

I n t e r n a t i o n a l T e l e c o m m u n i c a t i o n U n i o n

**ITU-T**

TELECOMMUNICATION  
STANDARDIZATION SECTOR  
OF ITU

**H.222.0**  
**Amendment 4**  
(12/2009)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS  
Infrastructure of audiovisual services – Transmission  
multiplexing and synchronization

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Information technology – Generic coding of moving  
pictures and associated audio information: Systems  
**Amendment 4: Transport of multiview video  
over Rec. ITU-T H.222.0 | ISO/IEC 13818-1**

Recommendation ITU-T H.222.0 (2006) – Amendment 4



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

**Amendment 4**

**Transport of multiview video over Rec. ITU-T H.222.0 | ISO/IEC 13818-1**

**Summary**

Amendment 4 to Recommendation ITU-T H.222.0 | ISO/IEC 13818-1 specifies the transport of bit-streams conforming to one or more profiles defined in Annex H of Recommendation ITU-T H.264 (03/2009) | ISO/IEC 14496-10:2009 over MPEG-2 Transport Streams as defined in Recommendation ITU-T H.222.0 (05/2006) | ISO/IEC 13818-1:2007 and Recommendation ITU-T H.222.0 (05/2006) | ISO/IEC 13818-1:2007/Amd.3 – Transport of scalable video over Rec. ITU-T H.222.0 | ISO/IEC 13818-1.

A number of use cases can be supported, if different view subsets with different values of view\_id of the multiview bit-stream are transported as different elementary streams (ES). This allows for de-multiplexing on transport stream (TS) level, which is the prerequisite for selective access to a certain set of views, selective content protection, or unequal error protection mechanisms. MPEG-2 TS already specifies the transport of network abstraction layer (NAL) units conforming to one or more profiles defined in Annex A of Recommendation ITU-T H.264 | ISO/IEC 14496-10. This amendment makes extensions for supporting NAL units and bit-streams according to Annex H of Recommendation ITU-T H.264 | ISO/IEC 14496-10.

**History**

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2.1	ITU-T H.222.0 (2000) Technical Cor. 1	2001-03-01	16
2.2	ITU-T H.222.0 (2000) Technical Cor. 2	2002-03-29	16
2.3	ITU-T H.222.0 (2000) Amend. 1	2002-12-14	16
2.4	ITU-T H.222.0 (2000) Amend. 1/Cor. 1	2003-06-29	16
2.5	ITU-T H.222.0 (2000) Amend. 2	2003-06-29	16
2.6	ITU-T H.222.0 (2000) Amend. 3	2004-03-15	16
2.7	ITU-T H.222.0 (2000) Technical Cor. 3	2005-01-08	16
2.8	ITU-T H.222.0 (2000) Amend. 4	2005-01-08	16
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2.10	ITU-T H.222.0 (2000) Technical Cor. 4	2005-09-13	16
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3.1	ITU-T H.222.0 (2006) Amend.1	2007-01-13	16
3.2	ITU-T H.222.0 (2006) Amend.2	2007-08-29	16
3.3	ITU-T H.222.0 (2006) Cor.1	2008-06-13	16
3.4	ITU-T H.222.0 (2006) Cor.2	2009-03-16	16
3.5	ITU-T H.222.0 (2006) Amend.3	2009-03-16	16
3.6	ITU-T H.222.0 (2006) Cor.3	2009-12-14	16
3.7	ITU-T H.222.0 (2006) Cor.4	2009-12-14	16
3.8	ITU-T H.222.0 (2006) Amend.4	2009-12-14	16

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INTERNATIONAL STANDARD  
RECOMMENDATION ITU-TInformation technology – Generic coding of moving pictures  
and associated audio information: Systems

## Amendment 4

## Transport of multiview video over Rec. ITU-T H.222.0 | ISO/IEC 13818-1

## 1) Subclause 1.2.2

In 1.2.2, Paired Recommendations | International Standards equivalent in technical content, replace:

- ITU-T Recommendation H.264 (2007), *Advanced video coding for generic audiovisual services*.  
ISO/IEC 14496-10:2008, *Information technology – Coding of audio-visual objects – Part 10: Advanced video coding*.

with:

- ITU-T Recommendation H.264 (2009), *Advanced video coding for generic audiovisual services*.  
ISO/IEC 14496-10:2009, *Information technology – Coding of audio-visual objects – Part 10: Advanced Video Coding*.

## 2) Subclause 2.1

a) In 2.1.78, replace:

**AVC video sub-bitstream:** The video sub-bitstream that contains the base layer as defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10 and that shall additionally contain NAL units with `nal_unit_type` equal to 14 (prefix NAL units). The AVC video sub-bitstream contains all VCL NAL units associated with `dependency_id` equal to 0.

with:

**AVC video sub-bitstream of SVC:** The video sub-bitstream that contains the base layer as defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10 and that shall additionally contain NAL units with `nal_unit_type` equal to 14 (prefix NAL units) as defined for SVC in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10. The AVC video sub-bitstream of SVC contains all VCL NAL units associated with `dependency_id` equal to 0.

b) In 2.1.81, replace:

**SVC slice (system):** A `byte_stream_nal_unit` as defined in ITU-T Rec. H.264 | ISO/IEC 14496-10 with `nal_unit_type` equal to 20.

with:

**SVC slice (system):** A `byte_stream_nal_unit` as defined in ITU-T Rec. H.264 | ISO/IEC 14496-10 with `nal_unit_type` equal to 20 of an AVC video stream which conforms to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10.

NOTE – As specified in ITU-T Rec. H.264 | ISO/IEC 14496-10, the value of `svc_extension_flag` is set equal to 1 for coded video sequences conforming to one or more profiles specified in Annex G. SVC slices should not include NAL units for which `nal_unit_type` is equal to 20 with `svc_extension_flag` equal to 0.

c) After 2.1.81, add subclauses 2.1.82 – 2.1.88:

**2.1.82 view order index:** An index that indicates the decoding order of MVC view components in an AVC access unit as defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10. The association of view order index values to the NAL unit header syntax element `view_id` is indicated for an AVC video sequence in the sequence parameter set MVC extension as defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10.

**2.1.83 MVC view\_id subset:** A set of one or more `view_id` values, as defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10 in the NAL unit header syntax element, associated with one set of consecutive view order index values.

**2.1.84 MVC video sub-bitstream:** The MVC video sub-bitstream is defined to be all VCL NAL units with `nal_unit_type` equal to 20 associated with the same MVC `view_id` subset of an AVC video stream and associated non-VCL NAL units which conform to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10.

NOTE – In contrast to a sub-bitstream as specified in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, an MVC video sub-bitstream according to this Specification is not necessarily a decodable MVC video sub-bitstream. The one exception is when an MVC video sub-bitstream is also an MVC base view sub-bitstream. Re-assembling MVC video sub-bitstreams in an increasing order of view order index, starting from the lowest value of view order index up to any value of view order index, results in a decodable AVC video stream.

**2.1.85 MVC base view sub-bitstream:** The MVC base view sub-bitstream is defined to contain the AVC video sub-bitstream of MVC conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10 and one additional MVC video sub-bitstream associated with an MVC `view_id` subset including the view order index that immediately follows the view order index associated with the base view.

