International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

H.222.0

Corrigendum 2

(03/2017)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Transmission multiplexing and synchronization

---

Information technology – Generic coding of moving pictures and associated audio information: Systems

Technical Corrigendum 2: STD buffer sizes for HEVC and miscellaneous editorial issues

Recommendation ITU-T H.222.0 (2014) – Technical Corrigendum 2

ITU-T H-SERIES RECOMMENDATIONS

AUDIOVISUAL AND MULTIMEDIA SYSTEMS

CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS	H.100–H.199
INFRASTRUCTURE OF AUDIOVISUAL SERVICES	
General	H.200–H.219
Transmission multiplexing and synchronization	**H.220–H.229**
Systems aspects	H.230–H.239
Communication procedures	H.240–H.259
Coding of moving video	H.260–H.279
Related systems aspects	H.280–H.299
Systems and terminal equipment for audiovisual services	H.300–H.349
Directory services architecture for audiovisual and multimedia services	H.350–H.359
Quality of service architecture for audiovisual and multimedia services	H.360–H.369
Telepresence	H.420–H.429
Supplementary services for multimedia	H.450–H.499
MOBILITY AND COLLABORATION PROCEDURES	
Overview of Mobility and Collaboration, definitions, protocols and procedures	H.500–H.509
Mobility for H-Series multimedia systems and services	H.510–H.519
Mobile multimedia collaboration applications and services	H.520–H.529
Security for mobile multimedia systems and services	H.530–H.539
Security for mobile multimedia collaboration applications and services	H.540–H.549
Mobility interworking procedures	H.550–H.559
Mobile multimedia collaboration inter-working procedures	H.560–H.569
BROADBAND, TRIPLE-PLAY AND ADVANCED MULTIMEDIA SERVICES	
Broadband multimedia services over VDSL	H.610–H.619
Advanced multimedia services and applications	H.620–H.629
Ubiquitous sensor network applications and Internet of Things	H.640–H.649
IPTV MULTIMEDIA SERVICES AND APPLICATIONS FOR IPTV	
General aspects	H.700–H.719
IPTV terminal devices	H.720–H.729
IPTV middleware	H.730–H.739
IPTV application event handling	H.740–H.749
IPTV metadata	H.750–H.759
IPTV multimedia application frameworks	H.760–H.769
IPTV service discovery up to consumption	H.770–H.779
Digital Signage	H.780–H.789
E-HEALTH MULTIMEDIA SERVICES AND APPLICATIONS	
Personal health systems	H.810–H.819
Interoperability compliance testing of personal health systems (HRN, PAN, LAN, TAN and WAN)	H.820–H.859
Multimedia e-health data exchange services	H.860–H.869

For further details, please refer to the list of ITU-T Recommendations.

INTERNATIONAL STANDARD ISO/IEC 13818-1
RECOMMENDATION ITU-T H.222.0

Information technology – Generic coding of moving pictures and associated audio information: Systems

