be appended to the URL base path.

Table 7.5.2‑1: Operations supported by the Ingest Protocols Discovery API

|  |  |  |  |
| --- | --- | --- | --- |
| Operation | Sub‑resource path | Allowed HTTP method(s) | Description |
| Fetch list of supported content protocols | protocols | GET | This operation is used to retrieve a list of supported content protocols. |

### 7.5.3 Data model

#### 7.5.3.1 ContentProtocols resource

The data model for the ContentProtocols resource is specified in table 7.5.3.1-1 below:

Table 7.5.3.1-1: Definition of ContentProtocols resource

| Property name | Data Type | Cardinality | Description |
| --- | --- | --- | --- |
| downlinkIngestProtocols | Array(Content‌Protocol‌Descriptor) | 0..1 | An array of ContentProtocolDescriptor objects, as specified in clause 7.5.3.2, each one uniquely identifying a content ingest protocol supported at interface M2d by the 5GMSd AS(s) associated with the corresponding 5GMSd AF. |
| uplinkEgestProtocols | Array(Content‌Protocol‌Descriptor) | 0..1 | An array of ContentProtocolDescriptor objects, as specified in clause 7.5.3.2, each one uniquely identifying a content egest protocol supported at interface M2u by the 5GMSu AS(s) associated with the corresponding 5GMSu AF. |
| geoFencingLocatorTypes | Array(URI String) | 0..1 | An array of fully-qualified term identifiers, each one indicating a content geo-fencing locator type supported by the 5GMS System.  Every 5GMS System shall support at least the locator type urn:3gpp:5gms:locatortype:iso3166. |

#### 7.5.3.2 ContentProtocolDescriptor type

The data model for the *ContentProtocolDescriptor* type is specified in table 7.5.3.2-1 below:

Table 7.5.3.2-1: Definition of ContentProtocolDescriptor type

|  |  |  |  |
| --- | --- | --- | --- |
| Property name | Data Type | Cardinality | Description |
| termIdentifier | URI String | 1..1 | A fully-qualified term identifier from the controlled vocabulary urn:3gpp:5gms:content-protocol, as specified in clause 8. |
| descriptionLocator | URL String | 0..1 | The location of a description of the content protocol, for example the public web URL of its specification. |

*---- <snipped> ----*

## 7.6 Content Hosting Provisioning API

### 7.6.1 Overview

This clause specifies the API that a 5GMSd Application Provider uses at interface M1d to provision and manage 5GMSd AS Content Hosting Configurations by interacting with a 5GMSd AF. Each such configuration is represented by a ContentHostingConfiguration, the data model for which is specified in clause 7.6.3 below. The RESTful resources for managing Content Hosting Configurations are specified in clause 7.6.2 and the operations on these resources are further elaborated in clause 7.6.4.

### 7.6.2 Resource structure

The Content Hosting Provisioning API is accessible through this URL base path:

{apiRoot}/3gpp-m1/v1/provisioning-sessions/{provisioningSessionId}/

Table 7.6.2-1 below specifies the operations and the corresponding HTTP methods that are supported by this API. In each case, the Provisioning Session identifier shall be substituted into {provisioningSessionId} in the above URL template and the sub-resource path specified in the second column shall be appended to the URL base path.

Table 7.6.2‑1: Operations supported by the Content Hosting Provisioning API

|  |  |  |  |
| --- | --- | --- | --- |
| Operation | Sub‑resource path | Allowed HTTP method(s) | Description |
| Create Content Hosting Configuration | content-hosting-configuration | POST | Used to create a Content Hosting Configuration resource. |
| Retrieve Content Hosting Configuration | GET | Used to retrieve an existing Content Hosting Configuration. |
| Update Content Hosting Configuration | PUT,  PATCH | Used to modify an existing Content Hosting Configuration. |
| Delete Content Hosting Configuration | DELETE | Used to delete an existing Content Hosting Configuration. |
| Purge Content Hosting Configuration cache | content-hosting-configuration/purge | POST | This operation is used to invalidate some or all cached media resources associated with this Content Hosting Configuration. |