NOTE – The MVC base view sub-bitstream is also an AVC video stream where no re-assembly is required before decoding.

**2.1.86 MVC view-component subset:** The VCL NAL units of an AVC access unit associated with the same MVC `view_id` subset and associated non-VCL NAL units.

NOTE – Re-assembling MVC view-component subsets ordered according to the view order index, starting from the minimum view order index up to the highest view order index present in the access unit, while reordering the non-VCL NAL units conforming to the order of NAL units within an access unit, as defined in ITU-T Rec. H.264 | ISO/IEC 14496-10, results in an AVC access unit.

**2.1.87 MVC slice (system):** A `byte_stream_nal_unit` with `nal_unit_type` syntax element equal to 20 of an AVC video stream which conforms to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10.

NOTE – As specified in ITU-T Rec. H.264 | ISO/IEC 14496-10, the value of `svc_extension_flag` is set equal to 0 for coded video sequences conforming to one or more profiles specified in Annex H. MVC slices should not include NAL units for which `nal_unit_type` is equal to 20 with `svc_extension_flag` equal to 1.

**2.1.88 AVC video sub-bitstream of MVC:** The video sub-bitstream that contains the base view as defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, containing all VCL NAL units associated with the minimum value of view order index present in each AVC video sequence of the AVC video stream. The AVC video sub-bitstream of MVC may additionally contain the associated NAL units with `nal_unit_type` syntax element equal to 14 (prefix NAL units), as defined for MVC in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10.

### 3) Subclause 2.4.2.8

*In 2.4.2.8, T-STD extensions for carriage of ITU-T Rec. H.264 | ISO/IEC 14496-10 video, replace:*

To define the decoding in the T-STD of ITU-T Rec. H.264 | ISO/IEC 14496-10 video streams carried in a Transport Stream, the T-STD model needs to be extended. The T-STD extension and T-STD parameters for decoding of AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10 are defined in 2.14.3.1 and T-STD extension and T-STD parameters for decoding of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10 are defined in 2.14.3.5.

*with:*

To define the decoding in the T-STD of ITU-T Rec. H.264 | ISO/IEC 14496-10 video streams carried in a Transport Stream, the T-STD model needs to be extended. The T-STD extension and T-STD parameters for decoding of AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10 are defined in 2.14.3.1, T-STD extension and T-STD parameters for decoding of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10 are defined in 2.14.3.5, and T-STD extension and T-STD parameters for decoding of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10 are defined in 2.14.3.7.

### 4) Subclause 2.4.3.5

*In 2.4.3.5, Semantic definition of fields in "adaptation field", make the following modifications:*

a) *In the section specifying the "discontinuity\_indicator", replace:*

For the purpose of this clause, an elementary stream access point is defined as follows:

- ISO/IEC 11172-2 video and ITU-T Rec. H.262 | ISO/IEC 13818-2 video – The first byte of a video sequence header.
- ISO/IEC 14496-2 visual – The first byte of the visual object sequence header.

- AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10 – The first byte of an AVC access unit. The SPS and PPS parameter sets referenced in this and all subsequent AVC access units in the coded video stream shall be provided after this access point in the byte stream and prior to their activation.
- Video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10 – The first byte of an SVC dependency representation is an elementary stream access point if the following conditions are met:
  - The subset sequence parameter sets and picture parameter sets referenced in this and all subsequent SVC dependency representation in the video sub-bitstream shall be provided after this access point in the byte stream and prior to their activation.
  - If this SVC video sub-bitstream access point requires the elementary stream access point of the same AVC access unit, if any, contained in the corresponding elementary stream that needs to be present in decoding order before decoding the elementary stream associated with this elementary stream access point, then the corresponding elementary stream shall also include an elementary stream access point.
 

NOTE 1 – If the hierarchy descriptor is present for this SVC video sub-bitstream then the video sub-bitstream of which the `hierarchy_layer_index` equals the `hierarchy_embedded_layer_index` of this SVC sub-bitstream should have an elementary stream access point in the same access unit.
- Audio – The first byte of an audio frame.
- ISO/IEC 14496-17 text stream – The first byte of a text access unit. In case in-band sample descriptions are used, each in-band sample description shall be provided in the ISO/IEC 14496-17 stream after this access point and prior to its use by an access unit.

*with:*

For the purpose of this clause, an elementary stream access point is defined as follows:

- ISO/IEC 11172-2 video and ITU-T Rec. H.262 | ISO/IEC 13818-2 video – The first byte of a video sequence header.
- ISO/IEC 14496-2 visual – The first byte of the visual object sequence header.
- AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10 – The first byte of an AVC access unit. The SPS and PPS parameter sets referenced in this and all subsequent AVC access units in the coded video stream shall be provided after this access point in the byte stream and prior to their activation.
- Video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10 – The first byte of an SVC dependency representation is an elementary stream access point if the following conditions are met:
  - The subset sequence parameter sets and picture parameter sets referenced in this and all subsequent SVC dependency representation in the video sub-bitstream shall be provided after this access point in the byte stream and prior to their activation.
  - If this SVC video sub-bitstream access point requires the elementary stream access point of the same AVC access unit, if any, contained in the corresponding elementary stream that needs to be present in decoding order before decoding the elementary stream associated with this elementary stream access point, then the corresponding elementary stream shall also include an elementary stream access point.
 

NOTE 1 – If the hierarchy descriptor is present for this SVC video sub-bitstream then the video sub-bitstream of which the `hierarchy_layer_index` equals the `hierarchy_embedded_layer_index` of this SVC sub-bitstream should have an elementary stream access point in the same access unit.
- MVC video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10 – The first byte of an MVC view-component subset is an elementary stream access point if the following two conditions are met:
  - The subset sequence parameter sets and picture parameter sets referenced in this and all subsequent MVC view-component subsets in the MVC video sub-bitstream shall be provided after this access point in the byte stream and prior to their activation.
  - If this MVC video sub-bitstream access point requires the elementary stream access point of the same AVC access unit, if any, contained in the corresponding elementary stream that needs to be present in decoding order before decoding the elementary stream associated with this elementary stream access point, then the corresponding elementary stream shall also include an elementary stream access point.

NOTE 2 – If the hierarchy descriptor is present for this MVC video sub-bitstream, then the MVC video sub-bitstream of which the hierarchy\_layer\_index equals the hierarchy\_embedded\_layer\_index of this MVC sub-bitstream should have an elementary stream access point in this same access unit.

- Audio – The first byte of an audio frame.
- ISO/IEC 14496-17 text stream – The first byte of a text access unit. In case in-band sample descriptions are used, each in-band sample description shall be provided in the ISO/IEC 14496-17 stream after this access point and prior to its use by an access unit.

b) *Replace:*

**elementary\_stream\_priority\_indicator** – The elementary\_stream\_priority\_indicator is a 1-bit field. It indicates, among packets with the same PID, the priority of the elementary stream data carried within the payload of this Transport Stream packet. A '1' indicates that the payload has a higher priority than the payloads of other Transport Stream packets.

In the case of ISO/IEC 11172-2 or ITU-T Rec. H.262 | ISO/IEC 13818-2 or ISO/IEC 14496-2 video, this field may be set to '1' only if the payload contains one or more bytes from an intra-coded slice.

