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Contents

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Speech and multimedia Transmission Quality (STQ).

1 Scope

The present document addresses combination network performance parameters and user perceived media (audio and video) quality parameters for audiovisual communications on IP networks.

The access technologies covered include both wired (e.g. xDSL) and wireless (e.g. UMTS, WLAN) technologies.

The display size range covered is from those of small mobile terminals (e.g. 2") up to large TV sets (e.g. 40" or more).

It is applicable to:

- Broadcasting and streaming applications such as IPTV and VoD.
- Interactive point-to-pint applications such as videotelephony and videoconferencing.

Where the media coding standards define two or more profiles, the baseline profile is addressed in the normative part of the standard.

Informative annexes present an overview of network QoS mechanisms and the effects on connection performance as well as guidance on terminal parameters that may influence the user perceived media performance.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific.

- For a specific reference, subsequent revisions do not apply.
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2.1 Normative references

The following referenced documents are indispensable for the application of the present document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ITU-T Recommendation Y.1540: "Internet protocol data communication service - IP packet transfer and availability performance parameters".

[2] ITU-T Recommendation Y.1541: "Network performance objectives for IP-based services".

[3] ITU-T Recommendation G.711: "Pulse Code Modulation (PCM) of voice frequencies".

[4] ITU-T Recommendation G.722: "7 kHz audio-coding within 64 kbit/s".

[5] ITU-T Recommendation G.723.1: "Dual rate speech coder for multimedia communications transmitting at 5,3 and 6,3 kbit/s".

[6] ITU-T Recommendation G.726: "40, 32, 24, 16 kbit/s Adaptive Differential Pulse Code Modulation (ADPCM)".

[7] ITU-T Recommendation G.728: "Coding of speech at 16 kbit/s using low-delay code exited linear prediction".

[8] ITU-T Recommendation G.729: "Coding of speech at 8 kbit/s using conjugate-structure algebraic-code-excited linear-prediction (CS-ACELP)".

[9] ITU-T Recommendation G.729.1: "G.729 Embedded Variable bit-rate coder: An 8-32 kbit/s scalable wideband coder bitstream interoperable with G.729".

[10] ETSI TS 126 071 (V6.0.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); AMR speech Codec; General description (3GPP TS 26.071, version 6.0.0 Release 6)".

[11] 3GPP2 C.S0014-C v1.0 Enhanced Variable Rate Codec, Speech Service Option 3, 68 and 70 for Wideband Spread Spectrum Digital Systems, January 2007.

[12] ITU-T Recommendation G.722.1: "Low-complexity coding at 24 and 32 kbit/s for hands-free operation in systems with low frame loss".

[13] ITU-T Recommendation G.711.1: "Wideband embedded extension for G.711 pulse code modulation".

[14] ETSI TS 126 171 (V6.0.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); AMR speech codec, wideband; General description (3GPP TS 26.171, version 6.0.0 Release 6)".

NOTE: TS 126 171 is identical to ITU-T Recommendation G.722.2.

[15] IETF RFC 3351: "RTP Profile for Audio and Video Conferences with Minimal Control".

[16] ISO/IEC 11172: "Information technology -- Coding of moving pictures and associated audio for digital storage media at up to about 1,5 Mbit/s (MPEG 1, 5 parts)".

[17] ISO/IEC 13818: "Information technology -- Generic coding of moving pictures and associated audio information (MPEG 2, 9 parts)".

[18] ISO/IEC 14496: "Information technology -- Coding of audio-visual objects (MPEG 4; currently in 11 parts)".

[19] ETSI TS 126 290 (V6.3.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS) Audio codec processing functions; Extended Adaptive Multi-Rate - Wideband (AMR-WB+) codec; Transcoding functions (3GPP TS 26.290, version 6.0.0 Release 6)".

[20] ITU-T Recommendation G.719: "Low-complexity full-band audio coding for high-quality conversational applications".

[21] ETSI TS 102 366: "Digital Audio Compression (AC-3, Enhanced AC-3) Standard".

[22] ITU-T Recommendation H.261: "Video codec for audiovisual services at p × 64 kbit/s".

[23] ITU-T Recommendation H.262: "Information technology - Generic coding of moving pictures and associated audio information: Video".

[24] ITU-T Recommendation H.263: "Video coding for low bit rate communication".