Technical Corrigendum 2

STD buffer sizes for HEVC and miscellaneous editorial issues

Summary

Corrigendum 2 of Rec. ITU-T H.222.0 (2014) | ISO/IEC 13818-1:2015 corrects parameter names used in the MPEG-2 Systems specification (ITU-T H.222.0 | ISO/IEC 13818-1), which differ from the corresponding parameter names in the HEVC specification (ITU-T H.265 | ISO/IEC 23008-2). In addition to this, the conversion needed to assign numbers measured in bits to variables expressing byte counts is harmonized. Further, table numbering is corrected.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T H.222.0	1995-07-10	15	11.1002/1000/1071
1.1	ITU-T H.222.0 (1995) Amd. 1	1996-11-11	16	11.1002/1000/3834
1.2	ITU-T H.222.0 (1995) Amd. 2	1996-11-11	16	11.1002/1000/4096
1.3	ITU-T H.222.0 (1995) Technical Cor. 1	1998-02-06	16	11.1002/1000/4532
1.4	ITU-T H.222.0 (1995) Amd. 3	1998-02-06	16	11.1002/1000/4228
1.5	ITU-T H.222.0 (1995) Amd. 4	1998-02-06	16	11.1002/1000/4229
1.6	ITU-T H.222.0 (1995) Amd. 5	1999-05-27	16	11.1002/1000/4498
1.7	ITU-T H.222.0 (1995) Amd. 6	1999-05-27	16	11.1002/1000/4671
2.0	ITU-T H.222.0	2000-02-17	16	11.1002/1000/5142
2.1	ITU-T H.222.0 (2000) Technical Cor. 1	2001-03-01	16	11.1002/1000/5419
2.2	ITU-T H.222.0 (2000) Technical Cor. 2	2002-03-29	16	11.1002/1000/5675
2.3	ITU-T H.222.0 (2000) Amd. 1	2002-12-14	16	11.1002/1000/6190
2.4	ITU-T H.222.0 (2000) Amd. 1/Cor. 1	2003-06-29	16	11.1002/1000/6449
2.5	ITU-T H.222.0 (2000) Amd. 2	2003-06-29	16	11.1002/1000/6363
2.6	ITU-T H.222.0 (2000) Amd. 3	2004-03-15	16	11.1002/1000/7208
2.7	ITU-T H.222.0 (2000) Technical Cor. 3	2005-01-08	16	11.1002/1000/7435
2.8	ITU-T H.222.0 (2000) Amd. 4	2005-01-08	16	11.1002/1000/7436
2.9	ITU-T H.222.0 (2000) Amd. 5	2005-01-08	16	11.1002/1000/7437
2.10	ITU-T H.222.0 (2000) Technical Cor. 4	2005-09-13	16	11.1002/1000/8560
3.0	ITU-T H.222.0	2006-05-29	16	11.1002/1000/8802
3.1	ITU-T H.222.0 (2006) Amd. 1	2007-01-13	16	11.1002/1000/9024
3.2	ITU-T H.222.0 (2006) Amd. 2	2007-08-29	16	11.1002/1000/9214
3.3	ITU-T H.222.0 (2006) Cor. 1	2008-06-13	16	11.1002/1000/9471
3.4	ITU-T H.222.0 (2006) Cor. 2	2009-03-16	16	11.1002/1000/9692
3.5	ITU-T H.222.0 (2006) Amd. 3	2009-03-16	16	11.1002/1000/9691

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

3.6	ITU-T H.222.0 (2006) Cor. 3	2009-12-14	16	11.1002/1000/10621
3.7	ITU-T H.222.0 (2006) Cor. 4	2009-12-14	16	11.1002/1000/10622
3.8	ITU-T H.222.0 (2006) Amd. 4	2009-12-14	16	11.1002/1000/10623
3.9	ITU-T H.222.0 (2006) Amd. 5	2011-05-14	16	11.1002/1000/11287
3.10	ITU-T H.222.0 (2006) Amd. 6	2011-05-14	16	11.1002/1000/11288
4.0	ITU-T H.222.0	2012-06-29	16	11.1002/1000/11655
4.1	ITU-T H.222.0 (2012) Amd. 1	2014-01-13	16	11.1002/1000/12054
4.2	ITU-T H.222.0 (2012) Amd. 2	2014-01-13	16	11.1002/1000/12055
4.3	ITU-T H.222.0 (2012) Amd. 3	2014-01-13	16	11.1002/1000/12056
4.4	ITU-T H.222.0 (2012) Amd. 4	2014-01-13	16	11.1002/1000/12057
4.5	ITU-T H.222.0 (2012) Amd. 5	2014-10-14	16	11.1002/1000/12306
5.0	ITU-T H.222.0	2014-10-14	16	11.1002/1000/12359
5.1	ITU-T H.222.0 (2014) Amd. 1	2015-04-29	16	11.1002/1000/12452
5.2	ITU-T H.222.0 (2014) Amd. 1 Cor. 1	2015-11-29	16	11.1002/1000/12625
5.3	ITU-T H.222.0 (2014) Amd. 2	2015-12-14	16	11.1002/1000/12632
5.4	ITU-T H.222.0 (2014) Amd. 3	2015-12-14	16	11.1002/1000/12633
5.5	ITU-T H.222.0 (2014) Amd. 1 Cor. 2	2016-07-14	16	11.1002/1000/12899
5.5	ITU-T H.222.0 (2014) Cor. 1	2016-07-14	16	11.1002/1000/12903
5.7	ITU-T H.222.0 (2014) Amd. 4	2016-07-14	16	11.1002/1000/12900
5.8	ITU-T H.222.0 (2014) Amd. 5	2016-07-14	16	11.1002/1000/12901
5.9	ITU-T H.222.0 (2014) Amd. 6	2016-07-14	16	11.1002/1000/12902
5.10	ITU-T H.222.0 (2014) Amd. 3 Cor. 1	2017-03-01	16	11.1002/1000/13184
5.10	ITU-T H.222.0 (2014) Cor. 2	2017-03-01	16	11.1002/1000/13188
5.12	ITU-T H.222.0 (2014) Amd. 7	2017-03-01	16	11.1002/1000/13186
5.13	ITU-T H.222.0 (2014) Amd. 8	2017-03-01	16	11.1002/1000/13187

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.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had 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/.