*---- <snipped> ----*

## 7.7 Consumption Reporting Provisioning API

### 7.7.1 Overview

The Consumption Reporting Provisioning API is a RESTful API that allows a 5GMSd Application Provider to configure the Consumption Reporting Procedure for a particular downlink media streaming Provisioning Session at interface M1d. The different procedures are described in clause 4.2.5. The Consumption Reporting Configuration is represented by a ConsumptionReportingConfiguration, the data model for which is specified in clause 7.7.3 below. The RESTful resources for managing the Consumption Reporting Configuration is specified in clause 7.7.2.

### 7.7.2 Resource structure

The Consumption Reporting Provisioning API is accessible through the following URL base path:

{apiRoot}/3gpp-m1/v1/provisioning-sessions/{provisioningSessionId}/

Table 7.7.2‑1 below specifies the operations and the corresponding HTTP methods that are supported by this API. In each case, the Provisioning Session identifier shall be substituted into {provisioningSessionId} in the above URL template and the sub-resource path specified in the second column shall be appended to the URL base path.

*---- <snipped> ----*

## 7.8 Metrics Reporting Provisioining API

### 7.8.1 Overview

The Metrics Reporting Provisioning API allow an 5GMS System operator or a 5GMS Application Provider to configure the Metrics Collection and Reporting procedure for a particular downlink or uplink media streaming Provisioning Session at interface M1.

### 7.8.2 Resource structure

The Metrics Reporting Provisioning API is accessible through the following URL base path:

{apiRoot}/3gpp-m1/v1/provisioning-sessions/{provisioningSessionId}/

Table 7.8.2‑1 below specifies the operations and the corresponding HTTP methods that are supported by this API. In each case, the Provisioning Session identifier shall be substituted into {provisioningSessionId} in the above URL template and the sub-resource path specified in the second column of the table shall be appended to the URL base path.

Table 7.8.2-1: Operations supported by the Metrics Reporting Provisioning API

|  |  |  |  |
| --- | --- | --- | --- |
| Operation | Sub‑resource path | Allowed HTTP method(s) | Description |
| Create Metrics Reporting Configuration | metrics‑reporting‑configuration | POST | Create and optionally provide a configuration.  If the operation succeeds, the URL of the created Metrics Reporting Configuration resource shall be returned in the Location header of the response. |
| Read Metrics Reporting Configuration | metrics‑reporting‑configuration/  {metricsReportingConfigurationId} | GET | Retrieve the values of an existing Metrics Reporting Configuration. |
| Update Metrics Reporting Configuration | PUT,  PATCH | Provide initial upload of a new configuration, or either the modification of, or replacement to an existing configuration. |
| Delete Metrics Reporting Configuration | DELETE | Delete a configuration, disables reporting. |

### 7.8.3 Data model

#### 7.8.3.1 MetricsReportingConfiguration resource

The data model for the MetricsReportingConfiguration resource is specified in Table 7.8.3-1 below:

Table 7.8.3‑1: Definition of MetricsReportingConfiguration resource

|  |  |  |  |
| --- | --- | --- | --- |
| Property name | Type | Cardinality | Description |
| metricsReportingConfigurationId | String | 1..1 | An identifier for this Metrics Reporting Configuration that is unique within the scope of the enclosing Provisioning Session. |
| scheme | Array(URI String) | 0..1 | The scheme associated with this Metrics Reporting Configuration. A scheme may be associated with 3GPP or with a non-3GPP entity.  For downlink media streaming, if not specified, the 3GPP metrics scheme urn:‌3GPP:‌ns:‌PSS:‌DASH:‌QM10 from TS 26.247 shall apply.  For uplink media streaming, if not specified, the implication is that no associated uplink metrics reporting shall be performed. |
| dataNetworkName | String | 0..1 | The Data Network Name (DNN) which shall be used when sending metrics reports.  If not specified, the default DNN shall be used. |
| reportingInterval | DurationSec | 0..1 | The time interval between successive metrics reports.  If not specified, a single final report shall be sent after the media streaming session has ended. |
| samplePercentage | Percentage | 0..1 | The proportion of media streaming sessions for which metrics shall be reported.  If not specified, reports shall be sent for all sessions. |
| urlFilters | Array(String) | 0..1 | A non-empty list of content URL patterns for which metrics shall be reported.  If not specified, reporting shall be done for all URLs. |
| metrics | Array(String) | 0..1 | A non-empty list of metrics which shall be collected and reported.  In the case of downlink media streaming and for the 3GPP scheme urn:‌3GPP:‌ns:‌PSS:‌DASH:‌QM10 the listed metrics shall correspond to one or more of the metrics as specified in clauses 10.3 and 10.4, respectively, of TS 26.247 [7], and the quality reporting scheme and quality reporting protocol as defined in clauses 10.5 and 10.6, respectively, of [7] shall be used.  In the case of uplink streaming, no standardized metrics nor metrics reporting protocol are defined in the present document. It is assumed that those quality metrics and reporting protocol are defined by the metrics scheme.  If not specified, the complete (or default if applicable) set of metrics associated with the specified scheme shall be collected and reported. |

## 7.9 Policy Templates Provisioning API

### 7.9.1 Overview

The Policy Templates Provisioning API allow a 5GMS Application Provider to configure a set of Policy Templates within the scope of a Provisioning Session that can subsequently be applied to downlink or uplink media streaming sessions belonging to that Application Provider using the Dynamic Policies API specified in clause 11.5. A Policy Template is used to specify the traffic shaping and charging policies to be applied to these media streaming sessions.

A Policy Template, identified by its policyTemplateId, represents a set of PCF/NEF API parameters which defines the service quality and associated charging for the corresponding downlink or uplink media streaming session(s). The Policy Template is configured as part of the provisioning procedures with the 5GMS AF and is then used by the 5GMS AF to request specific QoS and charging policies for that session from the PCF or NEF.

The state of a Policy Template can be:

- pending: The Policy Template is awaiting validation, potentially because not all required parameters have yet been provided. This is the default state after Policy Template creation.

- invalid: One or more of the Policy Template's properties failed validation by the 5GMS AF.

- ready: After successful validation by the 5GMS AF the Policy Template moves into this state.

- suspended: The 5GMS AF may move a Policy Template into this state under certain conditions defined within the Service Level Agreement.

When the Policy Template is used for QoS Flows, the qoSSpecification object (of type M1QoSSpecification) shall be present:

- The qosReference value is obtained with the Service Level Agreement. See TS 23.502 for detailed usage.

- The maxBtrUl and maxBtrDl properties define the maximal bit rate which can be used for QoS Flows. This value is defined by the 5G System.

- The maxAuthBtrUl and MaxAuthBtrDl properties define the maximal authorized bit rate values which can be requested by a Media Session Handler. Higher bit rate values are not authorized for use by the 5GMS Application Provider.

- The minPacketLossRateDl and minPacketLossRateUl properties define the minimal authorized packet loss rate, which can be requested by a Media Session Handler.

When the Policy Template is used for differential changing the chargingSpecification property shall be present.

The ApplicationSessionContext Object is a mandatory object, which contains at least the aspId property.

- The aspId identifies the API invoker.

- The dnn property contains the Data Network Name of the data network, in which the 5GMS AF is hosted.

- When Network Slicing is used, the sliceInfo property contains information about the network slice, which is serving the UE.

### 7.9.2 Resource structure

The Policy Template Provisioning API is accessible through the following URL base path:

{apiRoot}/3gpp-m1/v1/provisioning-sessions/{provisioningSessionId}/

Table 7.9.2‑1 below specifies the operations and the corresponding HTTP methods that are supported by this API. In each case, the Provisioning Session identifier shall be substituted into {provisioningSessionId} in the above URL template and the sub-resource path specified in the second column shall be appended to the URL base path.