[25] ITU-T Recommendation H.264: "Advanced video coding for generic audiovisual services".

NOTE: This recommendation is identical to MPEG 4 Annex 10.

[26] SMPTE 421M (2006): "Television - VC-1 Compressed Video Bitstream Format and Decoding Process".

[27] ITU-R Recommendation BT.1359-1: "Relative timing of sound and vision for broadcasting".

[28] IETF RFC 768: "User Datagram Protocol".

[29] ETSI TS 122 146 (V7.1.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); LTE; Multimedia Broadcast/Multicast Service (MBMS); Stage 1 (3GPP TS 22.146, version 7.1.0 Release 7)".

[30] IETF RFC 793: "Transmission Control Protocol".

[31] ITU-T Recommendation G.995.1: "Overview of digital subscriber line (DSL) Recommendations".

[32] IEEE 802.3 (2005): "IEEE Standard for Information technology-Telecommunications and information exchange between systems-Local and metropolitan area networks; Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications".

[33] ITU-T Recommendation G.992: Parts 1 to 5.

[34] ITU-T Recommendation G.993: Parts 1 and 2.

[35] ITU-T Recommendation G.991.1: "High bit rate Digital Subscriber Line (HDSL) transceivers".

[36] ITU-T Recommendation G.991.2: "Single-pair high-speed digital subscriber line (SHDSL) transceivers".

[37] ETSI TS 101 113 (V7.5.0): "Digital cellular telecommunications system (Phase 2+) (GSM); General Packet Radio Service (GPRS); Service description; Stage 1 (GSM 02.60, version 7.5.0 Release 1998)".

[38] ETSI TS 122 228 (V8.5.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Service requirements for the Internet Protocol (IP) multimedia core network subsystem (IMS); Stage 1 (3GPP TS 22.228, version 8.5.0 Release 8)".

[39] ETSI TS 122 173 (V7.5.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); IP Multimedia Core Network Subsystem (IMS) Multimedia Telephony Service and supplementary services; Stage 1 (3GPP TS 22.173, version 7.5.0 Release 7)".

[40] ETSI TS 125 308 (V7.7.0): "Universal Mobile Telecommunications System (UMTS); High Speed Downlink Packet Access (HSDPA); Overall description; Stage 2 (3GPP TS 25.308, version 7.7.0 Release 7)".

[41] ETSI TS 125 319 (V7.6.0): "Universal Mobile Telecommunications System (UMTS); Enhanced uplink; Overall description; Stage 2 (3GPP TS 25.319, version 7.6.0 Release 7)".

[42] ETSI TS 123 107 (V7.1.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Quality of Service (QoS) concept and architecture (3GPP TS 23.107, version 7.1.0 Release 7)".

[43] ETSI TS 123 207 (V7.0.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); End-to-end Quality of Service (QoS) concept and architecture (3GPP TS 23.207, version 7.0.0 Release 7)".

[44] ETSI EN 300 175-2: "Digital Enhanced Cordless Telecommunications (DECT); Common Interface (CI); Part 2: Physical Layer (PHL)".

[45] IEEE 802.16 (2004): "Standard for Local and metropolitan area networks. Part 16: Air Interface for Fixed Broadband Wireless Access Systems".

[46] IEEE 802.11 (2007): "Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks. Specific requirements. Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications".

[47] ETSI EN 300 401: "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".

[48] ETSI TS 102 428: "Digital Audio Broadcasting (DAB); DMB video service; User Application Specification".

[49] ETSI EN 302 307: "Digital Video Broadcasting (DVB); Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications".

[50] ETSI EN 300 744: "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television".

[51] ETSI EN 300 419: "Access and Terminals (AT); 2 048 kbit/s digital structured leased lines (D2048S); Connection characteristics".

[52] ETSI EN 302 304: "Digital Video Broadcasting (DVB); Transmission System for Handheld Terminals (DVB-H)".

[53] ETSI EN 302 583: "Digital Video Broadcasting (DVB); Framing Structure, channel coding and modulation for Satellite Services to Handheld devices (SH) below 3 GHz".

[54] ETSI TS 101 154: "Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream".

[55] ETSI TS 102 005: "Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in DVB services delivered directly over IP protocols".

[56] ITU-T Recommendation G.114: "One-way transmission time".

[57] IETF RFC 3550: "RTP: A Transport Protocol for Real-Time Applications".

