

RECOMMENDATION ITU-R BT.1720*

Quality of service ranking and measurement methods for digital video broadcasting services delivered over broadband Internet protocol networks

(Question ITU-R 100/6)

(2005)

Summary

This Recommendation specifies performance requirements and objective measuring methods of quality of service (QoS) for the delivery of digital video broadcasting services over broadband Internet protocol (IP) networks. The specified performance requirements are based on an IP QoS ranking at various levels, from “excellent” to “out-of-service”. They rely on the objective end-to-end measurement of the values of a small number of parameters on the delivered IP streams, performed at the consumer premises equipment and relayed back to the head-end. The recommended objective measurement methods and parameters are known to influence the QoS delivered to the user.

The ITU Radiocommunication Assembly,

considering

- a) that the development of broadcast and non-broadcast television systems is being widely undertaken, and, with their development, new levels of potential image quality are available;
- b) that with the development of new image transmission technologies in broadcast and non-broadcast television, television system parameters can be chosen on the basis of compromises between image quality and the cost of image;
- c) that for the definition of the requirements for television systems and for the various sections of the service delivery chain, the potential level of image quality to be provided by these systems is an important element;
- d) that ISO/IEC MPEG-2 have standardized the encoding and transport mechanisms for audio, video and accompanying data which are adopted for digital video services,

further considering

- a) that digital television services have begun to be distributed in IP broadband networks through IP multicast technologies and protocols (IP multicast distribution is analogous to broadcasting techniques in the radio transmission world);
- b) that, in an IP network, interactive television services, such as video-on-demand (VoD), usually associated with a unicast content distribution method, are now available to end-users;
- c) that, in an IP network, video receivers decode IP delivered television channels to the TV display,

* This Recommendation should be brought to the attention of Telecommunication Standardization Study Group 9.

noting

1 that packet loss ratio, latency and jitter are crucial IP transport requirements for end-to-end IP network performance assessment,

recommends

1 that methods for quality of service (QoS) measurements for digital television broadcasting services streamed in a broadband IP network should be tailored to the specific features of the transport services provided by an IP communications network;

2 that, for video services, the requirements in *noting* 1 should be measured and used for IP end-to-end network performance as described in Annex 1;

3 that end-to-end measurements should be performed on the video stream after its IP packetized structure is removed as described in Annex 2;

4 that QoS should be measured end-to-end in order to provide a close approximation to the quality offered to the end-user, taking into account the influence of the IP network on the video stream; Annex 3 shows a system measurement model of a chain for IP transmission of television services.

Annex 1

IP layer

1 IP transport requirements

IP networks are multi-hop, may be complex and different transmission technologies are usually employed along the network paths. The transmission control protocol (TCP)/IP protocol stack sees all these as “below layer 3” layers.

Measurements and quality parameters at the IP layer make it possible to define reference values for network requirements that are agnostic of the underlying transmission technologies and are suitable for use in end-to-end quality assessment.

The noise introduced in an IP packet network is described by the following parameters:

- *Packet loss ratio (PLR)*: The ratio between the number of the packets lost in the network and the total number of transmitted packets¹.

¹ According to the measurement scheme and the methodology proposed in this Recommendation, the total number of lost packets in the PLR parameter is the sum of IP packet loss ratio (IPLR) and IP packet error ratio (IPER) as defined in ITU-T Recommendation Y.1541. A more complete definition of this parameter is given in ITU-T Recommendation G.1020 where § 7.7.1 defines “Overall (frame/packet) loss ratio” for frames or packets. Being the measurement header on top of the transport layer, if, for an IP packet, the IP or user datagram protocol (UDP) checksum fails, this packet will not be presented to the measurement (or real time protocol (RTP)) layer.

- *Latency*: The time interval between initial transmission and final reception time of a packet.
- *Jitter*: The latency variation.

The quality of the video streams will impose a minimum value for the downstream throughput requirements; upstream end-to-end throughput requirements depend on application interactivity requirements.

This Annex 1 does not guarantee that the classification that it provides is sufficient for assessing the perceived quality on a TV broadcasting over IP system, since IP end-to-end network performance is measured before forward error correction (FEC) is applied.

2 Video streaming IP service class

Video services, such as VoD or TV services, are classified also as streaming services. In a high-quality television environment they have the following high-level requirements:

- good audio/video quality;
- high availability;
- medium interactivity.

These high-level requirements should be translated into values for transport requirements for an IP network.

As specified in Annex 3, it is up to the head-end to introduce good quality video content into the network according to the maximum end-to-end bandwidth and packet rate available for video services. Any packet loss will reduce the quality of the video.

To preserve good quality of the image, a low value of packet loss is required.

3 IP transport measurements

The IP network layer should be unaware if the video signal, or any upper layer, is employing forward-error correction (FEC) or any error-correction techniques, and it should only guarantee the performance needed before any error-correction scheme is applied at any of the above layers.

3.1 Parameters

Table 1 lists IP network measurement parameters. All measurements should be taken from points B to point C in the system measurement model described in Annex 3.

TABLE 1

Parameter	Equipment	Motivation	Monitoring method
PLR	Customer premises equipment (CPE) (set top box (STB))	Image quality, video information loss estimation	In service or through test streams with RTP/real-time control protocol (RTCP) or sequence numbers available on packet header Periodic PLR summary: Reports with one-minute resolution Measurements of PLR requires analysis of a number of packets at least ten times greater than the number related to the target PLR value This determines the rate at which the PLR is reported
Network latency	Test probe at user side, within CPE (STB) or as close as possible to user access link	Smooth playout	Test stream
Jitter	CPE (STB)	Smooth playout	In service or through test streams with RTP/RTCP or time stamps available on packet header
Downstream throughput	CPE (STB)	Service qualification, monitoring	Test signal representative of worst-case encoding scenario, throughput test
Upstream throughput	CPE (STB)	Service qualification, monitoring	Throughput test

3.2 Values

Before giving reference values for transport requirements, it is important to note that, in video services delivery architecture, a receiver buffer is employed at the CPE (STB) end to eliminate (to some extent) the jitter introduced by the network and to have a continuous video frame reproduction.

Values that should be achieved in the network are outlined and motivated in the next paragraphs.

3.2.1 PLR value

It is preferable to specify a PLR value that is “codec independent” and dimensioned on a worst-case scenario.

The PLR value needed to guarantee that an IP network seamlessly delivers video services is 10^{-5} .

This requirement on PLR is considerably more stringent than the IPLR objectives currently specified in ITU-T Recommendation Y.1541².

² There are plans to support digital video transport with some new QoS classes with values of IPLR $< 10^{-5}$.