Draft Recommendation G.IPTV-PMR

IPTV Performance Monitoring and Reporting

1   Scope

This draft Recommendation defines the aggregation and reporting model for IPTV services. The key use cases for IPTV performance management are described, and for each use case an aggregation and reporting model is defined. This draft Recommendation does not define new metrics but refers to those e.g. defined in ITU-T draft Recommendation G.IPTV-PMPD (Performance Monitoring Parameter Definitions).

Key measurement points in an IPTV network are specified in ITU-T Rec. G.1081.

[Editors' Note: During the development of this Recommendation the need for additional metrics may be identified. If metrics are simple and generic (i.e. time duration) or are summarizations (e.g. min, max, average) they may be defined in this document however any primary metrics that relate to aspects of IPTV performance should be incorporated into the appropriate Recommendation.]

2   Introduction

It is desirable to measure the performance of IPTV services at various points in the path from head-end to IPTV set top box to ensure that service levels are maintained and to determine the nature and cause

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of problems affecting service quality. This document defines the sets of metrics and associated aggregation and reporting models for several key points in the IPTV delivery path. The means for measuring or calculating the value of a metric and the definition of the protocol used for reporting are not part of this document.

The three key monitoring points identified are the "head-end" which generally refers to a point at which a large subset of the IPTV streams are continuously accessible for monitoring, the "customer-network access" which refers to a point at which the specific stream being viewed by the subscriber is accessible, and the "set top box" which refers to a point at which a specific stream is terminated and connected to a display device.

The approach to performance monitoring described in this draft Recommendation provides continuous visibility of IPTV service quality and the ability to identify problems affecting specific channels or individual subscribers. This permits the service provider to recognize problems before subscribers register complaints and hence reduces periods of degraded service.

3   References

The following ITU-T Recommendations and other references contain provisions, which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T.G.1081]   ITU-T recommendation G.1081 (2008), Performance Monitoring Points for IPTV

4   Definitions

This Recommendation uses or defines the following terms:

TBD

5   Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAA   Authentication, Authorization, and Accounting

AAASR   AAA Success Rate

BER   Bit Error Rate

CAT   Conditional Access Table

CMTS   Cable Modem Termination System

CR   Correctness Rate

CSR	Connection Success Rate
CT	Connect Time
DSLAM	DSL Access Multiplexer
EPG	Electronic Program Guide
GoP	Group of Pictures
HTML	HyperText Markup Language
HTTP	Hyper Text Transfer Protocol
IGMP	Internet Group Management Protocol
MER	Modulation Error Ratio
MI	Metadata Integrity
MOS	Mean Opinion Score
MV	Metadata Validity
NMS	Network Management System
MOS	Mean Opinion Score
ONU	Optical Network Unit
PESQ	Perceptual Estimation of Speech Quality
PID	Program Identifier
PMF	Performance Monitoring Function
QoE	Quality of Experience
QoS	Quality of Service
RED	Random Early Discard
RF	Radio Frequency
RTCP	RTP Control Protocol
RTP	Real Time Protocol
SI	System Information
SJ	Streaming Jitter
STB	Set-Top Box
TS	Transport Stream
VOD	Video on Demand
XML	Extensible Markup Language
XR	Extended Report

