International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.286

(03/2009)

SERIES J: CABLE NETWORKS AND TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Digital transmission of television signals

Seamless splicing for heterogeneous ITU-T H.262 | ISO/IEC 13818-2 (MPEG-2 video) and ITU-T H.264 | ISO/IEC 14496-10 bitstreams

Recommendation ITU-T J.286

Recommendation ITU-T J.286

Seamless splicing for heterogeneous ITU-T H.262 | ISO/IEC 13818-2 (MPEG-2 video) and ITU-T H.264 | ISO/IEC 14496-10 bitstreams

Summary

For distribution of video content encoded in the multiple types of compression methods, bitstream domain splicing between these heterogeneous bitstreams are necessary to avoid picture quality degradation and latency caused by transcoding.

Recommendation ITU-T J.286 defines a messaging format and constraints on bitstreams to achieve seamless splicing of heterogeneous bitstreams that conform to Recommendation ITU-T H.262 | ISO/IEC 13818-2 (also known as "MPEG-2 video") or Recommendation ITU-T H.264 | ISO/IEC14496-10 (also known as "MPEG-4 AVC"). The messaging format is defined as an extension of Recommendation ITU-T J.181, which is intended to enable the splicing device with relevant information of the bitstreams to be spliced. If the splicing device is aware of the video coding types of the subsequent bitstream in advance of the splicing event, it would be able to take more appropriate action for splicing of the different types of bitstreams. This Recommendation thus provides a mechanism to notify the type of the bitstream to be switched over. In addition, constraints on the bitstreams are also defined based on Recommendation ITU-T J.189 to facilitate seamless playback between MPEG-2 video and ITU-T H.264 by the decoder that satisfies requirements for seamless splicing of heterogeneous bitstreams.

For seamless splicing, such constraints can apply at the encoder when it compresses an input video or at the splicing device by making modifications on input bitstreams. The decoder is required to be capable of seamless decoding and playback of concatenated bitstreams conforming to the constraints defined by this Recommendation. This means that a conventional dual-mode decoder requiring firmware reloading and resetting to change the mode might not be functional. How to apply the constraints at the encoder or at the splicing device, how to upgrade the existing ITU-T J.181 splicing devices to ITU-T J.286 ones, and how to develop the decoder for this system is design dependent, and outside the scope of this Recommendation.

Source

Recommendation ITU-T J.286 was approved on 22 March 2009 by ITU-T Study Group 9 (2009-2012) under Recommendation ITU-T A.8 procedures.

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 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/.

CONTENTS

Recommendation ITU-T J.286

Seamless splicing for heterogeneous ITU-T H.262 | ISO/IEC 13818-2 (MPEG-2 video) and ITU-T H.264 | ISO/IEC 14496-10 bitstreams

1 Scope

While MPEG-2 video, defined in [MPEG-2], is adopted in a number of television systems, it is expected that the video coding method will be shifted to [ITU-T H.264] in order to take advantage of its improved coding efficiency. During the changeover period, there might be the situation where both MPEG-2 video and ITU-T H.264 exist as a compression method of video content. In addition to the migration purposes, there could be such cases that MPEG-2 video is preferably used even in the ITU-T H.264-based system to avoid transcoding when content owner wishes to maintain the original bitstreams. They can also take advantage of compression noise characteristics of MPEG-2 video, which is preferable to some source materials using [ITU-T H.264]. These situations would require distribution of video content encoded in the multiple types of compression methods and bitstream domain splicing between these heterogeneous bitstreams.

This Recommendation defines a messaging format and constraints on bitstreams to achieve seamless splicing of heterogeneous bitstreams that conform to ITU-T H.262 | ISO/IEC 13818-2 (also known as "MPEG-2 video") or ITU-T H.264 | ISO/IEC 14496-10 (also known as "MPEG-4 AVC"). The messaging format is defined as an extension of [ITU-T J.181], which is intended to enable the splicing device with relevant information of the bitstreams to be spliced. If the splicing device is aware of the video coding types of the subsequent bitstream in advance of the splicing event, it would be able to take more appropriate action for splicing of the different types of bitstreams. This Recommendation thus provides a mechanism to notify the type of the bitstream to be switched over. In addition, additional constraints on the bitstreams are also defined based on [ITU-T J.189] to facilitate seamless playback between MPEG-2 video and ITU-T H.264 by the decoder that satisfies requirements for seamless splicing of heterogeneous bitstreams.