In the case of ITU-T Rec. H.264 | ISO/IEC 14496-10 video, this field may be set to '1' only if the payload contains one or more bytes from a slice with slice\_type set to 2, 4, 7, or 9.

A value of '0' indicates that the payload has the same priority as all other packets which do not have this bit set to '1'.

*with:*

**elementary\_stream\_priority\_indicator** – The elementary\_stream\_priority\_indicator is a 1-bit field. It indicates, among packets with the same PID, the priority of the elementary stream data carried within the payload of this Transport Stream packet. A '1' indicates that the payload has a higher priority than the payloads of other Transport Stream packets.

In the case of ISO/IEC 11172-2 or ITU-T Rec. H.262 | ISO/IEC 13818-2 or ISO/IEC 14496-2 video, this field may be set to '1' only if the payload contains one or more bytes from an intra-coded slice.

In the case of ITU-T Rec. H.264 | ISO/IEC 14496-10 video, this field may be set to '1' only if the payload contains one or more bytes from a slice with slice\_type set to 2, 4, 7, or 9.

A value of '0' indicates that the payload has the same priority as all other packets which do not have this bit set to '1'.

For MVC video sub-bitstreams or MVC base view sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, this field may be set to '1' only if the payload contains one or more bytes from an anchor picture, indicated by the slice type equal to 2, 4, 7, or 9 and the anchor\_pic\_flag syntax element equal to 1 for all prefix NAL units and slice extension NAL units.

## 5) Subclause 2.4.3.7

*In 2.4.3.7, Semantic definition of fields in PES packet, make the following modifications:*

a) *Replace:*

**stream\_id** – In Program Streams, the stream\_id specifies the type and number of the elementary stream as defined by the stream\_id Table 2-22. In Transport Streams, the stream\_id may be set to any valid value which correctly describes the elementary stream type as defined in Table 2-22. In Transport Streams, the elementary stream type is specified in the Program Specific Information as specified in 2.4.4.

For AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, all video sub-bitstreams of the same AVC video stream shall have the same stream\_id value.

*with:*

**stream\_id** – In Program Streams, the stream\_id specifies the type and number of the elementary stream as defined by the stream\_id Table 2-22. In Transport Streams, the stream\_id may be set to any valid value which correctly describes the elementary stream type as defined in Table 2-22. In Transport Streams, the elementary stream type is specified in the Program Specific Information as specified in 2.4.4.

For AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, all video sub-bitstreams of the same AVC video stream shall have the same stream\_id value.

For AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, all MVC video sub-bitstreams of the same AVC video stream shall have the same stream\_id value.

b) *In the section specifying the PTS (presentation time stamp), replace:*

For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, if a PTS is present in the PES packet header, it shall refer to the first SVC dependency representation that commences in this PES packet. An SVC dependency representation commences in a PES packet if the first byte of the SVC dependency representation is present in the PES packet. To achieve consistency between the STD model and the HRD model defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10, for each re-assembled and decoded AVC access unit, the PTS value in the STD shall, within the accuracy of their respective clocks, indicate the same instant in time as the nominal DPB output time in the HRD, defined herein as  $t_{o,n,dpb}(n) = t_{r,n}(n) + t_c * dpb\_output\_delay(n)$ , where  $t_{r,n}(n)$ ,  $t_c$ , and  $dpb\_output\_delay(n)$  are defined as in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10.

*with:*

For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, if a PTS is present in the PES packet header, it shall refer to the first SVC dependency representation that commences in this PES packet. An SVC dependency representation commences in a PES packet if the first byte of the SVC dependency representation is present in the PES packet. To achieve consistency between the STD model and the HRD model defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10, for each re-assembled and decoded AVC access unit, the PTS value in the STD shall, within the accuracy of their respective clocks, indicate the same instant in time as the nominal DPB output time in the HRD, defined herein as  $t_{o,n,dpb}(n) = t_{r,n}(n) + t_c * dpb\_output\_delay(n)$ , where  $t_{r,n}(n)$ ,  $t_c$ , and  $dpb\_output\_delay(n)$  are defined as in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10.

For MVC video sub-bitstreams, MVC base view sub-bitstream or AVC video sub-bitstream of MVC of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, if a PTS is present in the PES packet header, it shall refer to the first MVC view-component subset that commences in this PES packet. An MVC view-component subset commences in a PES packet if the first byte of the MVC view-component subset is present in the PES packet. To achieve consistency between the STD model and the HRD model defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10, for each re-assembled and decoded AVC access unit, the PTS value in the STD shall, within the accuracy of their respective clocks, indicate the same instant in time as the nominal DPB output time in the HRD, defined herein as  $t_{o,n,dpb}(n) = t_{r,n}(n) + t_c * dpb\_output\_delay(n)$ , where  $t_{r,n}(n)$ ,  $t_c$ , and  $dpb\_output\_delay(n)$  are defined as in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10.

c) *In the section specifying the DTS (decoding time stamp), replace:*

For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, if a DTS is present in the PES packet header, it shall refer to the first SVC dependency representation that commences in this PES packet. An SVC dependency representation commences in a PES packet if the first byte of the SVC dependency representation is present in the PES packet. To achieve consistency between the STD model and the HRD model defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10, for each re-assembled AVC access unit the DTS value in the STD shall, within the accuracy of their respective clocks, indicate the same instant in time as the nominal CPB removal time  $t_{r,n}(n)$  in the HRD, as defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10.

*with:*

For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, if a DTS is present in the PES packet header, it shall refer to the first SVC dependency representation that commences in this PES packet. An SVC dependency representation commences in a PES packet if the first byte of the SVC dependency representation is present in the PES packet. To achieve consistency between the STD model and the HRD model defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10, for each re-assembled AVC access unit the DTS value in the STD shall, within the accuracy of their respective clocks, indicate the same instant in time as the nominal CPB removal time  $t_{r,n}(n)$  in the HRD, as defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10.

For MVC video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, if a DTS is present in the PES packet header, it shall refer to the first MVC view-component subset that commences in this PES packet. An MVC view-component subset commences in a PES packet if the first byte of the MVC view-component subset is present in the PES packet. To achieve consistency between the STD model and the HRD model defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10, for each re-assembled AVC access unit the DTS value in the STD shall, within the accuracy of their respective clocks, indicate the same instant in time as the nominal CPB removal time  $t_{r,n}(n)$  in the HRD, as defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10.

d) In the section specifying the *P-STD\_buffer\_size*, replace:

For AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10, the size  $BS_n$  shall be larger than or equal to the size of the CPB signalled by the *CpbSize[cpb\_cnt\_minus1]* specified by the NAL *hrd\_parameters()* in the AVC video stream. If the NAL *hrd\_parameters()* are not present in the AVC video stream, then  $BS_n$  shall be larger than or equal to the size of the NAL CPB for the byte stream format defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10 as  $1200 \times \text{MaxCPB}$  for the applied level.