6   Monitoring points

Performance monitoring points are defined in a ITU-T Rec. G.1081. The following picture has been borrowed from G.1081 for reference throughout the rest of this document. Each of the measurement points will only briefly be outlined. For a full explanation the reader is referred to G.1081.
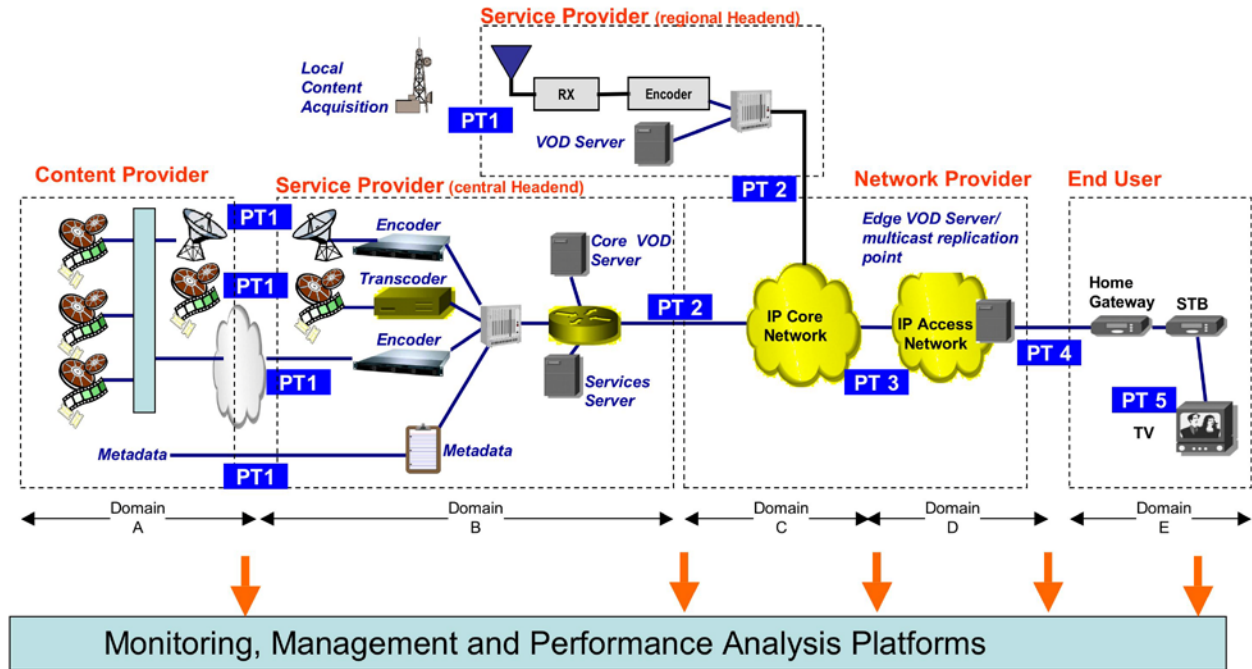

Figure 1 - Key Monitoring Points in an IPTV Network

6.1   Monitoring point 1 – PT1

This point demarcates the domain border between content provision and IPTV control. PT1 is located at the domain border between content providers (content owners and aggregators) and IPTV Service provider.

6.2   Monitoring point 2 – PT2

This point is located at the domain border between the service provider and network provider. It should aim for original streaming quality monitoring. PT2 monitors the service provider stream quality at the head-end egress.

6.3   Monitoring point 3 – PT3

This point is located at the boundary between the IP core and IP edge networks for monitoring of IP-related performance parameters. This point can be placed on any type of interface between the IPTV core network and the edge network.

6.4   Monitoring Point 4 – PT4

This point is closest to the user where monitoring the quality of streaming, audio-visual quality, and IPTV service attributes are important. Monitoring at this point can be implemented by introducing the performance monitoring function in Home Gateways and STBs, for example.

6.5   Monitoring point 5 – PT5

This point is at the final end-point and directly relates to end-user QoE. Monitoring audio-visual quality, text accuracy and IPTV service attributes as perceived by the end-user are important.

7   Monitoring parameters

Monitoring parameters are defined in a companion ITU-T draft Recommendation G.IPTV-PMPD.

8   Key Measurement Use Cases

8.1   Head-End Monitoring – PT1 and PT2

The objective of head-end monitoring is to verify that the IP video streams delivered to the network are of sufficient quality and within pre-determined limits or specifications. This use case is similar to the situation where an IP video stream is being accepted from another service provider.

There are two aspects of head-end monitoring:

(i) Measurement of video stream performance

This requires the measurement of key aspects of each video stream to be measured to provide performance information to support problem identification, network capacity planning and service optimization.

Typical parameters that would be measured at the head-end for each stream include:

Editor's Note: The following list depicts an excerpt of a parameter table in G.IPTV-PMPD. This list was placed here for the reasons to compare the original version of this document and the resulting version due to the request by the members of Q.13 to provide a more complete line-up with the existing G.IPTV-PMPD.

Monitoring Parameters	PT1	PT2
IP Layer/network Parameters		
Packet Loss	(✔)	
Packet Jitter	(✔)	
IP Flow List	(✔)	✓
Link IP Layer Used Bandwidth	(✔)	✓
Link IP Layer Avail Bandwidth	(✔)	✓
End-to-End IP Layer Bandwidth	(✔)	✓
End-to-End IP Layer Avail Bandwidth	(✔)	✓
Loss Run Length Distribution	(✔)	✓
Error Free Interval Distribution	(✔)	✓