Table 7.9.2‑1: Operations supported by the Policy Template Provisioning API

|  |  |  |  |
| --- | --- | --- | --- |
| Operation | Sub‑resource path | Allowed HTTP method(s) | Description |
| Create a new Policy Template | policy-templates | POST | Used to create a new Policy Template resource.  If the operation succeeds, the URL of the created Policy Template resource shall be returned in the Location header of the response. |
| Fetch a Policy Template | policy-templates/‌{policyTemplateId} | GET | Used to retrieve an existing Policy Template resource. |
| Update a Policy Template | PUT,  PATCH | Used to modify the configuration of an existing Policy Template. |
| Delete a Policy Template | DELETE | Used to delete an existing Policy Template resource. |

### 7.9.3 Data model

#### 7.9.3.1 PolicyTemplate resource

The data model for the PolicyTemplate resource is specified in table 7.9.3‑1 below:

Table 7.9.3-1: Definition of PolicyTemplate resource

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Property | Type | Cardinality | Usage | Visibility | Description |
| policyTemplateId | String | 1..1 | C: RO R: RO  U: RO |  | Unique identifier of this Policy Template within the scope of the Provisioning Session. |
| state | Enumeration of Strings | 1..1 | C: RO R: RO  U: RO |  | A Policy Template may be in the pending, ready, or suspended state.  Only a Policy Template in the ready state may be instantiated as a Dynamic Policy Instance and applied to media streaming sessions. |
| apiEndPoint | String | 1..1 | C: RW R: RO  U: RW | MNO Admin | The API endpoint that should be invoked when activating a Dynamic Policy Instance based on this Policy Template. |
| apiType | Enumeration of Strings | 1..1 | C: RW R: RO  U: RW | MNO Admin | N5: Npcf Policy Authorization Service.  N33: AsSessionWithQoS or CHargableParty. |
| externalReference | String | 1..1 | C: RW R: RO  U: RW |  | Additional identifier for this Policy Template, unique within the scope of its Provisioning Session, that can be cross-referenced with external metadata about the media streaming session. |
| qoSSpecification | M1QoSSpecification | 0..1 | C: RW R: RO  U: RW |  | Specifies the network quality of service to be applied to media streaming sessions at this Policy Template. |
| ApplicationSession‌Context | Object | 1..1 |  |  | Specifies information about the application session context to which this Policy Template can be applied. |
| afAppId | AfAppId | 0..1 |  | Read-Only | As defined in clause 5.6.2.3 of TS 29.514 [34]. |
| sliceInfo | Snssai | 0..1 |  |  |
| dnn | Dnn | 0..1 |  |  |
| aspId | AspId | 0..1 |  |  |
| chargingSpecification | ChargingSpecification | 0..1 |  |  | Provides information about the charging policy to be used for this Policy Template. |

Editor's Note: The parameter externalReference is for further study. It may be a provisioning parameter of the Media Player/Media Streamer and/or a Media Session Handler to assist mapping of external references to a policyTemplateId.

Editor's Note: The ChargingSpecification object may contain any charging related information, such as sponId or afChargeId

END OF 6th CHANGE

7th CHANGE: Corrections to sub-clauses of clause 11

# 11 Media Session Handling (M5) APIs

## 11.1 General

This clause defines the Media Session Handling APIs used by the Media Session Handler to access resources exposed by the 5GMS AF at interface M5.

NOTE: While the entirety of the Media Session Handling APIs apply to downlink media streaming, only a subset is applicable to uplink media streaming. Specifically, the Consumption Reporting API is not applicable to uplink media streaming.

## 11.2 Service Access Information API

### 11.2.1 General

The Service Access Information API is used by the Media Session Handler to obtain configuration information from the 5GMS AF that enables it to use the other Media Session Handling APIs specified in clause 11.3 *et seq.*

### 11.2.2 Resource structure

The Service Access Information API is accessible through the following URL base path:

{apiRoot}/3gpp-m5/v1/service-access-information/

The operations and the corresponding HTTP methods in Table 11.2.2-1 are supported. In each case, the sub-resource path specified in the second column shall be appended to the URL base path.