"Seamless splicing", as used in this Recommendation, means switching from one video elementary stream to a second video elementary stream in the following manner:

- Continuity of the spliced bitstream is maintained;
- Switching occurs at a Transport Stream packet boundary;
- No underflow or overflow of the decoder buffer occurs as a result of the splice;
- Correct syntax as defined in [ITU-T H.222.0] is maintained and the splice may result in discontinuities in timebase or continuity counter;
- No visible artifacts in the reconstructed baseband video are introduced;
- No audio codec change is supported by this Recommendation.

For seamless splicing, such constraints can apply at the encoder when it compresses an input video or at the splicing device by making modifications on input bitstreams. The decoder is required to be capable of seamless decoding and playback of concatenated bitstreams conforming to the constraints defined by this Recommendation. This means that a conventional dual-mode decoder that requires firmware reloading and resetting to change the mode might not be able to be used. How to apply the constraints at the encoder or at the splicing device, how to upgrade the existing ITU-T J.181 splicing devices to ITU-T J.286 ones, and how to develop the decoder for this system is design dependent, and outside the scope of this Recommendation.

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 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 H.264] Recommendation ITU-T H.264 (2005) | ISO/IEC 14496-10:2005, *Advanced video coding for generic audiovisual services*.

[ITU-T J.181] Recommendation ITU-T J.181 (2004), *Digital program insertion cueing message for cable television systems*.

[ITU-T J.189+Cor1] Recommendation ITU-T J.189 (2002), *Seamless splicing for MPEG-2 bitstreams*, plus Corrigendum 1 (2003).

[MPEG-2] Recommendation ITU-T H.262 (2000) | ISO/IEC 13818-2:2000, *Information technology – Generic coding of moving pictures and associated audio information: Video*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following term defined elsewhere:

3.1.1 NAL unit [ITU-T H.264]: A syntax structure containing an indication of the type of data to follow and bytes containing that data in the form of RBSP interspersed as necessary with emulation prevention bytes.

Other definitions refer to [ITU-T J.181] and [ITU-T J.189+Cor1].

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 MPEG-2 video: The video coding format defined in [ITU-T H.222.0]. The transport syntax of a spliceable bit stream is recommended in [ITU-T H.222.0], so called MPEG-2 Transport Stream or MPEG-2 TS.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

CPB Coded Picture Buffer

IDR Instantaneous Decoding Refresh

MPEG Moving Picture Experts Group

NAL Network Adaptation Layer

PES Packetized Elementary Stream

PID Packet Identifier

PPS Picture Parameter Set

RBSP Raw Byte Sequence Payload

SEI Supplemental Enhancement Information

SPS Sequence Parameter Set

TS Transport Stream

VBV Video Buffer Verifier

5 Bitstream splicing techniques

5.1 Configuration

The following descriptions are based on clause 4.1 of [ITU-T J.189+Cor1] with some enhancements.

The transport syntax of a spliceable bit stream is recommended in [ITU-T H.222.0], so called MPEG-2 Transport Stream or MPEG-2 TS. MPEG-2 TS carries both MPEG-2 encoded and ITU-T H.264 encoded video bit streams. A spliceable bit stream means a PID stream whose discontinuity in a time-stamp or a time base can be processed seamlessly by the MPEG-2/ ITU-T H.264 bit stream splicing device. This mechanism is not sufficient for achieving a reliable splicing operation because of the following reasons:

– Splicing devices cannot obtain any preceding information indicating the time schedule with regard to upcoming splice points where a seamless program insertion is ensured.

– In the case of a program insertion, synchronization of all PID streams, which constitute the program, cannot necessarily be established.

Figure 1 shows the configuration of the splicing technique for the MPEG-2/ITU-T H.264 heterogeneous bit streams assumed in this Recommendation. In this figure, ENC_A and ENC_B are different types of video encoders, for example ENC_A is MPEG-2 and ENC_B is H.264, or vice versa. The transport mechanism of scheduling information is based on [ITU-T J.181] with an extension defined in this Recommendation. In addition, constraints are required for the seamless splicing of the heterogeneous bit streams. This Recommendation defines additional constraints on bit-stream splice points based on [ITU-T J.189] and the desirable operation of the splicing device, which are required to achieve the seamless splicing.