Monitoring Parameters	PT1	PT2
Other Packet Loss Metrics & Models	(✓)	✓
Streaming Jitter	(✓)	✓
Packet Loss Rate	(✓)	✓
Out of Order Packet Rate	(✓)	✓
Burst Loss Rate	(✓)	✓
Gap Loss Rate	(✓)	✓
Mean Gap Length	(✓)	✓
Mean RTP Burst Length	(✓)	✓
Loss Period Count	(✓)	✓
IP Maximum Loss Period	(✓)	✓
Retransmissions	(✓)	✓
Transport Layer Parameters		
ETSI TR 101 290 P1	✓	✓
ETSI TR 101 290 P2	✓	✓
ETSI TR 101 290 P3	✓	
Service Line-Up Paramters		
Channel Line-Up		✓
Service Metadata	✓	✓
Channel Attribute Parameters		
Channel Attributes	✓	✓
Video Quality	✓	✓
Audio Quality	✓	✓
Video Blackout	✓	✓
Video Freeze Frame	✓	✓
Video Impairment	✓	✓
Audio Tone/Silence	✓	✓
Ancillary Channel Associated Attributes	✓	✓
Other Parameters		
AAA Success Rate		✓
AAA Time		✓

(✓) : Only for content over IP contribution at Monitoring Point PT1

Editor's Note: Following Channel Attributes are not yet defined in G.IPTV-PMPD but are listed in this draft for discussion to be included into G.IPTV-PMPD:
- I/B/P Frame Bandwidth
- Inter-I Frame Gap (Distance between I and/or P-frames)
- Packet Delay Variation (IPDV) due to smoothing (Editor's note: IPDV needs clarification; maybe any of the metrics below are actually meant)
  - MAPDV Mean Absolute Packet Delay Variation (ITU-T G.1020)
  - PPDV Packet to Packet Delay Variation (RFC3550)

(ii) Verification of IP video streams against expected behavior/ configuration

This requires a definition or profile for each IP video stream or class of IP video stream to be defined.

A profile may include the following information for example:

- Codec types permitted (Video, Audio)
- Image resolutions permitted (SD, HD, 1080i….)
- Scrambled/ Unscrambled
- Nominal video bandwidth limits (high/ low)
- Peak bandwidth
- Video MOS threshold
- Audio MOS threshold
- GoP size limits
- Time threshold for blank or still video

The head-end monitoring system measures or detects each of these parameters for each video stream and compares them to the defined profile. If any stream fails to meet the defined profile then an alarm is generated.

8.2   Subscriber Experience Monitoring – PT4 and PT5

It is essential to monitor the user experience (QoE) of the collective subscriber base, in order to estimate overall service quality and to identify and localize problems. In general it is desirable to do this with a minimal set of metrics in order to reduce the volume of reporting data and eliminate unnecessary data storage. The preferred location of a monitoring point for subscriber QoE monitoring is the IP set top box or home gateway, and/or the subscriber-network interface (for example ONU).

An individual subscriber will watch a single channel (video stream) at a time, which means that the monitoring function in an IP STB would typically see only one channel. If the subscriber selects a channel that has low quality, they may well change to another channel that has better quality. From the overall QoE perspective this would suggest that their experience was fairly good (as they are spending less time on the poor quality channel) however in reality they would obviously retain an opinion concerning the degraded quality channel and the service as a whole. This means that it is important to build a view of the subscriber experience in terms of both channel and service.

The parameters that should be measured include:

- Video/Audio MOS, PLR- aggregated per channel viewed
- Video/Audio MOS, PLR - aggregated across channels viewed
- Channel availability - measuring the extent to which requested channels were available when requested by the subscriber
- Peak bandwidth - which may be limited by the subscriber access connection or home network

8.3   Subscriber Problem Diagnosis – PT4 and PT5

There are several approaches to subscriber problem diagnosis. The summary data reported from each IP STB can be correlated to identify if problems are specific to particular channels, groups of subscribers, types of equipment, subscriber access bandwidth. Alternatively, an IP STB can be

requested to report a more comprehensive set of metrics to help with the diagnosis of a specific subscriber issue.

8.4   Network Problem Diagnosis – PT3, PT4 and PT5

Network problems will generally affect multiple subscribers. The summary data reported from each IP STB can be correlated with the IP STB's location within the network and hence certain classes of network problem identified. This would also assist with the location of transient network problems that may have a significant overall service impact but which may not impact an individual subscriber enough for them to complain.

9   Aggregation and Reporting Models

9.1   Head-End Monitoring

An IPTV performance monitoring function located at the head-end will in general be able to see multiple continuous broadcast/ multicast IPTV streams that will be unaffected by subscriber channel changes and may also see video-on-demand streams that would be discontinuous in nature.