For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, the size  $BS_n$  shall be larger than or equal to the size of the CPB signalled by the *CpbSize[cpb\_cnt\_minus1]* specified by the NAL *hrd\_parameters()* for the video sub-bitstream carried in elementary stream  $ES_n$  as defined in 2.14.3.6. If the NAL *hrd\_parameters()* are not present in the video sub-bitstream, the size  $BS_n$  shall be larger than or equal to the size of the NAL CPB for the byte stream format defined in ITU-T Rec. H.264 | ISO/IEC 14496-10 as  $1200 \times \text{MaxCPB}$  for the applied level for the elementary stream  $ES_n$ .

with:

For AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10, the size  $BS_n$  shall be larger than or equal to the size of the CPB signalled by the *CpbSize[cpb\_cnt\_minus1]* specified by the NAL *hrd\_parameters()* in the AVC video stream. If the NAL *hrd\_parameters()* are not present in the AVC video stream, then  $BS_n$  shall be larger than or equal to the size of the NAL CPB for the byte stream format defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10 as  $1200 \times \text{MaxCPB}$  for the applied level.

For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, the size  $BS_n$  shall be larger than or equal to the size of the CPB signalled by the *CpbSize[cpb\_cnt\_minus1]* specified by the NAL *hrd\_parameters()* for the video sub-bitstream carried in elementary stream  $ES_n$  as defined in 2.14.3.6. If the NAL *hrd\_parameters()* are not present in the video sub-bitstream, the size  $BS_n$  shall be larger than or equal to the size of the NAL CPB for the byte stream format defined in ITU-T Rec. H.264 | ISO/IEC 14496-10 as  $1200 \times \text{MaxCPB}$  for the applied level for the elementary stream  $ES_n$ .

For MVC video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, the size  $BS_n$  shall be larger than or equal to the size of the CPB signalled by the *CpbSize[cpb\_cnt\_minus1]* specified by the NAL *hrd\_parameters()* for the MVC video sub-bitstreams carried in elementary stream  $ES_n$ , as defined in 2.14.3.6. If the NAL *hrd\_parameters()* are not present in the MVC video sub-bitstreams, the size  $BS_n$  shall be larger than or equal to the size of the NAL CPB for the byte stream format defined in ITU-T Rec. H.264 | ISO/IEC 14496-10 as  $1200 \times \text{MaxCPB}$  for the applied level for the elementary stream  $ES_n$ .

## 6) Subclause 2.4.4.9

In 2.4.4.9, *Semantic definition of fields in Transport Stream program map section*, replace Table 2-34 with:

**Table 2-34 – Stream type assignments**

Value	Description
0x00	ITU-T   ISO/IEC Reserved
0x01	ISO/IEC 11172-2 Video
0x02	ITU-T Rec. H.262   ISO/IEC 13818-2 Video or ISO/IEC 11172-2 constrained parameter video stream
0x03	ISO/IEC 11172-3 Audio
0x04	ISO/IEC 13818-3 Audio
0x05	ITU-T Rec. H.222.0   ISO/IEC 13818-1 <i>private_sections</i>
0x06	ITU-T Rec. H.222.0   ISO/IEC 13818-1 PES packets containing private data
0x07	ISO/IEC 13522 MHEG
0x08	ITU-T Rec. H.222.0   ISO/IEC 13818-1 Annex A DSM-CC
0x09	ITU-T Rec. H.222.1
0x0A	ISO/IEC 13818-6 type A

Table 2-34 – Stream type assignments

Value	Description
0x0B	ISO/IEC 13818-6 type B
0x0C	ISO/IEC 13818-6 type C
0x0D	ISO/IEC 13818-6 type D
0x0E	ITU-T Rec. H.222.0   ISO/IEC 13818-1 auxiliary
0x0F	ISO/IEC 13818-7 Audio with ADTS transport syntax
0x10	ISO/IEC 14496-2 Visual
0x11	ISO/IEC 14496-3 Audio with the LATM transport syntax as defined in ISO/IEC 14496-3
0x12	ISO/IEC 14496-1 SL-packetized stream or FlexMux stream carried in PES packets
0x13	ISO/IEC 14496-1 SL-packetized stream or FlexMux stream carried in ISO/IEC 14496_sections
0x14	ISO/IEC 13818-6 Synchronized Download Protocol
0x15	Metadata carried in PES packets
0x16	Metadata carried in metadata_sections
0x17	Metadata carried in ISO/IEC 13818-6 Data Carousel
0x18	Metadata carried in ISO/IEC 13818-6 Object Carousel
0x19	Metadata carried in ISO/IEC 13818-6 Synchronized Download Protocol
0x1A	IPMP stream (defined in ISO/IEC 13818-11, MPEG-2 IPMP)
0x1B	AVC video stream conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264   ISO/IEC 14496-10 or AVC video sub-bitstream of SVC as defined in 2.1.78 or MVC base view sub-bitstream, as defined in 2.1.85, or AVC video sub-bitstream of MVC, as defined in 2.1.88
0x1C	ISO/IEC 14496-3 Audio, without using any additional transport syntax, such as DST, ALS and SLS
0x1D	ISO/IEC 14496-17 Text
0x1E	Auxiliary video stream as defined in ISO/IEC 23002-3
0x1F	SVC video sub-bitstream of an AVC video stream conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264   ISO/IEC 14496-10
<u>0x20</u>	<u>MVC video sub-bitstream of an AVC video stream conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264   ISO/IEC 14496-10</u>
0x21-0x7E	ITU-T Rec. H.222.0   ISO/IEC 13818-1 Reserved
0x7F	IPMP stream
0x80-0xFF	User Private

## 7) Subclause 2.5.2.7

*In 2.5.2.7, P-STD extensions for carriage of ITU-T Rec. H.264 | ISO/IEC 14496-10 Video, replace:*

For decoding of AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10 carried in a Program Stream in the P-STD model, see 2.14.3.2 and for decoding of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10 carried in a Program Stream in the P-STD model, see 2.14.3.6

*with:*

For decoding of AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10 carried in a Program Stream in the P-STD model, see 2.14.3.2, for decoding of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10 carried in a Program Stream in the P-STD model, see 2.14.3.6, and for decoding of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10 carried in a Program Stream in the P-STD model, see 2.14.3.8.

**8) Subclause 2.5.5**

*In 2.5.5, Program Stream directory, replace:*

For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, directory entries may be required to reference IDR picture or pictures to be re-assembled from video sub-bitstreams and associated with a recovery point SEI message present in a video sub-bitstream. Each such directory entry shall refer to the first byte of an SVC dependency representation.

*with:*

For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, directory entries may be required to reference IDR picture or pictures to be re-assembled from video sub-bitstreams and associated with a recovery point SEI message present in a video sub-bitstream. Each such directory entry shall refer to the first byte of an SVC dependency representation.

For MVC video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, directory entries may be required to reference IDR picture or pictures to be re-assembled from MVC video sub-bitstreams and associated with a recovery point SEI message present in an MVC video sub-bitstream. Each such directory entry shall refer to the first byte of an MVC view-component subset.