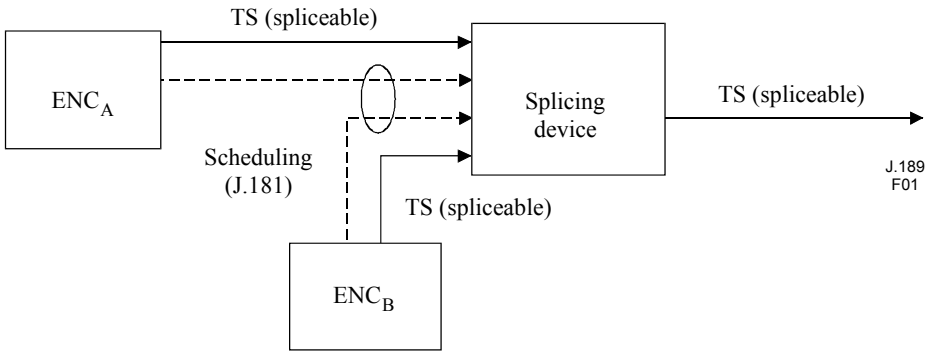

Figure 1 – Configuration of seamless splicing technique for the MPEG-2/ ITU-T H.264 heterogeneous bit streams

5.2 MPEG-2 Transport Stream syntax required for seamless splicing

Clause 4.2 of [ITU-T J.189+Cor1] describes requirements on transport stream syntax for seamless splicing. This section identifies usage of relevant fields contained in an adaptation field of transport stream packet, i.e., splicing_point_flag, splice_countdown, seamless_splice_flag, splice_type and DTS_next_AU. The same requirements shall apply to transport stream syntax for seamless splicing defined in this Recommendation. See clause 4.2 of [ITU-T J.189+Cor1] for further details.

5.3 Transport mechanism of scheduling information for splicing devices

5.3.1 Basic mechanism based on [ITU-T J.181]

The following descriptions are based on clause 4.3.1 of [ITU-T J.189+Cor1] with some enhancements.

Detailed information on a splicing event (the possible splice point, the PID of the spliced stream, the schedule of upcoming splicing events, etc.) can be mapped into a bit stream as the splice information section specified in [ITU-T J.181]. The splice information section notifies the splicing device of scheduled splice events prior to the arrival of splice points, and enables the splicing device to ensure a reliable splicing operation. The splice information section shall be carried in transport stream packets within their own PID streams. [ITU-T J.181] itself makes no requirements for the preconditioning of an input bit stream in addition to the MPEG-2 or ITU-T H.264 standards and it also places no requirements upon how a splicing device must operate. [ITU-T J.181] is limited entirely to the area of signalling.

It should be noted that the splice information section defined in this clause is intended to convey information to the splicing device, NOT to the decoder. The splice information section would be dropped at the splicing device or needs to be ignored by the decoder even if it arrives at the decoder.

5.3.1.1 Extended definition of the syntax of the splice information section

Table 1 shows the syntax enhancement of the splice information section defined in [ITU-T J.181].

Table 1 – splice_info_section()

Syntax	Bits	Mnemonic	Encrypted
splice_info_section() {			
table_id	**8**	**uimsbf**	
section_syntax_indicator	**1**	**bslbf**	
private_indicator	**1**	**bslbf**	
reserved	**2**	**bslbf**	
section_length	**12**	**uimsbf**	
protocol_version	**8**	**uimsbf**	
encrypted_packet	**1**	**bslbf**	
encryption_algorithm	**6**	**uimsbf**	
pts_adjustment	**33**	**uimsbf**	
cw_index	**8**	**uimsbf**	
reserved	**12**	**bslbf**	
splice_command_length	**12**	**uimsbf**	
splice_command_type	**8**	**uimsbf**	**E**
if (splice_command_type == 0x00)			
splice_null()			**E**
if (splice_command_type == 0x04)			
splice_schedule()			**E**

Table 1 – splice_info_section()