Table 11.2.2‑1: Operations supported by the Service Access Information API

|  |  |  |  |
| --- | --- | --- | --- |
| Operation | Sub-resource path | Allowed HTTP method(s) | Description |
| Fetch Service Access Information | {provisioningSessionId} | GET | Used to acquire the Service Access Information resource for the specified Provisioning Session.  The {provisioningSessionId} uniquely identifies the Service Access Information Resource and is allocated by the 5GMS AF during creation of a Provisioning Session. |

### 11.2.3 Data model

#### 11.2.3.1 ServiceAccessInformation resource type

The data model for the ServiceAccessInformation resource is specified in Table 11.2.3.1-1 below. Different properties are present in the resource depending on the type of Provisioning Session from which the Service Access Information is derived (as indicated in the provisioningSessionType property) and this is specified in the *Applicability* column.

Table 11.2.3.1‑1: Definition of ServiceAccessInformation resource

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Property name | Type | Cardinality | Usage | Description | Applicability |
| provisioningSessionId | String | 1..1 | RO | Unique identification of the M1 Provisioning Session. | All types |
| provisioningSession‌Type | Provisioning‌Session‌Type | 1..1 | RO | The type of Provisioning Session. | All types. |
| StreamingAccess | Object | 0..1 | RO |  | downlink |
| mediaPlayerEntry | URL String | 0..1 | RO | A document or a pointer to a document that defines a media presentation e.g. MPD for DASH content or URL to a video clip file. |
| ClientConsumptionReporting‌Configuration | Object | 0..1 | RO |  | downlink |
| reportingInterval | DurationSec | 0..1 | RO | The time interval, expressed in seconds, between consumption report messages being sent by the Media Session Handler. The value shall be greater than zero.  When this property is omitted, a single final report shall be sent immediately after the media streaming session has ended. |
| serverAddresses | Array(URL String) | 1..1 | RO | A list of 5GMSd AF addresses (URLs) where the consumption reporting messages are sent by the Media Session Handler.  (Opaque URL, following the 5GMS URL format.) |
| locationReporting | Boolean | 1..1 | RO | Stipulates whether the Media Session Handler is required to provide location data to the 5GMSd AF in consumption reporting messages (in case of MNO or trusted third parties). |
| samplePercentage | Percentage | 1..1 | RO | The percentage of media streaming sessions that shall send consumption reports, expressed as a floating point value between 0.0 and 100.0. |
| DynamicPolicyInvocation‌Configuration | Object | 0..1 | RO |  | downlink,  *uplink* |
| serverAddresses | Array(URL String) | 1..1 | RO | A list of 5GMSd AF addresses (URLs) which offer the APIs for dynamic policy invocation sent by the Media Session Handler.  (Opaque URL, following the 5GMS URL format.) |
| validPolicyTemplateIds | Array(String) | 1..1 | RO | A list of Policy Template identifiers which the 5GMS Client is authorized to use. |
| sdfMethods | Array(SdfMethod) | 1..1 | RO | A list of recommended service data flow description methods (descriptors), e.g. 5-Tuple, ToS, 2-Tuple, etc, which should be used by the Media Session Handler to describe the service data flows for the traffic to be policed. |
| externalReferences | Array(String) | 0..1 | RO | Additional identifier for this Policy Template, unique within the scope of its Provisioning Session, that can be cross-referenced with external metadata about the media streaming session.  Example: "HD\_Premium". |
| ClientMetricsReporting‌Configurations | Array(Object) | 0..1 | RO |  | downlink,  uplink |
| serverAddresses | Array(URL String) | 1..1 | RO | A list of 5GMS AF addresses to which metrics reports shall be sent.  (Opaque URL, following the 5GMS URL format.) |
| dataNetworkName | String | 0..1 | RO | The DNN which shall be used when sending metrics reports. If not specified, the name of the default DN shall be used. |
| reportingInterval | DurationSec | 0..1 | RO | The time interval, expressed in seconds, between metrics reports being sent by the Media Session Handler. The value shall be greater than zero.  When this property is omitted, a single final report shall be sent immediately after the media streaming session has ended. |
| samplePercentage | Percentage | 1..1 | RO | The percentage of media streaming sessions that shall report metrics, expressed as a floating point value between 0.0 and 100.0. |
| urlFilters | Array(String) | 0..1 | RO | A non-empty list of URL patterns for which metrics reporting shall be done. The format of each pattern shall be a regular expression as specified in [5].  If not specified, reporting shall be done for all sessions. |
| metrics | Array(String) | 1..1 | RO | A list of metrics which shall be reported. |
| NetworkAssistanceConfiguration | Object | 0..1 | RO |  | downlink,  uplink |
| serverAddress | URL String | 1..1 | RO | Address of the 5GMS AF that offers the APIs for 5GMS AF-based Network Assistance, for access by the 5GMSd Media Session Handler. This address shall be an opaque URL, following the 5GMS URL format. |

