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Foreword

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1 Scope

The present document describes the enhancement of Quality of Experience (QoE) for operator managed streaming service, 3rd party managed streaming service and Over-The-Top (OTT) streaming service.

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] Yiting Liao, et al. "Achieving high QoE across the compute continuum: How compression, content, and devices interact." 7th International Workshop on Video Processing and Quality Metrics for Consumer Electronics, Scottsdale, Arizona, USA. 2013.

[3] ITU-T SG12 "T13-SG12-150505-TD-GEN-0671!R1!MSW-E-P.NATS Terms of Reference (ToR)".

[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] 3GPP TS 26.233: "Transparent end-to-end packet switched streaming service (PSS); General description".

[6] 3GPP TR 26.938: "Packet-switched Streaming Service (PSS); Improved support for dynamic adaptive streaming over HTTP in 3GPP".

[7] 3GPP TS 26.244: "Transparent end-to-end packet switched streaming service (PSS); 3GPP file format (3GP)".

[8] Recommendation ITU-R BT.500: "Methodology for the subjective assessment of the quality of television pictures".

[9] DASH-IF Position Paper: "Proposed QoE Media Metrics standardization for segmented media playback": http://dashif.org/wp-content/uploads/2016/10/ProposedMediaMetricsforSegmentedMediaDelivery-r12.pdf

[10] ISO/IEC 23001-10: "Information technology -- MPEG systems technologies -- Part 10: Carriage of timed metadata metrics of media in ISO base media file format".

[11] 3GPP TS 32.422: "Telecommunication management; Subscriber and equipment trace; Trace control and configuration management".

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].

A/V MOS Audio/Video Mean Opinion Score

IQoE	Improved Quality of Experience
DASH	Dynamic Adaptive Streaming over HTTP
KPI	Key Performance Indicators
KQI	Key Quality Indicator
MDT	Minimization of Drive Tests
MNO	Mobile Network Operator
MOS	Mean Opinion Score
MOS-AVQO	Audio-Visual-Quality-Objective
MPD	Media Presentation Description
OTT	Over The Top
PSS	Packet Streaming Server
TCE	Trace Collection Entity
VSSQM	Video Streaming Service Quality Monitoring

4 A/V Quality Monitoring Support for 3GPP PSS

4.1 WebTV Quality Monitoring

4.1.1 Use case

Over-The-Top video streaming is increasingly dominating the traffic in the networks. An increasing number of services employing a variety of streaming formats are appearing. In addition, movie services are increasingly causing traffic in mobile networks.

It is crucial for mobile network operators to manage the video traffic in their networks and services in an optimal manner. A major objective is to ensure that the customers remain satisfied. Hence monitoring the users QoE with an appropriate quality indicator is of fundamental importance.

The derivation of quality indicators for the streaming quality may be supported by the service to a lesser or greater extend. Further dedicated agreements between mobile operator and service provider would help to obtain better quality indicators. The level of accuracy on the quality indicator would depend on the level of agreement between the mobile network operator and the service provider.

The main Key Performance Indicators (KPIs) for characterizing insufficient video streaming performance as perceived by the user are:

- initial stalling of the playout;
- periods of stalling and freezing of the video while playing;
- interruption of the audio while playing;
- low coding quality appearing as blurring, macroblocking or mosquito artefacts;
- varying coding quality while playing.

Beside these KPIs the monitoring system will also provide a Key Quality Indicator (KQI) characterizing the user's quality experience.

Quality is fundamentally related to the subjective assessment of the considered aspect. The KQI will be related to corresponding subjective quality assessments. The quality often is rated as an opinion score on a 5-point scale ranging from "bad" (1), "poor" (2), "fair" (3), "good" (4) to "excellent" (5). The average of these scores calculated from a group of subjects is the Mean Opinion Score (MOS).

For operational tasks instrumental measurement tools are required. Hence, the subjective test results are used to develop instrumental methods that replicates the MOS scores obtained in subjective tests. Ideally, the derived quality model will be established as internationally agreed standard specification, for increasing the confidence that the measured quality results are reliable and comparable. The estimated MOS values will be labelled as result stemming from an objective model. For example, the estimated AV-streaming MOS could be named MOS-AVQO (Audio-Visual-Quality-Objective).

The use of a KQI, estimating the MOS of a video streaming session has the major advantage of combining the quality impact of occurring stalling and coding effects in a single number. By this means the service can be monitored efficiently.

In addition to the KPIs and KQI, further the related data such as time, location, service and network will be collected for each considered streaming session.