Syntax	Bits	Mnemonic	Encrypted
if (splice_command_type == 0x05)			
splice_insert()			**E**
if (splice_command_type == 0x06)			
splice_signal()			**E**
if (splice_command_type == 0x07)			
bandwidth_reservation()			**E**
if (splice_command_type == 0x08)			
stream_type_change()			**E**
descriptor_loop_length	**16**	**uimsbf**	**E**
for (i = 0; i < N1; i++)			
splice_descriptor()			**E**
for (i = 0; i < N2; i++)			
alignment_stuffing	**8**	**bslbf**	**E**
if (encrypted_packet)			
E_CRC_32	**32**	**rpchof**	**E**
CRC_32	**32**	**rpchof**	
}			

This Recommendation extends the value of table_id and the definition of stream_command_type_value as follows.

table_id: This is an 8-bit field, which shall always be set to the unique value that is defined by the regional authority for numbering on digital broadcasting.

Table 2 – splice_command_type values

splice_command_type_value	Command
0x00	splice_null
0x01	Reserved
0x02	Reserved
0x03	Reserved
0x04	splice_schedule
0x05	splice_insert
0x06	time_signal
0x07	bandwidth_reservation
0x08	stream_type_change
0x09-0xFF	Reserved

5.3.1.2 Definition of the stream_type_change() command

The stream_type_change() command is provided to notify the change in the coding method in splice events to be conveyed in advance. See Table 3.

Table 3 – stream_type_change()

Syntax	Bits	Mnemonic

stream_type_change() {
splice_event_id
next_stream_program_map()
}
	32	**uimsbf**

5.3.1.2.1 Semantic definition of fields in stream_type_change()

splice_event_id: A 32-bit unique splice event identifier.

5.3.1.3 next_stream_program_map()

The next_stream_program_map() command is provided to notify the splicing device of parameters contained in the program map table (PMT), bit rate and the buffer size of the stream which will appear after the splice event. This PMT may include PID of the elementary stream and its program clock Reference (pCR). See Table 4.

Table 4 – next_stream_program_map()

Syntax	Bits	Mnemonic
next_stream_program_map() {		
reserved	**8**	**uimsbf**
syntax_indicator	**1**	**bslbf**
'0'	**1**	**bslbf**
reserved	**2**	**bslbf**
length	**12**	**uimsbf**
program_number	**16**	**uimsbf**
reserved	**2**	**bslbf**
version_number	**5**	**uimsbf**
current_next_indicator	**1**	**bslbf**
section_number	**8**	**uimsbf**
last_section_number	**8**	**uimsbf**
reserved	**3**	**bslbf**
PCR_PID	**13**	**uimsbf**
for (i = 0; i < N; i++) {		
stream_type	**8**	**uimsbf**
reserved	**3**	**bslbf**
elementary_PID	**13**	**uimsbf**
bit_rate	**30**	**uimsbf**
buffer_size	**18**	**uimsbf**
}		
CRC_32	**32**	**rpchof**
}		

5.3.1.3.1 Semantic definition of fields in next_stream_program_map()

syntax_indicator: The syntax_indicator is a 1-bit field which shall be set to '1'.

length: This is a 12-bit field, the first two bits of which shall be '00'. The remaining 10 bits specify the number of bytes of the data contained in next_stream_program_map() starting immediately

following the length field, and including the CRC. The value in this field shall not exceed 1021 (0x3FD).

program_number: See clause 2.4.4.9 in [ITU-T H.222.0].

version_number: See clause 2.4.4.9 in [ITU-T H.222.0].

current_next_indicator: See clause 2.4.4.9 in [ITU-T H.222.0].

section_number: See clause 2.4.4.9 in [ITU-T H.222.0].

last_section_number: See clause 2.4.4.9 in [ITU-T H.222.0].

PCR_PID: See clause 2.4.4.9 in [ITU-T H.222.0].

stream_type: See clause 2.4.4.9 in [ITU-T H.222.0].

elementary_PID: See clause 2.4.4.9 in [ITU-T H.222.0].

bit_rate: This 30-bit field indicates the bit rate of the elementary stream and is measured in units of 400 bits/second. In case of ITU-T H.264 video streams, the bit_rate value might need to be truncated into an integer value.

buffer_size: This 18-bit field indicates the size of the buffer required to decode the elementary stream. It is defined as:

$$B = 16 * 1024 * \text{buffer\_size (bits)}$$

where B is the actual size of the buffer. B shall be interpreted as a VBV buffer size for MPEG-2 video. B shall be interpreted as the CPB buffer size at the splice point for ITU-T H.264 video. In case of ITU-T H.264 video streams, the buffer_size value might need to be truncated into an integer value.