[58] IETF RFC 3095: "RObust Header Compression (ROHC): Framework and four profiles: RTP, UDP, ESP, and uncompressed".

[59] ETSI TS 181 005: "Telecommunications and Internet Converged Services and Protocols for Advanced Networking (TISPAN); Service and Capability Requirements".

[60] ITU-R Recommendation BS.1534-1: "Method for the subjective assessment of intermediate quality levels of coding systems".

[61] ITU-T Recommendation G.107: "The E-model, a computational model for use in transmission planning".

[62] ITU-T Recommendation G.1010: "End-user Multimedia QoS Categories".

[63] ETSI ES 202 737: "Speech Processing, Transmission and Quality Aspects (STQ); Transmission requirements for narrowband VoIP terminals (handset and headset) from a QoS perspective as perceived by the user".

[64] ETSI ES 202 738: "Speech Processing, Transmission and Quality Aspects (STQ); Transmission requirements for narrowband VoIP loudspeaking and handsfree terminals from a QoS perspective as perceived by the user".

[65] ETSI ES 202 739: "Speech Processing, Transmission and Quality Aspects (STQ); Transmission requirements for wideband VoIP terminals (handset and headset) from a QoS perspective as perceived by the user".

[66] ETSI ES 202 740: "Speech Processing, Transmission and Quality Aspects (STQ); Transmission requirements for wideband VoIP loudspeaking and handsfree terminals from a QoS perspective as perceived by the user".

[67] ETSI TS 126 235 (V7.4.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Packet switched conversational multimedia applications; Default codecs (3GPP TS 26.235, version 7.4.0 Release 7)".

[68] ITU-T Recommendation J.247: "Objective perceptual multimedia video quality measurement in the presence of a full reference".

[69] ITU-T Recommendation P.911: "Subjective audiovisual quality assessment methods for multimedia applications".

[70] ETSI TS 181 018: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Requirements for QoS in a NGN".

[71] ETSI TS 122 105 (V8.4.0): "Universal Mobile Telecommunications System (UMTS); Services and service capabilities (3GPP TS 22.105, version 8.4.0 Release 8)".

[72] ETSI TS 126 234 (V7.5.0): "Universal Mobile Telecommunications System (UMTS); Transparent end-to-end Packet-switched Streaming Service (PSS); Protocols and codecs (3GPP TS 26.234, version 7.5.0 Release 7)".

[73] ETSI TS 126 346 (V7.8.0): "Universal Mobile Telecommunications System (UMTS); Multimedia Broadcast/Multicast Service (MBMS); Protocols and codecs (3GPP TS 26.346, version 7.8.0 Release 7)".

2.2 Informative references

The following referenced documents are not essential to the use of the present document but they assist the user with regard to a particular subject area**.** For non-specific references, the latest version of the referenced document (including any amendments) applies.

[i.1] ETSI ETR 310: "Digital Enhanced Cordless Telecommunications (DECT); Traffic capacity and spectrum requirements for multi-system and multi-service DECT applications co-existing in a common frequency band".

[i.2] ETSI TS 126 091 (V7.0.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); AMR speech Codec; Error concealment of lost frames (3GPP TS 26.091, version 7.0.0 Release 7)".

[i.3] ETSI TS 126 191 (V7.0.0): "Digital cellular telecommunications system (Phase 2+); Universal Mobile Telecommunications System (UMTS); Speech codec speech processing functions; Adaptive Multi-Rate - Wideband (AMR-WB) speech codec; Error concealment of erroneous or lost frames (3GPP TS 26.191, version 7.0.0 Release 7)".

[i.4] ETSI TR 102 479: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Review of available material on QoS requirements of Multimedia Services".

[i.5] IETF RFC 1633: "Integrated services in the Internet architecture: An overview".

[i.6] IETF RFC 2205: "Resource ReSerVation Protocol (RSVP) Version 1 Functional Specification".

[i.7] IETF RFC 2475: "An Architecture for Differentiated Services".

[i.8] Cicconetti, C., Lezini, L., Mingozzi, E. and Eklund, C.: "Quality of Service support in 802.16 networks. IEEE Network, vol. 29", March/April 2006.

[i.9] Pedersen, K., Mogensen, P. and Kolding, T.: "Overview of QoS options for HSDPA. IEEE Communications Magazine vol. 44", July 2006.