INTERNATIONAL STANDARD
ITU-T RECOMMENDATION

Information technology – Generic coding of moving pictures and associated audio information: Systems

Technical Corrigendum 2

STD buffer sizes for HEVC and miscellaneous editorial issues

1) Clause 2.4.2.3, Extensions for single layer HEVC

In clause 2.4.2.3, replace:

NOTE 2 – In the following equations, unit conversion should be implicitly performed as appropriate.

With:

NOTE 2 – In the following equations, unit conversion should be implicitly performed as appropriate. Values expressed in bits are implicitly converted into values expressed in bytes by: *number_of_bytes* = (*number_of_bits* +7) / 8.

2) Clause 2.17.2, Extensions for single layer HEVC

In clause 2.17.2, replace:

- There is exactly one multiplexing buffer MB_n for the HEVC video stream or HEVC temporal video sub-bitstream, where the size MBS_n of the multiplexing buffer MB is constrained as follows:

$$MBS_n = BS_{mux} + BS_{oh} + CpbBrNalFactor \times MaxCPB[tier, level] - cpb\_size$$

  where BS_{oh}, packet overhead buffering, is defined as:

$$BS_{oh} = (1/750) \text{ seconds} \times \max\{ CpbBrNalFactor \times MaxBR[tier, level], 2\,000\,000 \text{ bit/s}\}$$

  and BS_{mux}, additional multiplex buffering, is defined as:

$$BS_{mux} = 0.004 \text{ seconds} \times \max\{ CpbBrNalFactor \times MaxBR[tier, level], 2\,000\,000 \text{ bit/s}\}$$

  MaxCPB[tier, level] and MaxBR[tier, level] are taken from Annex A of Recommendation. ITU-T H.265 | ISO/IEC 23008-2 for the tier and level of the HEVC video stream or HEVC temporal video sub-bitstream. Cpb_size is taken from the HRD parameters, as specified in Annex E of Recommendation. ITU-T H.265 | ISO/IEC 23008-2, included in the HEVC video stream or HEVC temporal video sub-bitstream.

- There is exactly one elementary stream buffer EB_n for all the elementary streams in the set of received elementary streams associated by hierarchy descriptors, with a total size EBS_n

$$EBS_n = cpb\_size \text{ (measured in bytes)}$$

  where cpb_size is taken from the HRD parameters, as specified in Annex E of Recommendation. ITU-T H.265 | ISO/IEC 23008-2, included in the HEVC video stream or the HEVC temporal video sub-bitstream.

With:

- There is exactly one multiplexing buffer MB_n for the HEVC video stream or HEVC temporal video sub-bitstream, where the size MBS_n of the multiplexing buffer MB is constrained as follows:

$$MBS_n = BS_{mux} + BS_{oh} + CpbNalFactor \times MaxCPB[tier, level] - cpb\_size$$

  where BS_{oh}, packet overhead buffering, is defined as:

$$BS_{oh} = (1/750) \text{ seconds} \times \max\{ BrNalFactor \times MaxBR[tier, level], 2\,000\,000 \text{ bit/s}\}$$

  and BS_{mux}, additional multiplex buffering, is defined as:

$$BS_{mux} = 0.004 \text{ seconds} \times \max\{ BrNalFactor \times MaxBR[tier, level], 2\,000\,000 \text{ bit/s}\}$$

  MaxCPB[tier, level] and MaxBR[tier, level] are taken from Annex A of Rec. ITU-T H.265 | ISO/IEC 23008-2 for the tier and level of the HEVC video stream or HEVC temporal video sub-bitstream, where rates are expressed in bit/s. cpb_size is taken from the HRD parameters, as specified in Annex E of Rec. ITU-T H.265 | ISO/IEC 23008-2, included in the HEVC video stream or HEVC temporal video sub-bitstream, where the size is expressed in bits. Implicit conversion is carried out according to Note 2 in 2.4.2.3.