CRC_32: This is a 32-bit field that contains the CRC value that gives a zero output of the registers in the decoder defined in Annex A of [ITU-T H.222.0] after processing the entire next_stream_program_map.

5.3.2 Constraints for seamless splicing

When applying [ITU-T J.181] as the splice information section, this Recommendation requires that the Out Point and the In Point shall meet the following constraints in order to achieve seamless splicing. For video PID streams, seamless splicing between a low-delay sequence and a sequence containing at least one B-picture is not aimed at in this Recommendation.

5.3.2.1 Out Point constraints

5.3.2.1.1 For all PID streams

See clause 4.3.2.1.1 of [ITU-T J.189+Cor1].

5.3.2.1.2 For video or audio PID streams

The following are out point constraints for video or audio PID streams based on clause 4.3.2.1.2 of [ITU-T J.189+Cor1].

- The seamless_splice_flag shall be set to 1 in the Out Point packet.
- DTS_next_AU shall be set in the Out Point packet, according to the definition in [ITU-T H.222.0].
- The Out Point packet shall carry the splice_type field.
- For video PID streams, the value of the splice_type shall be selected from the table defined in [ITU-T H.222.0]. For audio PID streams, the value of the splice_type shall be set to "0000".

- For MPEG-2 video PID streams, the last picture (in presentation order) preceding an Out Point shall be either a P- or an I-picture. An Out Point shall not occur between the two fields of a coded frame.
- For ITU-T H.264 video PID streams, the last picture (in presentation order) preceding an Out Point shall be a picture that consists of I- or P-slices where only forward predictions are used. An Out Point shall not occur between the two fields of a coded frame.
- For ITU-T H.264 video PID streams, bitstream shall end with end_of_stream NAL unit.
- For audio PID streams, if audio is organized into frames, then the last byte of an Out Point packet shall be the last byte of an audio frame.
- To enable seamless splicing, the last payload byte of the Out Point Packet shall remain in the VBV or CPB buffer an amount of time equal to:
  - splice_decoding_delay – Display_Period_last_AU_{old};

  where Display_Period_last_AU_{old} is the display duration of the video access unit of the old material which begins presentation at the time when the last video access unit is removed from the buffer (see [ITU-T H.222.0]).
- To enable seamless splicing, the last picture (in presentation order) before an Out Point shall be either a frame picture or a bottom field picture.

  For MPEG-2 video, in the case of an interlaced sequence (progressive_sequence equals '0'), the following constraints on the use of top_field_first and repeat_first_field shall apply:
  - If the last picture (in presentation order) before an Out Point is a frame picture with the top_field_first bit equal to '1', then the repeat_first_field bit of that picture shall be '0'.
  - If the last picture (in presentation order) before an Out Point is a frame picture with the top_field_first bit equal to '0', then the repeat_first_field bit of that picture shall be '1'.

  For ITU-T H.264 video, in the case of an interlaced sequence (mb_adaptive_frame_field_flag equals '1' and field_pic_flag equals '0'), the following constraints on the use of pic_struct in Picture Timing SEI message shall apply:
  - If the last picture (in presentation order) before an Out Point is a frame picture with 'top field first', then the pic_struct value of that picture shall be '3' (top, bottom, in that order).
  - If the last picture (in presentation order) before an Out Point is a frame picture with 'bottom field first', then the pic_struct value of that picture shall be '6' (bottom, top, bottom repeated, in that order).

5.3.2.2 In Point constraints

5.3.2.2.1 For all PID streams

See clause 4.3.2.2.1 of [ITU-T J.189+Cor1].

5.3.2.2.2 For video or audio PID streams

The following are in point constraints for video or audio PID streams based on clause 4.3.2.2.2 of [ITU-T J.189+Cor1].