[i.10] ETSI ES 282 003: "Telecommunications and Internet converged Services and Protocols for Advanced Networking (TISPAN); Resource and Admission Control Sub-System (RACS): Functional Architecture".

[i.11] Perkins, C, Hodson, O. and Hardman, V.: "A Survey of Packet Loss Recovery Techniques for Streaming Audio. IEEE Network vol. 12, No. 5", 1998.

[i.12] Wah, B., Su, X. and Lin, D.: "A Survey of Error-Concealment Schemes for Real-Time Audio and Video Transmissions over the Internet. IEEE International Symposium on Multimedia Software Engineering 2000 (MSE 2000)"; Taipei, Taiwan, 11-13 December 2000.

[i.13] ITU-T Recommendation G.711 (Appendix I).: "Pulse code modulation (PCM) of voice frequencies; A high quality low-complexity algorithm for packet loss concealment with G.711".

[i.14] ITU-T Recommendation G.722 (Appendix III): "7 kHz audio-coding within 64 kbit/s; A high-quality packet loss concealment algorithm for G.722".

[i.15] ITU-T Recommendation G.722 (Appendix IV): "7 kHz audio-coding within 64 kbit/s; A low-complexity algorithm for packet loss concealment with G.722".

[i.16] Wenger, S.: "H.264/AVC over IP. IEEE Transactions on circuits and systems for video technology, vol. 13, No. 7", 2003.

[i.17] ETSI TR 101 329-6: "Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON) Release 3; End-to-end Quality of Service in TIPHON systems; Part 6: Actual measurements of network and terminal characteristics and performance parameters in TIPHON networks and their influence on voice quality".

[i.18] Kövesi, B. and Ragot, S.: "A low complexity packet loss concealment algorithm for ITU-T Recommendation G.722. 2008 IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)". Las Vegas, USA, 30th March - 4th April, 2008.

[i.19] ITU-T Recommendation I.113: "Vocabulary of terms for broadband aspects of ISDN".

[i.20] ITU-T Recommendation G.722.2: "Wideband coding of speech at around 16 kbit/s using Adaptive Multi-Rate Wideband (AMR-WB)".

[i.21] ITU-T Recommendation SG.12: "Temporary Documents".

[i.22] Layer 1 specifications.

NOTE: Available at http://3GPP specification series: 05series.

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

audio: all signals that are audible to human beings, including speech and music

broadcasting: communication capability which denotes unidirectional distribution from a single source to all users connected to the network

multipoint: value of the service attribute "communication configuration", which denotes that the communication involves more than two network terminations

NOTE: Source: ITU-T Recommendation I.113 [i.19].

narrowband speech: speech restricted to the frequency band from 300 Hz to 3 400 Hz

speech: oral production of information by a human being

streaming: mechanism whereby media content can be rendered at the same time that it is being transmitted to the client over the network

video: signal that contains timing/synchronization information as well as luminance (intensity) and chrominance (colour) information that when displayed on an appropriate device gives a visual representation of the original image sequence

videoconferencing: service providing interactive, bi-directional and real time audio-visual communication

NOTE: Normally intended for multiple users at each end.

videotelephony: service providing an interactive, bi-directional, real time audio-visual communication between users

wideband speech: speech restricted to the frequency band from 50 Hz to 7 000 Hz

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

3GPP	3rd Generation Partnership Project
3GPP2	3rd Generation Partnership Project 2

NOTE: A 3G project comprising North American and Asian interests.