### 11.2.4 Operations

This clause defines the behaviour that is expected from the 5GMS AF when a Service Access Information resource is acquired by the Media Session Handler. The main operation that is performed is to look up or generate the Service Access Information corresponding to the requested Provisioning Session.

## 11.3 Consumption Reporting API

### 11.3.1 General

The Consumption Reporting API allows the Media Session Handler to report downlink media consumption to the 5GMSd AF. The API defines data models, resources and the related procedures for the creation and management of the consumption reporting procedures. This procedure is configured by the ServiceAccessInformation resource, as defined in clause 11.2.3.

### 11.3.2 Reporting procedure

Consumption reports shall be submitted to one of the URLs selected from the ClientConsumptionReporting‌Configuration.‌serverAddresses array of the ServiceAccessInformation resource (see clause 11.2.3). The path of the URL should conform to the following general format:

{apiRoot}/3gpp-m5/v1/consumption-reporting/{aspId}

where {aspId} shall be substituted by the 5GMS Client with the relevant Application Service Provider identifier.

The only HTTP method supported by this endpoint is POST.

*---- <snipped> ----*

## 11.4 Metrics Reporting API

### 11.4.1 General

The Metrics Reporting API allows the Media Session Handler to send metrics reports to the 5GMS AF. This procedure is configured by the ServiceAccessInformation resource, as defined in clause 11.2.3. Note that multiple metrics configurations can be active at the same time, each identified by a unique metricsReportingConfigurationId.

### 11.4.2 Reporting procedure

Metrics reports related to a specific metricsReportingConfigurationId shall be submitted to one of the URLs selected from the ClientMetricsReportingConfiguration.serverAddresses array of the ServiceAccessInformation resource (see clause 11.2.3). The path of the URL should conform to the following general format:

{apiRoot}/3gpp-m5/v1/metrics-reporting/{provisioningSessionId}/{metricsReportingConfigurationId}

where {provisioningSessionId} shall be substituted by the 5GMS Client with the relevant Provisioning Session identifier and {metricsReportingConfigurationId} shall be substituted with the relevant Metrics Reporting Configuration identifier.

The only HTTP method supported by this endpoint is POST.

### 11.4.3 Report format

Metrics reports shall be submitted by the Media Session Handler in a format specified by the metrics reporting scheme in question. The Content-Type HTTP request header shall be set in accordance with the relevant metrics reporting scheme specification.

NOTE: For downlink media streaming, TS 26.247 [7] clauses 10.6.1 and 10.6.2 specify the required MIME content type and metrics report format for the 3GPP urn:‌3GPP:‌ns:‌PSS:‌DASH:‌QM10 metrics reporting scheme.

## 11.5 Dynamic Policies API

### 11.5.1 Overview

The Dynamic Policies API allows the Media Session Handler to request a specific policy and charging treatment to be applied to a particular application data flow of a downlink or uplink media streaming session by invoking RESTful operations on the 5GMS AF at interface M5. The API defines a set of data models, resources and the related procedures for the creation and management of the dynamic policy request.

### 11.5.2 Resource structure

The Dynamic Policies API is accessible through the following URL base path:

{apiRoot}/3gpp-m5/v1/dynamicpolicies/

Table 11.5.2‑1 below specifies the operations and the corresponding HTTP methods that are supported by this API. The sub-resource path specified in the second column shall be appended to the URL base path.