- There is exactly one elementary stream buffer EB_n for all the elementary streams in the set of received elementary streams associated by hierarchy descriptors, with a total size EBS_n

$$EBS_n = cpb\_size$$

where cpb_size is taken from the HRD parameters, as specified in Annex E of Rec. ITU-T H.265 | ISO/IEC 23008-2, included in the HEVC video stream or the HEVC temporal video sub-bitstream, where the size is expressed in bits. Implicit conversion is carried out according to Note 2 in 2.4.2.3.

Further, replace:

When there is no data in TB_n then Rx_n is equal to zero. Otherwise:

$$Rx_n = bit\_rate$$

where bit_rate is CpbBrNalFactor/CpbBrVclFactor x BitRate[SchedSelIdx] of data flow into the CPB for the byte stream format and BitRate[SchedSelIdx] is as defined in Annex E of Rec. ITU-T H.265 | ISO/IEC 23008-2 when NAL hrd_parameters() is present in the VUI parameters of the HEVC video stream.

With:

When there is no data in TB_n then Rx_n is equal to zero. Otherwise:

$$Rx_n = bit\_rate$$

where bit_rate is BrNalFactor/BrVclFactor x BitRate[SchedSelIdx] of data flow into the CPB for the byte stream format and BitRate[SchedSelIdx] is as defined in Annex E of Rec. ITU-T H.265 | ISO/IEC 23008-2 when NAL hrd_parameters() is present in the VUI parameters of the HEVC video stream.

Further, replace:

Otherwise, the leak method shall be used to transfer data from MB_n to EB_n as follows:

$$Rbx_n = CpbBrNalFactor \times MaxBR[tier, level]$$

with:

Otherwise, the leak method shall be used to transfer data from MB_n to EB_n as follows:

$$Rbx_n = BrNalFactor \times MaxBR[tier, level]$$

3) Clause 2.17.3, Extensions for layered transport of HEVC temporal video subsets

In clause 2.17.3, replace:

- There is one multiplex buffer $MB_{n,k}$ for each received elementary stream $ES_{n,k}$, where the size $MBS_{n,k}$ of the multiplex buffer $MB_{n,k}$ is constrained as follows:

$$MBS_{n,k} = BS_{mux} + BS_{oh} + CpbBrNalFactor \times MaxCPB[tier, level] - cpb\_size \text{ (measured in bytes)}$$

where cpb_size is taken from the HRD parameters, as specified in Annex E of Recommendation. ITU-T H.265 | ISO/IEC 23008-2, included in the HEVC highest temporal sub-layer representation associated with $ES_{n,H}$.

with

- There is one multiplex buffer $MB_{n,k}$ for each received elementary stream $ES_{n,k}$, where the size $MBS_{n,k}$ of the multiplex buffer $MB_{n,k}$ is constrained as follows:

$$MBS_{n,k} = BS_{mux} + BS_{oh} + CpbNalFactor \times MaxCPB[tier, level] - cpb\_size$$

where cpb_size is taken from the HRD parameters, as specified in Annex E of Rec. ITU-T H.265 | ISO/IEC 23008-2, included in the HEVC highest temporal sub-layer representation associated with $ES_{n,H}$. In the HRD parameters, cpb_size is expressed in bits, and its value is implicitly converted into a value expressed in bytes according to Note 2 in 2.4.2.3.

Further, replace

- There is exactly one elementary stream buffer EB_n for the H + 1 elementary streams in the set of received elementary streams $ES_{n,0}$ to $ES_{n,H}$, with a total size EBS_n

$$EBS_n = cpb\_size \text{ (measured in bytes)}$$

where cpb_size is taken from the HRD parameters, as specified in Annex E of Recommendation. ITU-T H.265 | ISO/IEC 23008-2, included in the HEVC highest temporal sub-layer representation associated with $ES_{n,H}$.

with

- There is exactly one elementary stream buffer EB_n for the H + 1 elementary streams in the set of received elementary streams $ES_{n,0}$ to $ES_{n,H}$, with a total size EBS_n

$$EBS_n = cpb\_size$$

where cpb_size is taken from the HRD parameters, as specified in Annex E of Rec. ITU-T H.265 | ISO/IEC 23008-2, included in the HEVC highest temporal sub-layer representation associated with $ES_{n,H}$. In the HRD parameters, cpb_size is expressed in bits, and its value is implicitly converted into a value expressed in bytes according to Note 2 in 2.4.2.3.