- For video or audio PID streams, the data_alignment_indicator of the PES packet shall be set to 1.
- For video or audio PID streams, the random_access_indicator shall be set to 1 in the In Point packet.
- For MPEG-2 video PID streams, the first PES packet payload following an In Point shall begin with a sequence header. Any P-picture or B-picture following an In Point shall not use a prediction which references pictures prior to the In Point. In other words, in the case

of a progressive refresh coding structure being applied, the first coded picture after the sequence header shall be a P picture whose macroblocks are all intra coded. When progressive refresh coding is not being used, the first coded picture following an In Point shall be an I-frame.

- For H.264 video PID streams, the first PES packet payload following an In Point shall begin with an access unit delimiter NAL unit, followed by Sequence and Picture Parameter Sets (SPS and PPS) NAL units and SEI NAL units of Buffering Period SEI and Picture Timing SEI. Any P-slice or B-slice following an In Point shall not use a prediction which references pictures prior to the In Point. In the case of a progressive refresh coding structure being applied, the first coded picture after the SPS or PPS shall consist of I- or P-slices whose macroblocks are all intra coded. When progressive refresh coding is not being used, the first coded picture following an In Point shall be an IDR-frame. This Recommendation does NOT support splicing with the use of the Recovery Point SEI message.
- The value of splice_type shall be selected from Table 2-7 through Table 2-20 of [ITU-T H.222.0] or an extended definition listed in Table 1 of [ITU-T J.189+Cor1] for MPEG-2 video PID streams. To enable seamless splicing, the value shall not be '1111'. For In Points which do not satisfy the constraints for seamless splicing, the value shall be '1111'.
- For ITU-T H.264 video PID streams, the value of splice_type shall be '0000' according to the definition of [ITU-T H.222.0]. This means that no conditions are specified for ITU-T H.264 video PID streams with regard to splice_decoding_delay and max_splice_rate, both of which can be interpreted from the splice_type value in case of MPEG-2 video PID streams. This condition would prevent buffer overflow during the period where the payload before an Out Point and that following an In Point co-exist in a buffer. For ITU-T H.264 video PID streams, buffer overflow shall be avoided even without any condition specified by splice_type during the period between the arrival time of the last byte of the payload before an Out Point and the removal time of the last picture before an Out Point from the buffer.
- For MPEG-2 video PID streams, to enable seamless splicing, the time between when the first byte of the PES payload following an In Point enters the VBV buffer and the time when that byte is removed from the VBV buffer shall be equal to the splice_decoding_delay time given in Table 1 of [ITU-T J.189+Cor1] as determined by the value of splice_type in the In Point Packet and the profile_and_level_indication in the sequence_extension().
- For ITU-T H.264 video PID streams, to enable seamless splicing, the time between when the first byte of the PES payload following an In Point enters the HRD buffer and the time when that byte is removed from the HRD buffer shall be equal to the initial_cpb_removal_delay time in the Buffering Period SEI NAL unit.
- For MPEG-2 video PID streams, to enable seamless splicing, the picture_structure of the first picture (in presentation order) after an In Point shall be either Frame picture ('11') or Top Field ('01'). In the case of an interlaced sequence (progressive_sequence equals '0'), the following constraint shall hold:
  - If the picture_structure of the first picture (in presentation order) after an In Point is Frame picture, then the top_field_first bit shall be equal to '1' for that picture.
- For ITU-T H.264 video PID streams, to enable seamless splicing, the pic_struct of the first picture (in presentation order) after an In Point shall be either Frame picture ('0') or Top Field ('1'). In the case of an interlaced sequence, the following constraint shall hold:
  - If the first picture (in presentation order) after an In Point is Frame picture, then the pic_struct value shall be equal to '3' or '5' for that picture.

- For video PID streams, scan method (progressive or interlaced) and field structure (if interlaced) is strongly recommended to be maintained between an Out Point and an In Point to avoid the scan mode change at the video display device.
- For audio PID streams, if audio is organized into frames, the first payload byte following an In Point shall be the first byte of an audio frame.
- For audio PID streams, data required for decoding the audio access units following the In Point shall not be contained in any audio frames prior to the In Point.

5.3.2.3 Program Splice Point constraints

See clause 4.3.2.3 of [ITU-T J.189+Cor1].

5.3.2.3.1 Out Point constraints

See clause 4.3.2.3.1 of [ITU-T J.189+Cor1].

5.3.2.3.2 In Point constraints

See clause 4.3.2.3.2 of [ITU-T J.189+Cor1].

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
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	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	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
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 and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2010