 (i) Reporting Model

Metrics must be aggregated over a predetermined time period, for example 15 minutes. A PMF may be configured to report these metrics at, or shortly after, the end of the measurement period and may be configured to report these metrics on a sampled basis or if a metric value exceeds or is below some threshold value. The Report may be communicated to a performance management function using either a push or pull reporting model.

(ii) Aggregation Model

The following metrics should be accumulated over the measurement period. Most metrics are reset at the end of the measurement period, with the exception of the "time on channel" measurement.

Object	Metric	Comments
Per-Channel Performance	Video Quality	For each channel
	Mean Video bandwidth	
	Peak Video bandwidth	
	I, B, P frame bandwidth	
	GoP size	
	Inter-I frame Gap	
	Blank/Frozen video duration	
	Frame rate	
	Audio Quality	
	Silenced audio duration	

	Sampling rate	
	Mean Audio bandwidth	
	Peak Audio bandwidth	
	TR101290 Errors	
Per-Channel Profile	Video Codec	For each channel
	Audio Codec	
	Image resolution	
	Scrambling state	
	Nominal Video Bandwidth	
	Peak Bandwidth	
	Video Quality threshold	
	Audio Quality threshold	
	GoP size threshold (?)	
	Blank/frozen video time threshold	
	Silenced audio time threshold	
Per Network Interface	Audiovisual Quality	Across all channels monitored at a network interface
	Packet Loss Rate	
	Peak Network Bandwidth	
Per Service	Audiovisual Quality	For example HD, SD, VoD
	Packet Loss Rate	
	Peak Network Bandwidth	
	Peak Video Bandwidth	

9.2 Subscriber Experience Monitoring

9.2.1 IP STB Requirements

An IPTV set top box will in general "see" a small set of IPTV streams, for example a single stream, a single stream plus picture-in-picture, a stream being watched and a secondary stream being recorded. These streams will be discontinuous as the user may change channel.

A performance monitoring function (IPTV PMF) integrated within an IPTV Set Top Box that complies with this Recommendation must support the following metrics aggregation and reporting requirements:

(i) Reporting Model

Metrics must be aggregated over a predetermined time period, for example 15 minutes. A PMF may be configured to report these metrics at, or shortly after, the end of the measurement period and may be configured to report these metrics on a sampled basis or if a metric value exceeds or is below some threshold value. The Report may be communicated to a performance management function using either a push or pull reporting model; in general a push model is more efficient and is able to traverse firewall functionality integrated into customer premise routers.

(ii) Aggregation Model

The following metrics should be accumulated over the measurement period. Most metrics are reset at the end of the measurement period, with the exception of the "time on channel" measurement.

Object	Metric	Comments
Overall Experience	Video Quality	Across all channels watched
	Audio Quality	
	Packet Loss Rate	
	Peak Network Bandwidth	
	Peak Video Bandwidth	
	Channel Change Delay	
Per-Channel	Video Quality	For each channel watched
	Audio Quality	
	Minimum Video Quality	
	Time spent on Channel	
	Packet Loss Rate	
	TR101290 Errors	

9.2.2 Subscriber-Network Interface

An IPTV performance monitoring function integrated into a Subscriber-Network Interface device such as an ONU will need to measure the performance of multiple discontinuous IPTV streams

A performance monitoring function (IPTV PMF) integrated within a subscriber-network interface device that complies with this Recommendation must support the following metrics aggregation and reporting requirements:

(i) Reporting Model

Metrics must be aggregated over a predetermined time period, for example 15 minutes. A PMF may be configured to report these metrics at, or shortly after, the end of the measurement period and may be configured to report these metrics on a sampled basis or if a metric value exceeds or is below some threshold value. The Report may be communicated to a performance management function using

either a push or pull reporting model; in general a push model is more efficient and is able to traverse firewall functionality integrated into customer premise routers.

(ii) Aggregation Model

The following metrics should be accumulated over the measurement period. Most metrics are reset at the end of the measurement period, with the exception of the "time on channel" measurement.

Object	Metric	Comments
Overall Experience	Audiovisual Quality	Across all channels watched for all IP STB's
	Packet Loss Rate	
	Peak Network Bandwidth	
	Peak Video Bandwidth	
	Channel Change Delay	
Per-Channel	Mean audiovisual quality	For each channel watched
	Minimum audiovisual quality	
	Time spent on Channel	
	Packet Loss Rate	
	TR101290 Errors	

9.2.3   Overall Subscriber Experience Monitoring Requirements

9.2.4   Subscriber Problem Diagnosis

9.3   Network Problem Diagnosis

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