Table 11.5.2-1: Operations supported by the Dynamic Policies API

|  |  |  |  |
| --- | --- | --- | --- |
| Resource name | Sub-resource path | Allowed HTTP methods | Description |
| Dynamic Policies | policies | POST | Create a new Dynamic Policy resource.  If the operation succeeds, the URL of the created Dynamic Policy Instance resource shall be returned in the Location header of the response. |
| Dynamic Policy | policies/{dynamicPolicyId} | GET | Read a Dynamic Policy resource. |
| PUT | Replace an existing Dynamic Policy resource. |
| PATCH | Modify an existing Dynamic Policy resource. |
| DELETE | Delete an existing Dynamic Policy resource. |

*---- <snipped> ----*

### 11.5.4 Operations

This clause defines the behaviour that is expected when activating a Dynamic Policy Instance. The policyTemplateId uniquely identifies the Policy Template, to which the Dynamic Policy Instance is associated. The provisioningSessionId associates the Dynamic Policy Instance to a Provisioning Session.

The Dynamic Policy resource contains a serviceDataFlowDescription property which contains the service data flow template according to TS 23.503. The ServiceDataFlowDescription shall contain one of:

- a flowDescription Object (incl. 5-Tuples, Type of Service, Security Parameter Index, etc.).

- a domainName.

When the Media Session Handler activate a QoS-related Dynamic Policy Template, then the qosSpecifcation property shall be present and it shall contain the following properties:

- marBwDlBitRate or marBwUlBitRate, indicating the maximum requested bit rate by the Media Session Handler.

- mirBwDlBitRate or mirBwUlBitRate, indicating the minimum requested bit rate by the Media Session Handler.

- minDesBwDlBitRate or minDesBwUlBitrate, indicating the minimum bit rate desired by the Media Session Handler.

When the 5G System employs a traffic enforcement function to ensure that the traffic is complying a certain traffic policy, the Dynamic Policy resource may contain the following two properties:

- an enforcementMethod, indicating the type of enforcement method (like leaky bucket).

- an enforcementBitrate property, indicating the maximal permitted bit rate.

## 11.6 Network Assistance API

### 11.6.1 Overview

If AF-based Network Assistance is supported, then the Network Assistance API component of interface M5, as defined in the present sub-clause, is first used to provision a Network Assistance Session resource. The Network Assistance Resource can then be used to obtain bit rate recommendations and to issue delivery boost requests during the ongoing media streaming session.

### 11.6.2 Resource structure

The Network Assistance API is accessible via the following URL base path:

*{apiRoot}*/3gpp‑m5/v1/network-assistance/

Table 11.6.2‑1 below specifies the operations and the corresponding HTTP methods that are supported by this API. In each case, the sub-resource path specified in the second column of the table shall be appended to the URL base path.

Table 11.6.2-1: Operations supported by the Network Assistance API

|  |  |  |  |
| --- | --- | --- | --- |
| Operation | Sub‑resource path | Allowed HTTP method(s) | Description |
| Create Network Assistance Session resource |  | POST | Provision a new Network Assistance Session.  If the operation succeeds, the URL of the created Network Assistance Session resource shall be returned in the Location header of the response. |
| Fetch a Network Assistance Session resource | {naSessionId} | GET | Fetch the properties of an existing Network Assistance Session. |
| Update a Network Assistance Session resource | {naSessionId} | PUT,  PATCH | Update the properties of an existing Network Assistance Session. |
| Request a bit rate recommendation | {naSessionId}/recommendation | GET | Obtain a bit rate recommendation for the next recommendation window. |
| Request a delivery boost | {naSessionId}/boostRequest | POST | Request a delivery boost for the next recommendation window. |
| Terminate Network Assistance Session | {naSessionId} | DELETE | Terminate a Network Assistance session. |

### 11.6.3 Data model

#### 11.6.3.1 NetworkAssistanceSession resource

The NetworkAssistanceSession resource is specified in table 11.6.3.1-1 below.

