INTERNATIONAL TELECOMMUNICATION UNION

TELECOMMUNICATION STANDARDIZATION SECTOR

STUDY PERIOD 2005-2008

FOCUS GROUP ON IPTV

FG IPTV-C-xxx

English only

WG(s): 2

3rd FG IPTV meeting:
Mountain View, CA, USA, 22-26 Jan 2007

CONTRIBUTION

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Title: IPTV QoS/QoE Metrics

1. Introduction

This contribution proposes a set of IPTV QoS/QoE metrics grouped into key layers – *Transport Metrics*, *Video Stream Metrics* and *Perceptual Quality Metrics*.

- *Perceptual Quality Metrics* provide high level Video and Audio Quality of Experience (QoE) scores, giving immediate visibility of the impact of a wide range of impairments on user perceived quality
- *Video Stream Metrics* provide essential visibility into the performance and configuration of the encoded video stream.
- *Transport Metrics* provide key information on performance of IP, UDP, FEC, RTP and MPEG transport protocols, which are typically the major source of transient video quality problems.

2. Perceptual Quality Metrics

These metrics provide high level QoS scores for Video, Audio and overall quality, giving visibility of the impact of a wide range of impairments.

Perceptual Quality Metrics	
Metric	***Description***
MOS-V	Video MOS, a 1-5 score that considers the effect of the video codec, frame rate, packet loss distribution and GoP structure on viewing quality [1]
MOS-A	Audio MOS, a 1-5 score that considers the effect of the audio codec, bit rate, sample rate and packet loss on viewing quality [1]
MOS-AV	Audio-Video MOS – a 1-5 score that considers the effect of picture & audio quality and audio-video synchronization on overall user experience [1]
Video Service Transmission Quality (VSTQ)	Transmission quality, a 0-50 codec independent score measuring the ability of the IP network to carry reliable video [1]
MOS-C	Control plane MOS, a 1-5 score that provides a measure of control interactions such as channel change on user perceived quality
Estimated PSNR (EPSNR)	Estimated Peak Signal to Noise Ratio (PSNR) expressed in dB. This is an estimate of the distortion that has occurred between the source video stream and the output video stream.

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3. Video Stream Metrics

The Video Stream Description provides information on the type of codec being used, Group of Pictures structure and length, image size and other key factors.

Video Stream Description	
Metric	***Description***
Codec type	Type of codec (e.g. MPEG4)
GoP type	Group of Pictures type (e.g. IBBP…)
GoP length	Number of frames in Group of Pictures
Image size	Image size in pixels (X x Y)
Frames per second	Number of frames per second
Scan type	Interlaced/ Progressive scan

Video Stream Metrics provide insight into the proportion of different type of video frame that are impacted by packet loss and discard, and to the overall video bandwidth.

Video Stream Metrics	
Metric	***Description***
Proportion of I frames impaired	Percentage of I frames impaired by loss/discard
Proportion of P frames impaired	Percentage of P frames impaired by loss/discard
Proportion of B frames impaired	Percentage of B frames impaired by loss/discard
I, P, B frame packets received	Counts of the numbers of I, P and B frame packets received
I, P, B frame packets lost	Counts of the numbers of I, P and B frame packets
I, P, B frame packets discarded	Counts of the numbers of I, P and B frame packets
Mean bandwidth	Average video bandwidth excluding IP overhead, FEC and retransmissions
Peak bandwidth	Peak video bandwidth excluding IP overhead, FEC and retransmissions

4. Transport Metrics

Packet Loss Metrics provide essential data on IP packet loss before and after the effects of error correction (such as FEC or Reliable UDP). Burst and gap statistics provide valuable insight into the time distribution of lost and discarded packets.

Packet Loss Metrics	
Metric	***Description***
Uncorrected Packet Loss Rate	Percentage of IP packets lost in the network [1]
Corrected Packet Loss Rate	Packet loss rate after correction by Forward Error Correction or retransmission [1]
Packet Discard Rate	Percentage of packets discarded due to late arrival [1, 4]
Out of Sequence Packet Rate	Percentage of packets arriving out of sequence [1]
Duplicate Packet Rate	Percentage of duplicate packets
Burst Loss Rate	Percentage of packets lost within (sparse) burst periods [1,4]

Burst Length	Average length of (sparse) burst periods [1,4]
Gap Loss Rate	Percentage of packets lost within gap periods [1,4]
Gap Length	Average length of gaps between bursts [1,4]
Mean Consecutive Loss Period	Average length of consecutive loss periods [1]
Max Consecutive Loss Period	Maximum length of consecutive loss periods [1]

Forward Error Correction can replace lost packets however carries some overhead. The FEC metrics provide a measure of the effectiveness of FEC if used, and provide information on optimum FEC configuration independently of whether FEC is in use or not (allowing service providers to assess whether FEC would be useful).

FEC Metrics	
Metric	***Description***
FEC Effectiveness	Percentage improvement in packet loss rate due to Forward Error Correction

Reliable UDP metrics provide insight into the performance of retransmission based protocols such as Reliable UDP. These protocols improve packet loss rate but increase the variability of bandwidth.

Reliable UDP Metrics	
Metric	***Description***
Proportion of packets retransmitted	Percentage of packets retransmitted
Ratio of peak to mean bandwidth	Ratio of bandwidth peak due to retransmission to average bandwidth

Jitter and Delay metrics provide a view of the impact of deliberate packet smoothing/ rate shaping and network congestion on overall delay and delay variation.

Jitter and Delay Metrics	
Metric	***Description***
Smoothing jitter	Delay variation due to deliberate smoothing of the packet flow [1]
Jitter Measured Independently from smoothing	
MAPDV	Mean Absolute Packet Delay Variation [3]
PPDV	Packet to Packet Delay Variation [5]
Positive Jitter Threshold	Positive jitter threshold
Positive Jitter Percentile	Percentage of packets arriving within positive jitter threshold
Negative Jitter Threshold	Negative jitter threshold (defined)
Negative Jitter Percentile	Percentage of packets arriving within negative jitter threshold
Round trip delay	Round trip delay (control plane)

TR101 290 metrics provide information on certain key error types that occur with MPEG Transport protocols, and are useful in identifying and resulting these error conditions.

TR 101 290 MPEG Metrics [2]	
Metric	***Description***
PCR Jitter	PCR jitter level
TS_sync_loss	Loss of synchronization at MPEG transport layer
Sync_byte_error	Invalid MPEG transport sync byte
Continuity_count_error	Incorrect packet order, duplicate packet or lost packet
Transport_error	Transport error indicator in MPEG transport header set
PCR_error	Discontinuity in program clock reference (PCR)
PCR_repetition_error	Time interval between two successive PCR values more than 40ms
PCR_discontinuity_indicator_error	Difference between two consecutive PCR values is over 100ms without discontinuity bit set
PTS_error	Interval between presentation time stamps more than 700ms

5. Summary

This contribution proposes a set of QoS/QoE Metrics for IPTV applications. These metrics can in general be measured at both the IPTV endpoint and midpoints.

References

[1] IETF draft-ietf-avt-rtcpxr-video-00.txt “RTCP XR Video Metrics”

[2] ETSI TR. 101290. “Measurement guidelines for DVB systems”

[3] ITU-T G.1020 “Performance parameter definitions for the quality of speech and other voiceband applications utilizing IP networks”

[4] IETF RFC3611 RTCP Extended Reports

[5] IETF RFC3550 Real-time Transport Protocol