**9) Subclause 2.6.1**

*In 2.6.1, Semantic definition of fields in program and program element descriptors, replace Table 2-45 with:*

**Table 2-45 – Program and program element descriptors**

descriptor_tag	TS	PS	Identification
0	n/a	n/a	Reserved
1	n/a	X	Forbidden
2	X	X	video_stream_descriptor
3	X	X	audio_stream_descriptor
4	X	X	hierarchy_descriptor
5	X	X	registration_descriptor
6	X	X	data_stream_alignment_descriptor
7	X	X	target_background_grid_descriptor
8	X	X	video_window_descriptor
9	X	X	CA_descriptor
10	X	X	ISO_639_language_descriptor
11	X	X	system_clock_descriptor
12	X	X	multiplex_buffer_utilization_descriptor
13	X	X	copyright_descriptor
14	X		maximum_bitrate_descriptor
15	X	X	private_data_indicator_descriptor
16	X	X	smoothing_buffer_descriptor
17	X		STD_descriptor
18	X	X	IBP_descriptor
19-26	X		Defined in ISO/IEC 13818-6
27	X	X	MPEG-4_video_descriptor
28	X	X	MPEG-4_audio_descriptor
29	X	X	IOD_descriptor
30	X		SL_descriptor
31	X	X	FMC_descriptor
32	X	X	external_ES_ID_descriptor
33	X	X	MuxCode_descriptor
34	X	X	FmxBufferSize_descriptor

Table 2-45 – Program and program element descriptors

descriptor_tag	TS	PS	Identification
35	X		multiplexBuffer_descriptor
36	X	X	content_labeling_descriptor
37	X	X	metadata_pointer_descriptor
38	X	X	metadata_descriptor
39	X	X	metadata_STD_descriptor
40	X	X	AVC video descriptor
41	X	X	IPMP_descriptor (defined in ISO/IEC 13818-11, MPEG-2 IPMP)
42	X	X	AVC timing and HRD descriptor
43	X	X	MPEG-2_AAC_audio_descriptor
44	X	X	FlexMuxTiming_descriptor
45	X	X	MPEG-4_text_descriptor
46	X	X	MPEG-4_audio_extension_descriptor
47	X	X	auxiliary_video_stream_descriptor
48	X	X	SVC extension descriptor
49	X	X	MVC extension descriptor
50-63	n/a	n/a	ITU-T Rec. H.222.0   ISO/IEC 13818-1 Reserved
64-255	n/a	n/a	User Private

## 10) Subclause 2.6.7

a) In 2.6.7, *Semantic definition of fields in hierarchy descriptor*, replace:

**hierarchy\_type** – The hierarchical relation between the associated hierarchy layer and its hierarchy embedded layer is defined in Table 2-50. If scalability applies in more than one dimension, this field shall be set to the value of '8' ("Combined Scalability"), and the flags `temporal_scalability_flag`, `spatial_scalability_flag` and `quality_scalability_flag` shall be set accordingly.

**hierarchy\_layer\_index** – The `hierarchy_layer_index` is a 6-bit field that defines a unique index of the associated program element in a table of coding layer hierarchies. Indices shall be unique within a single program definition. For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, this is the program element index, which is assigned in a way that the bitstream order will be correct if associated SVC dependency representations of the video sub-bitstreams of the same access unit are re-assembled in increasing order of `hierarchy_layer_index`.

with:

**hierarchy\_type** – The hierarchical relation between the associated hierarchy layer and its hierarchy embedded layer is defined in Table 2-50. If scalability applies in more than one dimension, this field shall be set to the value of '8' ("Combined Scalability"), and the flags `temporal_scalability_flag`, `spatial_scalability_flag` and `quality_scalability_flag` shall be set accordingly. For MVC video sub-bitstreams, this field shall be set to the value of '9' ("MVC video sub-bitstream") and the flags `temporal_scalability_flag`, `spatial_scalability_flag` and `quality_scalability_flag` shall be set to '1'. For MVC base view sub-bitstreams, this field shall be set to the value of '15' and the flags `temporal_scalability_flag`, `spatial_scalability_flag` and `quality_scalability_flag` shall be set to '1'.

**hierarchy\_layer\_index** – The `hierarchy_layer_index` is a 6-bit field that defines a unique index of the associated program element in a table of coding layer hierarchies. Indices shall be unique within a single program definition. For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, this is the program element index, which is assigned in a way that the bitstream order will be correct if associated SVC dependency representations of the video sub-bitstreams of the same access unit are re-assembled in increasing order of `hierarchy_layer_index`. For MVC video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, this is the program element index, which is assigned in a way that the bitstream order will be correct if associated MVC view-component subsets of the MVC video sub-bitstreams of the same access unit are re-assembled in increasing order of `hierarchy_layer_index`.

b) Replace Table 2-50 with:

**Table 2-50 – Hierarchy\_type field values**

Value	Description
0	Reserved
1	Spatial Scalability
2	SNR Scalability
3	Temporal Scalability
4	Data partitioning
5	Extension bit-stream
6	Private Stream
7	ISO/IEC 13818-2 Multi-view Profile
8	Combined Scalability
9	<u>MVC video sub-bitstream</u>
10-14	Reserved
15	Base layer <u>or MVC base view sub-bitstream or AVC video sub-bitstream of MVC</u>

## 11) Subclause 2.6.11

In 2.6.11, *Semantic definition of fields in data stream alignment descriptor*, make the following modifications:

a) Replace:

Table 2-54 describes the alignment type for ITU-T Rec. H.264 | ISO/IEC 14496-10 video when the data\_alignment\_indicator in the PES packet header has a value of '1'.

In this case:

- For AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10, the first PES\_packet\_data\_byte following the PES header shall be the first byte of an AVC access unit or the first byte of an AVC slice, as signalled by the alignment\_type value.
- For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, the first PES\_packet\_data\_byte following the PES header shall be the first byte of an SVC dependency representation or the first byte of an SVC slice, as signalled by the alignment\_type value.

with:

Table 2-54 describes the alignment type for ITU-T Rec. H.264 | ISO/IEC 14496-10 video when the data\_alignment\_indicator in the PES packet header has a value of '1'.

In this case:

- For AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10, the first PES\_packet\_data\_byte following the PES header shall be the first byte of an AVC access unit or the first byte of an AVC slice, as signalled by the alignment\_type value.
- For video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, the first PES\_packet\_data\_byte following the PES header shall be the first byte of an SVC dependency representation or the first byte of an SVC slice, as signalled by the alignment\_type value.
- For MVC video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, the first PES\_packet\_data\_byte following the PES header shall be the first byte of an MVC view-component subset or the first byte of an MVC slice, as signalled by the alignment\_type value.

b) Replace Table 2-54 with:

**Table 2-54 – AVC video stream alignment values**

Alignment type	Description
00	Reserved
01	AVC slice or AVC access unit
02	AVC access unit
03	SVC slice or SVC dependency representation
04	SVC dependency representation
<u>05</u>	<u>MVC slice or MVC view-component subset</u>
<u>06</u>	<u>MVC view-component subset</u>
07-FF	Reserved

## 12) Subclause 2.6.64

In 2.6.64, *AVC video descriptor*, replace:

For AVC video streams, the AVC video descriptor provides basic information for identifying coding parameters of the associated AVC video stream, such as on profile and level parameters included in the SPS of an AVC video stream or in the subset SPS of an SVC video sub-bitstream.

For AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10, there may be one AVC video descriptor associated to each of the video sub-bitstreams identifying coding parameters of the associated re-assembled AVC video streams.

The AVC video descriptor also signals the presence of AVC still pictures and the presence of AVC 24-hour pictures in the AVC video stream. If this descriptor is not included in the PMT for an AVC video stream or a video sub-bitstream in a transport stream or in the PSM, if present, for an AVC video stream or a video sub-bitstream in a program stream, then such AVC video stream shall not contain AVC still pictures and shall not contain AVC 24-hour pictures. (See Table 2-89.)

with:

For AVC video streams, the AVC video descriptor provides basic information for identifying coding parameters of the associated AVC video stream, such as on profile and level parameters included in the SPS of an AVC video stream or in the subset SPS of an SVC video sub-bitstream.