The use case "WebTV Quality Monitoring" demands for means that allow collecting accurate KPIs and the audio-visual KQI for supporting the quality management of the networks and customer services. The collected KPI and KQI data supports a wide range of utilizations such as the short-term detection of problems and the long term quality monitoring. With additional other monitoring data sources, the complete delivery chain, from server, via networks, to the user's terminal can be observed. Data analytics methods can be applied to reveal inherent quality dependencies. The detection of critical combinations of KPIs with the help of a KQI focuses on the user's quality experience and is therefore very efficient. In conclusion, the MOS-AVQO is foreseen as mean to increase the usefulness of the quality monitoring systems significantly.

4.1.2 Potential Recommended requirements

The proposed potential requirements for implementing the WebTV Quality Monitoring use case are based on the assumption that the user's end device is collecting and aggregating the QoE-related data. The collected QoE-related data then is further processed and forwarded to a central QoE monitoring server in a next step:

- The monitoring software of the end device can provide a generic applicable subsystem for Video Streaming Service Quality Monitoring (VSSQM).
- The VSSQM subsystem provides an API for logging QoE related events. The API provides a handler for receiving and digesting QoE related events and for retrieval of QoE-related data to be reported to a QoE Server using an appropriate communication channel.
- VSSQM subsystem provides an API for third party QoE monitoring applications running on the end device. This API allows retrieving the aggregated QoE-related data. The QoE monitoring application may transmit the QoE-related data to a third party QoE Monitoring Service.

Figure 4.1-1 illustrates the Video Streaming Service Quality Monitoring subsystem with the provided API's for QoE-related event logging and for QoE data digestion.

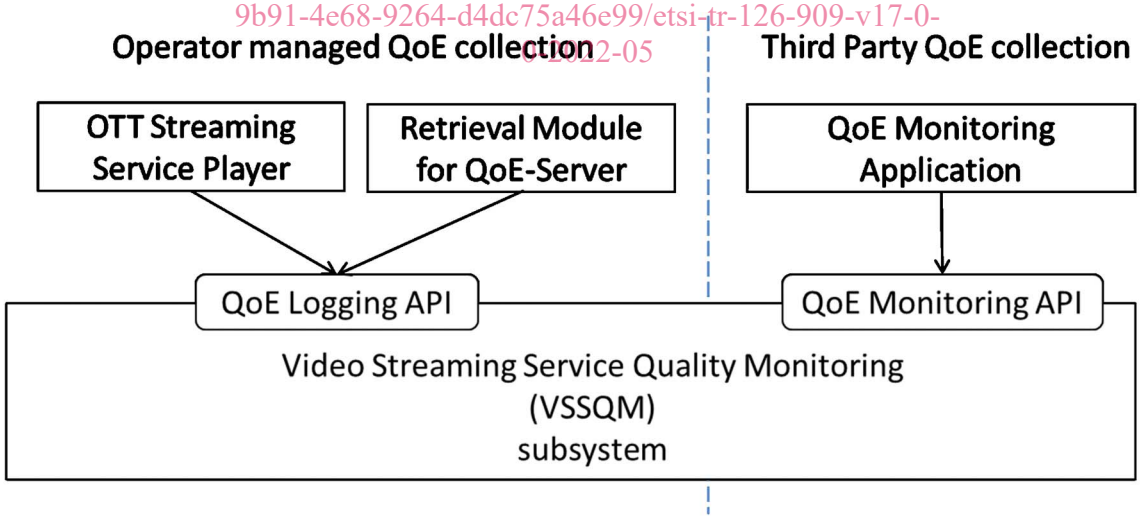

Figure 4.1-1: Proposed subsystem for logging and digesting QoE-related data for Video Streaming Service Quality Monitoring

Detailed proposed requirements for the VSSQM Logging API

1. The VSSQM subsystems provides an interface for registering video streaming service and its player for monitoring the play-out performance
2. The player of the streaming service is recommended to support the sending of following events:

- AnouncementOfVideoStreamingSession (ServiceProvider)
- InitialisingPlayer (AudioCodec, VideoCodec, Profile)
- ChangeProfile (Profile)
- LoadingContent (SourceIP)
- Playing
- BitrateReport(Audio,Video)
- Stalling
- Pause
- ScrollForward
- ScrollBackward

3. The mobile clients provides additional related information such as:
   - Time
   - Location
   - Network: 2G, 3G, 4G, Cell-ID, WLAN
   - Route: Source IP, destination IP, …
   - Device: brand, screen parameters, headphones, processing power, battery usage

The VSSQM subsystem would collect this information via the appropriate API's in that moment when the player event is processed.