AAC	Advanced Audio Coding
ADPCM	Adaptive Differential Pulse Code Modulation
AMR	Adaptive Multi Rate
AMR-WB	Adaptive Multi Rate Wide Band
AMR-WB+	Adaptive Multi Rate extended Wide Band
AP	Access Point (IEEE 802.11 WLAN [46])
ATM	Asynchronous Transfer Mode
AVC	Advanced Video Coding
CCIR	Comité Consultatif International pour la Radio; Now ITU-R
CELP	Code-Excited Linear Predictive
CIF	Common Intermediate Format
CPCFC	Custom Picture Clock Frequency Code
CPFMT	Custom Picture ForMaT
DECT	Digital Enhanced Cordless Telecommunications
DPCM	Differential Pulse Code Modulation
EUL	Enhanced UpLink
FER	Frame Error Rate
FP	Fixed Part (DECT)
HDTV	High Definition TV
HE-AAC	High Efficiency AAC
HSPA	High-Speed Packet Access
HSDPA	High-Speed Downstream Packet Access
HSUPA	High-Speed Upstream Packet Access
IETF	Internet Engineering Task Force
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPDV	IP Packet Delay Variation
IPER	IP Packet Error Ratio
IPLR	IP Packet Loss Ratio
IPTD	IP Packet Transfer Delay
ITU-R	International Telecommunication Union - Radiocommunication sector
ITU-T	International Telecommunication Union - Telecommunication standardization sector
LPC	Linear Predictive Coding
MAC	Medium Access Control
MBMS	Mobile Broadcast/Multicast Service
MDCT	Modified Discrete Cosine Transform
MCU	Multipoint Control Unit
MPE	Multi-Pulse Excited
MPEG 2 TS	MPEG 2 Transport Stream
MPEG	Moving Picture Experts Group
MUSHRA	MUlti Stimulus with Hidden Reference and Anchors
NTSC	National Television System Committee

NOTE: Used to identify an analogue TV standard used outside Europe.

PAL	Phase-Alternating Line

NOTE: Colour-encoding system used in television systems.

PBX	Private Branch eXchange
PCM	Pulse Code Modulation
PP	Portable Part (DECT)
QCIF	Quart CIF
QVGA	Quart VGA
RTP	Real-time Transport Protocol
RTT	Round Trip Time
SDTV	Standard Definition TV
SVC	Scalable Video Coding
TCP	Transport Control Protocol
TTI	Transmission Time Interval
UDP	User Datagram Protocol
UMTS	Universal Mobile Telecommunications System
VGA	Video Graphics Array
W-CDMA	Wideband-Code Division Multiple Access
WLAN	Wireless Local Area Network

NOTE: IPER, IPDV, IPLR and IPTD are defined in ITU-T Recommendations Y.1540 [1] and Y.1541 [2].

4 Parameters affecting audiovisual user perceived quality

4.1 Audiovisual user perceived quality model

The characteristics affecting audiovisual user perceived quality and their interactions are illustrated in figure 1.

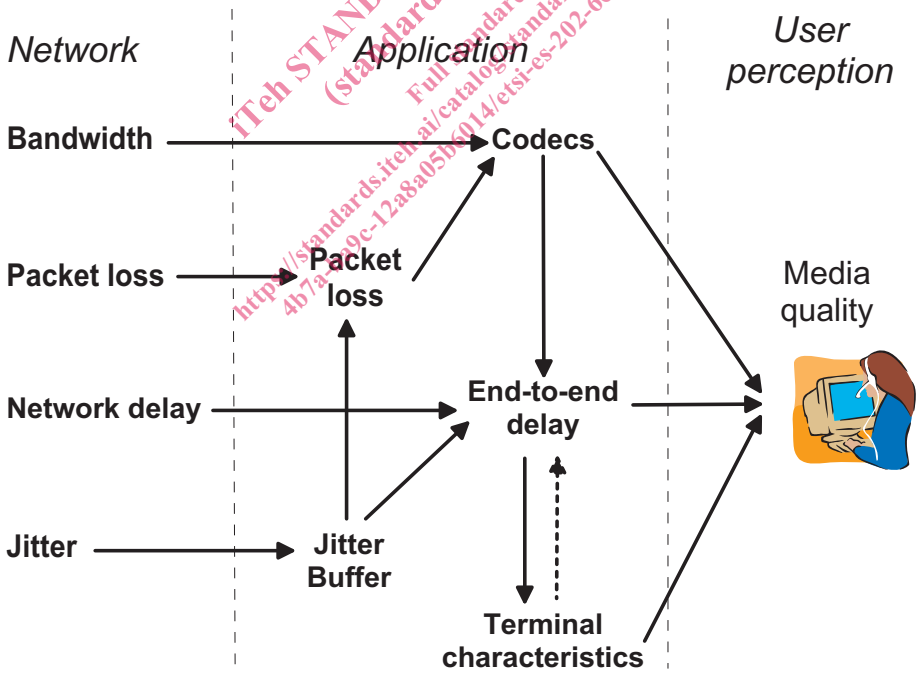

Figure 1: Characteristics affecting audiovisual user perceived quality