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SERIES G: TRANSMISSION SYSTEMS AND MEDIA,
DIGITAL SYSTEMS AND NETWORKS

Multimedia Quality of Service and performance – Generic
and user-related aspects

Buffer models for development of client performance metrics

Recommendation ITU-T G.1021



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Recommendation ITU-T G.1021

Buffer models for development of client performance metrics

Summary

Recommendation ITU-T G.1021 defines buffer models that describe the behaviour of the client buffers used at the receiver side of audio/video applications.

Buffer models receive as input IP packets associated with meta information on their content and provide as output client states associated with relevant timing information.

The buffer models are intended to be used for the development of client performance metrics in order to complement the IP-layer metrics defined in Recommendation ITU-T Y.1540.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.1021	2012-07-14	12

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

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Buffer models for development of client performance metrics

1 Scope

Audio and video applications currently used in packet networks implement client buffers (e.g., de-jitter buffers and play-out buffers) at the receiver side. The behaviour of these buffers is essential to the end-to-end performance of these applications. This Recommendation defines models for these client buffers for audio/video applications currently used in actual networks, in order to estimate the client state based on the dynamic network behaviour.

In this Recommendation, different buffer models are derived depending on the different applications taken into account. However, these buffer models may be based on common intrinsic characteristics: i.e., buffer size, service rate, initial delay and re-buffering delay. Example buffer performance metrics include peak/average/instantaneous buffer occupation.

In this Recommendation, buffer models may accept as input, either live traffic arriving on measurement points, packet capture (pcap) files, or post-processed files. Buffer models are expected to provide client states (e.g., codec play-out begin, buffer overflow, buffer dry out, play-out resume) associated with relevant timing information. As part of future work, these buffer models could be used to derive new performance parameters and associated statistics in order to complement the IP-layer metrics defined in Recommendation Y.1540.

It is out of scope for this Recommendation to define specific de-jitter buffers for use in actual client media stream delivery.

In this Recommendation the following applications, rate and buffer characteristics, and associated protocol stacks are considered:

- a) Audio applications:
 - i) Ideally constant fill, constant play-out rate and relatively low bandwidth.
- b) Video "low bitrate mode" quarter common intermediate format-quarter video graphics array (QCIF-QVGA) resolutions, mostly for mobile TV and streaming with the sub application areas:
 - i) Linear mobile TV over real-time transport protocol (RTP) (including mobile TV over a 3G mobile network with multimedia broadcast/multicast services (MBMS) and with unicast transport over RTP/UDP/IP).
 - ii) Multimedia streaming (including 3GPP packet-switched streaming service (PSS) with transport over RTP/UDP/IP).
 - iii) [IETF RFC 3984] variable bit rate, up to 2 Mbps, with separate buffers for audio and video, and separate play-out rates for each buffer.
- c) Video "high bitrate mode" standard-definition (SD) and high-definition (HD) television, mostly for Internet Protocol television (IPTV) with the following sub-application areas:
 - i) Linear broadcast TV (including transmission over MPEG2-TS/RTP/UDP/IP, MPEG2-TS/UDP/IP and RTP/UDP/IP transport).
 - ii) Video on-demand (including transmission over MPEG2-TS/RTP/UDP/IP, MPEG2-TS/UDP/IP and RTP/UDP/IP transport).
 - iii) [IETF RFC 2250], constant bit rate (CBR) or variable bit rate (VBR) up to 50 Mbps, with separate buffers for audio and video, and separate play-out rates for each buffer.

- d) Over-the-top video applications:
 - i) Non-adaptive streaming (MPEG4_fileformat/HTTP/TCP, HTTP progressive download, HTTP partial download, chunks):
 - Progressive download: TCP transport, TCP flow control (65Mbps super-peak rates, peak rate depends on network conditions and path), classic single buffer, leaky bucket at constant frame rate.
 - ii) Adaptive streaming dynamic adaptive streaming over HTTP (DASH/TCP):
 - Chunk Delivery: (e.g., DASH) bursts of packets, like sequential FTP file transfers.

2 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.1020] Recommendation ITU-T G.1020 (2006), *Performance parameter definitions for quality of speech and other voiceband applications utilizing IP networks*.
- [ITU-T H.222.0] Recommendation ITU-T H.222.0 (2006) | ISO/IEC 13818-1:2007, *Information technology – Generic coding of moving pictures and associated audio information: Systems*.
- [ITU-T Y.1540] Recommendation ITU-T Y.1540 (2010), *Internet protocol data communication service – IP packet transfer and availability performance parameters*.
- [IETF RFC 2250] IETF RFC 2250 (1998), *RTP Payload Format for MPEG1/MPEG2 Video*.
- [IETF RFC 3984] IETF RFC 3984 (2005), *RTP Payload Format for H.264 Video*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 decoding time-stamp (DTS) [ITU-T H.222.0]: A field that may be present in a PES packet header that indicates the time that an access unit is decoded in the system target decoder.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ARQ	Automatic Retransmission on Request
CBR	Constant Bit Rate
DASH	Dynamic Adaptive Streaming over HTTP
DSL	Digital Subscriber Line
DSP	Digital Signal Processor
DTS	Decoding Time Stamp
EWMA	Exponentially Weighted Moving Average