4. The QoE Logging API supports the retrieval of the raw QoE data with different aggregation levels. A QoE data retrieval module forwards these reports to a QoE server using an appropriate communication channel.

5. Video streaming traffic may be monitored also with a traffic analysis tool operating on the client network interface. Such a tool would register at the VSSQM in the same manner as streaming services. The tool may help to observe video streams that do not register and provide QoE related monitoring events.

Detailed proposed requirements for the QoE Monitoring API

6. The QoE Monitoring API allows deriving aggregated QoE reports. A third party monitoring application can process the data and forward derived QoE reports to a third party QoE server.

7. The QoE Monitoring Application may support to derive the following metrics:
   - Initial stalling of the playout
   - Periods of stalling and freezing of the video while playing
   - Interruption of the audio while playing
   - Statistics on coding quality
   - Statistics on varying coding quality while playing
   - Estimation on overall audio-visual quality (MOS-AVQO)

4.2 ITU-T P.NATS Quality Assessment Model for HTTP Adaptive Streaming

ITU-T P.NATS project ([3]) will develop the objective assessment model for progressive download and adaptive type media streaming. It supports both the OTT and operator managed video service. The supported protocol scope includes HTTP/TCP/IP, RTMP/TCP/IP, HLS/HTTP/TCP/IP, and DASH/HTTP/TCP/IP. It supports 3GPP, MP4 and other file format, and the model is agnostic to the type of file format.

It will support sequence duration of 60 sec to 5 min for quality evaluation. The supported video resolution is 240p, 360p, 480p, 720p and 1080p. The supported frame rate range is 8 to 50 fps.

ITU-T P.NATS phase 2 aims at extending the quality model for supporting 2K and 4K.

The current working model agreed in P.NATS project is depicted in figure 4.2-1.

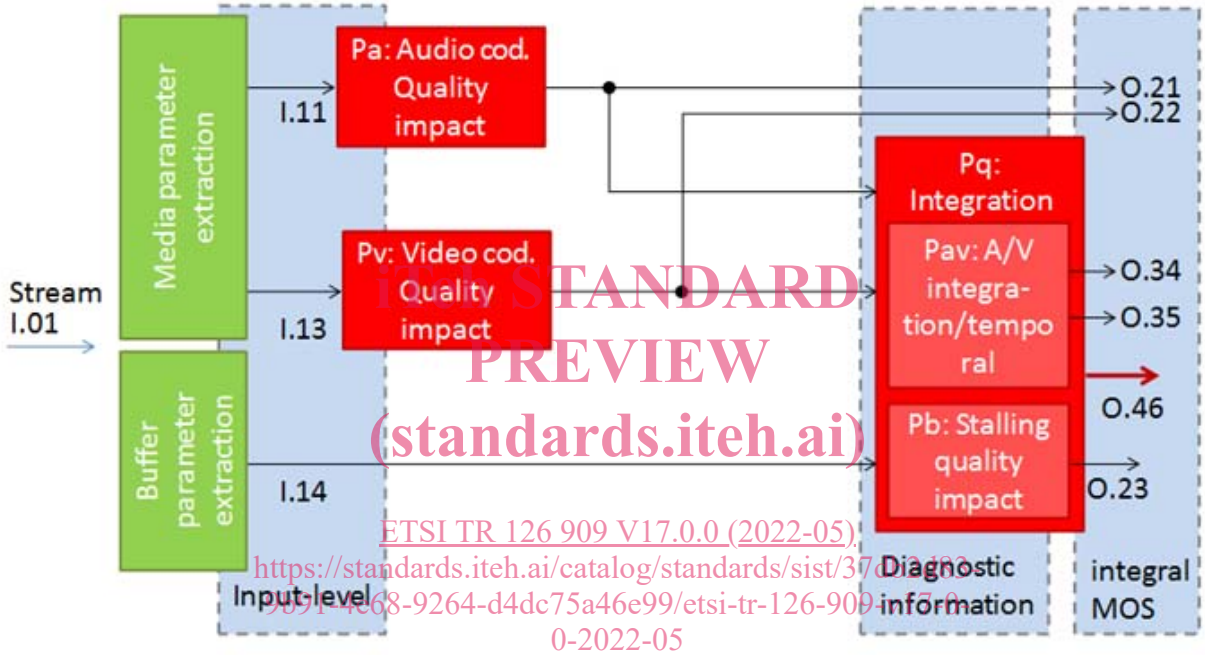

Figure 4.2-1: Building blocks of the P.NATS model

As shown in table 4-1, P.NATS will support 4 modes.