For AVC video streams conforming to one or more profiles defined in Annex G or Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, there may be one AVC video descriptor associated to each of the video sub-bitstreams or MVC video subsets identifying coding parameters of the associated re-assembled AVC video streams.

The AVC video descriptor also signals the presence of AVC still pictures and the presence of AVC 24-hour pictures in the AVC video stream. If this descriptor is not included in the PMT for an AVC video stream, a video sub-bitstream or an MVC video sub-bitstream in a transport stream or in the PSM, if present, for an AVC video stream, a video sub-bitstream or an MVC video sub-bitstream in a program stream, then such AVC video stream shall not contain AVC still pictures and shall not contain AVC 24-hour pictures. (See Table 2-89.)

## 13) Subclause 2.6.66

In 2.6.66, *AVC timing and HRD descriptor*, replace:

The AVC timing and HRD descriptor provides timing and HRD parameters of the associated AVC video stream. For each AVC video stream and for each video sub-bitstream carried in an ITU-T Rec. H.222.0 | ISO/IEC 13818-1 stream, the AVC timing and HRD descriptor shall be included in the PMT or in the PSM, if PSM is present in the program stream, unless the AVC video stream or the video sub-bitstream carries VUI parameters with the `timing_info_present_flag` set to '1':

- for each IDR picture or re-assembled IDR picture; and
- for each picture or re-assembled picture that is associated with a recovery point SEI message.

## ISO/IEC 13818-1:2007/Amd.4:2010 (E)

Absence of the AVC timing and HRD descriptor in the PMT for an AVC video stream or a re-assembled AVC video stream signals usage of the leak method in the T-STD for the transfer from MB<sub>n</sub> to EB<sub>n</sub> as defined:

- in 2.14.3.1 for an AVC video stream conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10;
- in 2.14.3.5 for video sub-bitstreams of an AVC video stream conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10.

But such usage can also be signalled by the `hrd_management_valid_flag` set to '0' in the AVC timing and HRD descriptor. If the transfer rate into buffer EB<sub>n</sub> can be determined from HRD parameters contained in an AVC video stream or an AVC video stream re-assembled from video sub-bitstreams, and if this transfer rate is used in the T-STD for the transfer between MB<sub>n</sub> to EB<sub>n</sub>, then the AVC timing and HRD descriptor with the `hrd_management_valid_flag` set to '1' shall be included in the PMT for that AVC video stream or for the re-assembled AVC video stream. (See Table 2-90.)

*with:*

The AVC timing and HRD descriptor provides timing and HRD parameters of the associated AVC video stream. For each AVC video stream and for each video sub-bitstream or MVC video sub-bitstream carried in an ITU-T Rec. H.222.0 | ISO/IEC 13818-1 stream, the AVC timing and HRD descriptor shall be included in the PMT or in the PSM, if PSM is present in the program stream, unless the AVC video stream, the video sub-bitstream or the MVC video sub-bitstream carries VUI parameters with the `timing_info_present_flag` set to '1':

- for each IDR picture or re-assembled IDR picture; and
- for each picture or re-assembled picture that is associated with a recovery point SEI message.

Absence of the AVC timing and HRD descriptor in the PMT for an AVC video stream or a re-assembled AVC video stream signals usage of the leak method in the T-STD for the transfer from MB<sub>n</sub> to EB<sub>n</sub> as defined:

- in 2.14.3.1 for an AVC video stream conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10;
- in 2.14.3.5 for video sub-bitstreams of an AVC video stream conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10;
- in 2.14.3.7 for MVC video sub-bitstreams of an AVC video stream conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10.

But such usage can also be signalled by the `hrd_management_valid_flag` set to '0' in the AVC timing and HRD descriptor. If the transfer rate into buffer EB<sub>n</sub> can be determined from HRD parameters contained in an AVC video stream or an AVC video stream re-assembled from video sub-bitstreams or MVC video sub-bitstreams, and if this transfer rate is used in the T-STD for the transfer between MB<sub>n</sub> to EB<sub>n</sub>, then the AVC timing and HRD descriptor with the `hrd_management_valid_flag` set to '1' shall be included in the PMT for that AVC video stream or for the re-assembled AVC video stream. (See Table 2-90.)

### 14) Subclause 2.6.67

*In 2.6.67, Semantic definition of fields in AVC timing and HRD descriptor, replace:*

**hrd\_management\_valid\_flag** – This 1-bit field is only defined for use in transport streams.

When the AVC timing and HRD descriptor is associated to an AVC video stream or a re-assembled AVC video stream carried in a transport stream, then the following applies. If the `hrd_management_valid_flag` is set to '1', then Buffering Period SEI and Picture Timing SEI messages, as defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10, shall be present in the associated AVC video stream or re-assembled AVC video stream. These Buffering Period SEI messages shall carry coded `initial_cpb_removal_delay` and `initial_cpb_removal_delay_offset` values for the NAL HRD. If the `hrd_management_valid_flag` is set to '1', then the transfer of each byte from MB<sub>n</sub> to EB<sub>n</sub> in the T-STD shall be according to the delivery schedule for that byte into the CPB in the NAL HRD, as determined from the coded `initial_cpb_removal_delay` and `initial_cpb_removal_delay_offset` values for `SchedSelIdx = cpb_cnt_minus1`. When the `hrd_management_valid_flag` is set to '0', the leak method for the transfer from MB<sub>n</sub> to EB<sub>n</sub> in the T-STD shall be used:

- as defined in 2.14.3.1 for AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10;
- as defined in 2.14.3.5 for video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10.

When the AVC timing and HRD descriptor is associated to an AVC video stream or a re-assembled AVC video stream carried in a program stream, then the meaning of the `hrd_management_valid_flag` is not defined.

with:

**hrd\_management\_valid\_flag** – This 1-bit field is only defined for use in transport streams.

When the AVC timing and HRD descriptor is associated to an AVC video stream or a re-assembled AVC video stream carried in a transport stream, then the following applies. If the `hrd_management_valid_flag` is set to '1', then Buffering Period SEI and Picture Timing SEI messages, as defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10, shall be present in the associated AVC video stream or re-assembled AVC video stream. These Buffering Period SEI messages shall carry coded `initial_cpb_removal_delay` and `initial_cpb_removal_delay_offset` values for the NAL HRD. If the `hrd_management_valid_flag` is set to '1', then the transfer of each byte from  $MB_n$  to  $EB_n$  in the T-STD shall be according to the delivery schedule for that byte into the CPB in the NAL HRD, as determined from the coded `initial_cpb_removal_delay` and `initial_cpb_removal_delay_offset` values for `SchedSelIdx = cpb_cnt_minus1`. When the `hrd_management_valid_flag` is set to '0', the leak method for the transfer from  $MB_n$  to  $EB_n$  in the T-STD shall be used:

- as defined in 2.14.3.1 for AVC video streams conforming to one or more profiles defined in Annex A of ITU-T Rec. H.264 | ISO/IEC 14496-10;
- as defined in 2.14.3.5 for video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex G of ITU-T Rec. H.264 | ISO/IEC 14496-10;
- as defined in 2.14.3.7 for MVC video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10.