Table 11.6.3.1-1: Definition of NetworkAssistanceSession resource

| Property name | Type | Cardinality | Usage | Description |
| --- | --- | --- | --- | --- |
| naSessionId | String | 1..1 | C: RO  R: RO  U: RO | Unique identifier for this Network Assistance Session. |
| serviceDataFlowInformation | Array(ServiceDataFlowDescription) | 0..1 | C: RW  R: RO  U: RW | Identification of the application flows for the media streaming session for which Network Assistance is to be used, e.g. 2-tuple (IP addresses) or 5-tuple (IP Addresses, protocol and ports). |
| policyTemplateId | String | 0..1 | C: RW  R: RO  U: RW | Identification of the policy that is in force for the media streaming session. |
| requestedQoS | M5QoSSpecification | 0..1 | C: RW  R: RO  U: RW | The requested QoS parameters. |
| recommendedQoS | M5QoSSpecification | 0..1 | C: RO  R: RO  U: RO | The QoS parameters currently recommended by the 5GMS AF. |
| notficationURL | String | 0..1 | C: RO  R: RO  U: RO | A URL to the MQTT channel over which notifications are to be sent by the 5GMS AF for this session. When set, the Media Session Handler shall subscribe to this channel. The notification messages shall be in the form of the M5QoSSpecification data type. |

### 11.6.4 Operations

The 5GMS Client uses the POST method to create a Network Assistance session with the 5GMS AF. The AF returns the Network Assistance session identifier if session setup was successful, otherwise an error code is returned without a Network Assistance session identifier.

The 5GMS Client uses the Network Assistance session resource identifier (naSessionId) provided by the AF to refer all subsequent API calls to the AF applicable to that Network Assistance session.

The 5GMS AF populates the Network Assistance session resource with the service data flow information and optionally the policy template identifier that are valid for the media streaming session for which Network Assistance operations are to be performed. The AF uses this information to execute Network Assistance operations in the 5GC.

The 5GMS Client uses the GET method with the Network Assistance Session resource identifier to retrieve a Network Assistance Session resource from the 5GMS AF. The AF returns the Network Assistance Session resource if retrieval was successful, otherwise an appropriate error code is returned without the session resource in case of failure.

The 5GMS Client uses the GET method with the sub-resource path specified in Table 11.6.2‑1 to request a bit rate recommendation from the 5GMS AF. The 5GMS AF shall return the recommended bit rate in an HTTP response body of type M5QoSSpecification if a bit rate recommendation could be obtained, otherwise an appropriate HTTP error code shall be returned with no response body.

* For a downlink media streaming session, the recommended minimum and maximum downlink bit rates shall be indicated in the properties mirBwDlBitRate and marBwDlBitRate, respectively. ia
* For an uplink media streaming session, the recommended minimum and maximum uplink bit rates shall be indicated in the properties mirBwUlBitRate and marBwUlBitRate, respectively. The 5GMSu Client shall ignore the mandatory properties related to downlink streaming, i.e. mirBwDlBitRate and marBwDlBitRate.

If a unique recommendation is given by the 5GMSd AF then this recommended bit rate shall be set in both of these properties. The optional properties minDesBwDlBitRate, minDesBwUlBitRate, desLatency and desLoss shall not be included in the response.

The 5GMS Client uses the POST method with the sub-resource path specified in Table 11.6.2‑1 to request a delivery boost from the 5GMS AF. The 5GMS AF shall respond with the OperationSuccessResponse data type indicating whether or not the delivery boost will be attempted by the network within an upcoming nominal time period.

The 5GMS Client uses the PUT or PATCH methods to replace the existing steaming session parameters with new settings. The 5GMS AF returns the NetworkAssistanceSession resource with settings resulting from the PUT or PATCH update operation.

The 5GMS Client uses the DELETE method to terminate the indicated Network Assistance session. The 5GMS AF returns an appropriate response code. If the termination was successful, then any subsequent calls referring to the terminated session will result in the error 404 (Not Found).

END OF 7th CHANGE