Table 4-1: Different modes defined in P.NATS

Mode	Encryption	Input
0	Encrypted media payload and media frame headers	Meta-data
1	Encrypted media payload	Meta-data and frame header information
2	No encryption	Meta-data and up-to 2% of the media stream
3	No encryption	Meta-data and any information from the video stream

The P.NATS model will receive media information and prior knowledge about the media stream or streams. The model receives the following input signals regardless of the mode of operation:

- I.GEN: display resolution and device type
- I.11: audio coding information
- I.13: video coding information

- I.14: Stalling events

The P.NATS model input parameters are provided in table 4-2 below.

Table 4-2: ITU-T P.NATS model input parameters.

ID	Description	Values	Frequency	Modes available
I.GEN				
0	The resolution of the image displayed to the user	Number of pixels (WxH) in displayed video	Per media session	All
1	The device type on which the media is played	pc or mobile	Per media session	All
I.11				
7	Target Audio bit-rate	Bit-rate in kbps.	Per media segment	All
8	Segment duration	Duration in seconds	Per media segment	All
9	Audio frame number	Integer, starting with 1	Per media segment	1,2,3
10	Audio frame size	Size of the frame in bytes	Per audio frame	1,2,3
11	Audio frame duration	Duration in seconds	Per audio frame	1,2,3
12	Audio codec	One of: AAC-LC, AAC-HEv1, AAC-HEv2, AC3	Per media segment	All
13	Audio sampling frequency	In Hz	Per media segment	All
14	Number of audio channels	2	Per media segment	All
15	Audio bit-stream	Encoded audio bytes for the frame	Per audio frame	2,3
I.13				
16	Target Video bit-rate	Bit-rate in kbps.	Per media segment	All
13	Video frame-rate	Frame rate in frames per second.	Per media segment	All
14	Segment duration	Duration in seconds	Per media segment	All
15	Video encoding resolution	Number of pixels (WxH) in transmitted video	Per media segment	All
16	Video codec and profile	One of: H264-baseline, H264-high, H264-main	Per media segment	All
17	Video frame number	Integer, starting at 1, denoting the frame sequence number in encoding order.	Per video frame	1,2,3
18	Video frame duration	Duration of the frame in seconds	Per video frame	1,2,3
19	Frame presentation timestamp	The frame presentation timestamp	Per video frame	1,2,3
20	Frame decoding timestamp	The frame decoding timestamp	Per video frame	1,2,3
21	Video frame size	The size of the encoded video frame in bytes	Per video frame	1,2,3
22	Type of each picture	"I" or "Non-I" for mode 1	Per video frame	1,2,3
23	Video bit-stream	Encoded video bytes for the frame	Per video frame	2,3
I.14				
22	Buffering event start	The start time of the buffering/stalling event in seconds relative to the start of the original video clip, expressed in media time (not wall clock time) NOTE: This is 0 for initial buffering.	Per buffering/ stalling event	All
23	Event duration	The duration of the buffering/stalling event in seconds.	Per buffering/ stalling event	All

The P.NATS model outputs are as follows:

- O.21: Audio coding quality per output sampling interval
  - Multiple segment scores provided per session and on a 1-5 quality scale.

- O.22: Video coding quality per output sampling interval
  - Multiple segment scores provided per session and on a 1-5 quality scale.
- O.23: Perceptual buffering indication
  - Single score on a 1-5 quality scale for the session.
- O.34: Audiovisual segment coding quality per output sampling interval.
  - Multiple segment scores provided per session.
  - Window-size same as for/synced with O.21, O.22
- O.35: Final audio-visual coding quality score
  - Single score for the session, on a 1-5 quality scale.
  - Includes aspects of temporal integration.
- O.46: Final media session quality score
  - Single score for the session, on a 1-5 quality scale.
  - Includes initial buffering and stalling aspects.

4.3 Gap analysis of PSS QoE metrics for support of ITU-T P.NATS

4.3.1 Supported Mode

For operator managed streaming service, media information, prior knowledge about the media stream and/or stream is visible to the operator, which mode can be configured by the operator. The P.NATS mode selection is the tradeoff between quality assessment accuracy and processing complexity.

For OTT streaming service, stream information is not visible to the operator any more especially if HTTPs is in place. P.NATS mode 1 to 3 does not apply to OTT streaming service any more.

It is proposed to introduce Mode 0 for both OTT and operator managed streaming service. Other Mode is FFS.

4.3.2 Supported Input parameter

In order to support Mode 0 quality assessment, the required parameter is listed in table 4-3 below.