When the AVC timing and HRD descriptor is associated to an AVC video stream or a re-assembled AVC video stream carried in a program stream, then the meaning of the `hrd_management_valid_flag` is not defined.

## 15) New subclauses 2.6.78 to 2.6.79

After 2.6.77, *Semantics of fields in SVC extension descriptor*, add subclauses 2.6.78 to 2.6.79:

### 2.6.78 MVC extension descriptor

For MVC video sub-bitstreams of AVC video streams conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, the MVC extension descriptor provides information about the AVC video stream resulting from re-assembling (up to) the associated MVC video sub-bitstream and provides information about the contained MVC video sub-bitstream and for the re-assembly of the associated MVC video sub-bitstream. There may be one MVC extension descriptor associated to any of the MVC video sub-bitstreams (with `stream_type` equal to 0x20) of an AVC video stream conforming to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10. When the MVC video sub-bitstream is an MVC base view sub-bitstream, the MVC extension descriptor shall be present in the associated PMT or PSM for `stream_type` equal to 0x1B.

**Table AMD4.1 – MVC extension descriptor**

Syntax	No. of bits	Mnemonic
MVC_extension_descriptor() {		
<b>descriptor_tag</b>	8	<b>uimsbf</b>
<b>descriptor_length</b>	8	<b>uimsbf</b>
<b>average_bit_rate</b>	16	<b>uimsbf</b>
<b>maximum_bitrate</b>	16	<b>uimsbf</b>
<b>reserved</b>	4	<b>bslbf</b>
<b>view_order_index_min</b>	10	<b>bslbf</b>
<b>view_order_index_max</b>	10	<b>bslbf</b>
<b>temporal_id_start</b>	3	<b>bslbf</b>
<b>temporal_id_end</b>	3	<b>bslbf</b>
<b>no_sei_nal_unit_present</b>	1	<b>bslbf</b>
<b>no_prefix_nal_unit_present</b>	1	<b>bslbf</b>
}		

### 2.6.79 Semantics of fields in MVC extension descriptor

**average\_bitrate** – This 16-bit field indicates the average bit rate, in kbits per second, of the re-assembled AVC video stream. When set to 0, the average bit rate is not indicated.

**maximum\_bitrate** – This 16-bit field indicates the maximum bit rate, in kbits per second, of the re-assembled AVC video stream. When set to 0, the maximum bit rate is not indicated.

**view\_order\_index\_min** – This 10-bit field indicates the minimum value of the view order index of all the NAL units contained in the associated MVC video sub-bitstream.

**view\_order\_index\_max** – This 10-bit field indicates the maximum value of the view order index of all the NAL units contained in the associated MVC video sub-bitstream.

**temporal\_id\_start** – This 3-bit field indicates the minimum value of the temporal\_id of the NAL unit header syntax element of all the NAL units contained in the associated MVC video sub-bitstream.

**temporal\_id\_end** – This 3-bit field indicates the maximum value of the temporal\_id of the NAL unit header syntax element of all the NAL units contained in the associated MVC video sub-bitstream.

**no\_sei\_nal\_unit\_present** – This 1-bit flag when set to '1' indicates that no SEI NAL units are present in the associated video sub-bitstream.

NOTE – In case the no\_sei\_nal\_unit\_present flag is set to '1' for all MVC video sub-bitstreams and is not set to '1' or not present for the AVC video sub-bitstream of MVC, any SEI NAL units, if present, are included in the AVC video sub-bitstream of MVC. If the MVC extension descriptor is absent for all MVC video sub-bitstreams, SEI NAL units may be present in any MVC view-component subset of an MVC video sub-bitstream, and may require re-ordering to the order of NAL units within an access unit as defined in ITU-T Rec. H.264 | ISO/IEC 14496-10 before access unit re-assembling.

**no\_prefix\_nal\_unit\_present** – This 1-bit flag when set to '1' indicates that no prefix NAL units are present in either the AVC video sub-bitstream of MVC or MVC video sub-bitstreams. When this bit is set to '0', it indicates that prefix NAL units are present in the AVC video sub-bitstream of MVC only.

## 16) Subclause 2.14

a) *Replace the fourth bullet in 2.14.1 for the SVC extensions by the following:*

- In each elementary stream with stream\_type equal to 0x1F, exactly one VDRD\_nal\_unit as defined in 2.14.3.3 may precede all the NAL units of the same SVC dependency representation.

NOTE 5 – If any VDRD\_nal\_unit is included in any SVC dependency representation, then the HRD model should include this VDRD\_nal\_unit in the buffer model as additional non-VCL NAL units. The NAL unit type 24 may be used in a different way by other specifications out of scope of this Specification.

b) *After the last sentence of 2.14.1, Carriage of ITU-T Rec. H.264 | ISO/IEC 14496-10 Video, add:*

When an AVC video stream conforms to one or more profiles defined in Annex H of ITU-T Rec. H.264 | ISO/IEC 14496-10, the following constraints additionally apply:

- The AVC video sub-bitstream of MVC or MVC base view sub-bitstream, as defined in 2.1.88 and 2.1.85, shall be an element of an ITU-T Rec. H.222.0 | ISO/IEC 13818-1 program and the stream\_type for this elementary stream shall be equal to 0x1B.
- For each MVC video sub-bitstream, as defined in 2.1.84, that is an element of the same ITU-T Rec. H.222.0 | ISO/IEC 13818-1 program, the stream\_type for this elementary stream shall be equal to 0x20.
- Each MVC video sub-bitstream shall be associated with one or more consecutive view order index values.
- Each view order index value shall be associated to exactly one MVC view\_id subset.  
NOTE 8 – This restriction greatly simplifies the re-assembly of any decodable sub-bitstream.
- When an ITU-T Rec. H.222.0 | ISO/IEC 13818-1 program includes more than one MVC video sub-bitstream or more than one AVC video sub-bitstream of MVC and at least one MVC video sub-bitstream, a hierarchy descriptor, as defined in 2.6.6 and 2.6.7, shall be used to indicate the dependencies of the related video sub-bitstreams. The syntax element hierarchy\_type shall be set to the value 9 or 15.
- The subset sequence parameter sets and picture parameter sets necessary for decoding an MVC video sub-bitstream shall be present within the elementary stream carrying the MVC video sub-bitstream.

- In each elementary stream with stream type equal to 0x20 exactly one VDRD\_NAL\_unit, as defined in 2.14.3.3, may precede all the NAL units of the same MVC view-component subset.  
NOTE 9 – If any VDRD\_nal\_unit is included in any MVC view component subset, then the HRD model should include this VDRD\_nal\_unit in the buffer model as additional non-VCL NAL units. The NAL unit type 24 may be used in a different way by other specifications out of scope of this Specification.
- All NAL units of a re-assembled AVC access unit shall be passed to the decoder in the order of NAL units within an access unit, as defined in ITU-T Rec. H.264 | ISO/IEC 14496-10.  
NOTE 10 – If SEI NAL units are present in any MVC view-component subset of an MVC video sub-bitstream, these NAL units may require re-ordering to the order of NAL units within an access unit, as defined in ITU-T Rec. H.264 | ISO/IEC 14496-10 before access unit re-assembling.
- The profile\_idc and level\_idc indication in the AVC\_video\_descriptor, if present, and the Type II HRD parameters in the AVC\_timing\_and\_HRD\_descriptor, if present, for an AVC video stream resulting from re-assembling (up to) the MVC video sub-bitstream associated to the descriptors shall include NAL units with nal\_unit\_type syntax element equal to 14, if present, in the AVC video sub-bitstream of MVC or MVC base view sub-bitstream and, if present, in the MVC video sub-bitstream, NAL units with nal\_unit\_type syntax element equal to 20 and 24.

c) Replace 2.14.3.3 and 2.14.3.4 by the following:

### 2.14.3.3 View and dependency representation delimiter NAL unit

See Table AMD3-2.