Further, replace

Otherwise, the leak method shall be used to transfer data from $MB_{n,k}$ to EB_n as follows:

$$Rbx_{n,k} = CpbBrNalFactor \times MaxBR[tier, level]$$

with

Otherwise, the leak method shall be used to transfer data from $MB_{n,k}$ to EB_n as follows:

$$Rbx_{n,k} = BrNalFactor \times MaxBR[tier, level]$$

4) Clause 2.17.4, Extensions for layered transport of HEVC sub-partitions with bitstream-partition-specific CPB operation

In clause 2.17.4, replace:

- There is one multiplex buffer $MB_{l,k}$ for each received elementary stream $ES_{l,k}$, where the size $MBS_{l,k}$ of the multiplex buffer $MB_{l,k}$ is constrained as follows:

$$MBS_{n,k} = BS_{mux} + BS_{oh} + CpbBrNalFactor \times MaxCPB[tier, level] - cpb\_size \text{ (measured in bytes)}$$

where

BS_{oh}, packet overhead buffering, and BS_{mux}, additional multiplex buffering, are as specified in clause 2.17.2;

MaxCPB[tier, level] and MaxBR[tier, level] are taken from the tier and level specification of HEVC for the tier and level of $ES_{l,k}$ the HEVC operation point associated with $ES_{l,k}$;

cpb_size is taken from the sub-layer HRD parameters within the applicable hrd_parameters( ), as specified in Annex F of Recommendation. ITU-T H.265 | ISO/IEC 23008-2, for the HEVC operation point associated with $ES_{l,k}$.

There is one elementary stream buffer EB_l for the Hl + 1 elementary streams in the set of received elementary streams $ES_{l,0}$ to $Esl_{m,Hl}$, with a total size EBS_l

$$EBS_l = cpb\_size \text{ (measured in bytes)}$$

where cpb_size is taken from the sub-layer HRD parameters within the applicable hrd_parameters( ), as specified in Annex F of Recommendation. ITU-T H.265 | ISO/IEC 23008-2, for the HEVC operation point associated with $ES_{l,H}$.

with

- There is one multiplex buffer $MB_{l,k}$ for each received elementary stream $ES_{l,k}$, where the size $MBS_{l,k}$ of the multiplex buffer $MB_{l,k}$ is constrained as follows:

$$MBS_{l,k} = BS_{mux} + BS_{oh} + CpbNalFactor \times MaxCPB[tier, level] - cpb\_size$$

where

BS_{oh}, packet overhead buffering, and BS_{mux}, additional multiplex buffering, are as specified in 2.17.2;

MaxCPB[tier, level] and MaxBR[tier, level] are taken from the tier and level specification of HEVC for the tier and level of $ES_{l,k}$ the HEVC operation point associated with $ES_{l,k}$;

cpb_size is taken from the sub-layer HRD parameters within the applicable hrd_parameters( ), as specified in Annex F of Rec. ITU-T H.265 | ISO/IEC 23008-2, for the HEVC operation point associated with $ES_{l,k}$. In the HRD parameters, cpb_size is expressed in bits, and its value is implicitly converted into a value expressed in bytes according to Note 2 in 2.4.2.3.

There is one elementary stream buffer EB_l for the Hl + 1 elementary streams in the set of received elementary streams $ES_{l,0}$ to $Esl_{m,Hl}$, with a total size EBS_l

$$EBS_l = cpb\_size$$

where cpb_size is taken from the sub-layer HRD parameters within the applicable hrd_parameters( ), as specified in Annex F of Rec. ITU-T H.265 | ISO/IEC 23008-2, for the HEVC operation point associated with $ES_{l,H}$. In the HRD parameters, cpb_size is expressed in bits, and its value is implicitly converted into a value expressed in bytes according to Note 2 in 2.4.2.3.

Further, replace

- Otherwise, the leak method shall be used to transfer data from $MB_{l,k}$ to EB_l as follows:

$$Rbx_{n,k} = CpbBrNalFactor \times MaxBR[tier, level]$$

with

- Otherwise, the leak method shall be used to transfer data from $MB_{l,k}$ to EB_l as follows:

$$Rbx_{l,k} = BrNalFactor \times MaxBR[tier, level]$$

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	**Audiovisual and multimedia systems**
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2017