**Table AMD3-2 – View and dependency representation delimiter NAL unit**

Syntax	No. of bits	Mnemonic
VDRD_nal_unit() {		
<b>forbidden_zero_bit</b>	<b>1</b>	<b>bslbf</b>
<b>nal_ref_idc</b>	<b>2</b>	<b>bslbf</b>
<b>nal_unit_type</b>	<b>5</b>	<b>bslbf</b>
}		

### 2.14.3.4 Semantics of view and dependency representation delimiter NAL unit

**forbidden\_zero\_bit** – shall be equal to 0x0

**nal\_ref\_idc** – shall be equal to 0x0

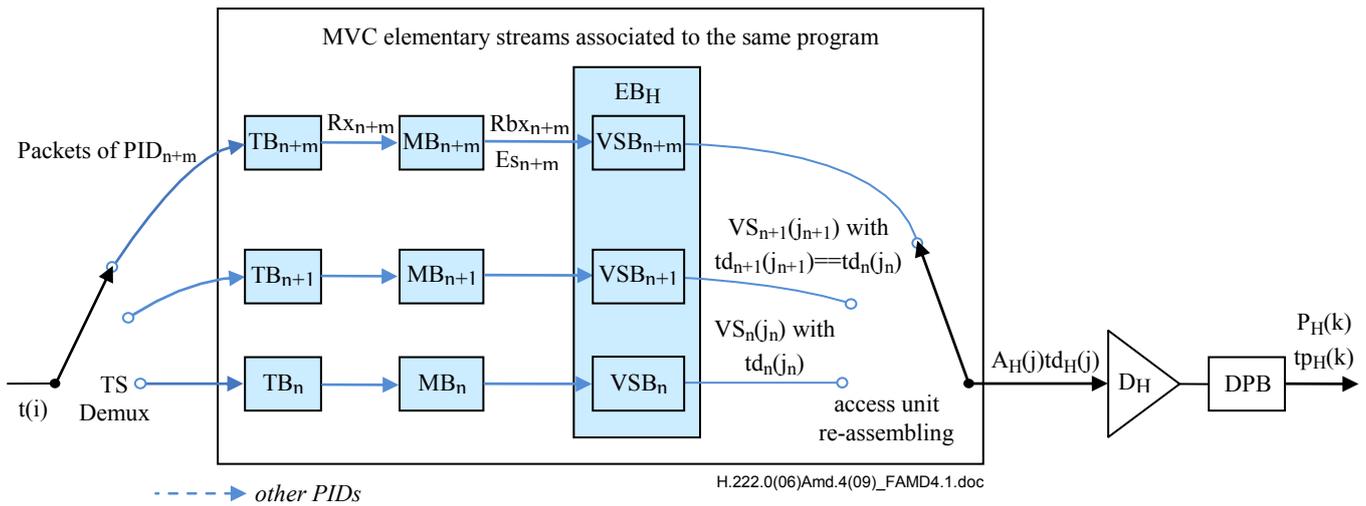
**nal\_unit\_type** – shall equal to 0x18

d) After 2.14.3.6, P-STD extensions for SVC, add subclauses 2.14.3.7 to 2.14.3.8:

### 2.14.3.7 T-STD extensions for MVC

The T-STD model described in 2.14.3.1 is applied if the received elementary stream is a video sub-bitstream of stream\_type 0x1B, i.e., only the AVC video sub-bitstream of MVC or MVC base view sub-bitstream is received and decoded.

When there is a set of received video sub-bitstreams and MVC video sub-bitstreams in an ITU-T Rec. H.222.0 | ISO/IEC 13818-1 program, of which dependencies may be signalled in the hierarchy descriptor, as defined in 2.6.7, and when there is at least one of the MVC video sub-bitstreams in the set of received elementary streams having the value of stream\_type equal to 0x20, the T-STD model as described in 2.14.3.1 is extended as illustrated in Figure AMD4.1 and as specified below.



**Figure AMD4.1 – T-STD model extensions for ITU-T Rec. H.264 | ISO/IEC 14496-10 Video with MVC video sub-bitstreams**

The following additional notations are used to describe the T-STD extensions and are illustrated in Figure AMD4.1 above.

- $ES_n$  is the received elementary stream associated to the n-th MVC video sub-bitstream, where n is the index to the MVC view\_id subsets starting with value 0 for the MVC view\_id subset containing the base view and ordered according to the minimum view order index contained in each MVC video sub-bitstream
- $ES_H$  is the received elementary stream associated to the H-th MVC video sub-bitstream which includes the view components with the highest view order index present in all MVC video sub-bitstreams of received elementary streams
- j is an index to the re-assembled access units
- $j_n$  is an index to the MVC view-component subsets of the elementary stream  $ES_n$  associated to the n-th MVC video sub-bitstream
- $VS_n(j_n)$  is the  $j_n$ -th MVC view-component subset of the MVC video sub-bitstream associated to  $ES_n$
- $A_H(j)$  is the j-th access unit resulting from re-assembling (up to) the H-th MVC view-component subset associated to  $ES_H$
- $td_n(j_n)$  is the decoding time, measured in seconds, in the system target decoder of the MVC view-component subset  $VS_n(j_n)$
- $td_H(j)$  is the decoding time, measured in seconds, in the system target decoder of the j-th access unit  $A_H(j)$  resulting from re-assembling (up to) the MVC view-component subset  $VS_H(j_H)$
- $TB_n$  is the transport buffer for elementary stream  $ES_n$
- $TBS_n$  is the size of the transport buffer  $TB_n$ , measured in bytes
- $MB_n$  is the multiplexing buffer for elementary stream  $ES_n$
- $MBS_n$  is the size of the multiplexing buffer  $MB_n$ , measured in bytes
- $VSB_n$  is the view component subset buffer for elementary stream  $ES_n$
- $VSBS_n$  is the size of view component subset buffer  $VSB_n$ , measured in bytes
- $EB_H$  is the elementary stream buffer for the AVC video sub-bitstream of MVC and all MVC video sub-bitstreams
- $EBS_H$  is the size of elementary stream buffer  $EB_H$ , measured in bytes
- $Rx_n$  transfer rate from  $TB_n$  to  $MB_n$ , as specified below
- $Rbx_n$  transfer rate from  $MB_n$  to  $VSB_n$ , as specified below

### Carriage in PES packets

For correct re-assembling of the MVC view-component subsets to an AVC access unit, the following applies:

- a PES packet per MVC view-component subset start shall be present, i.e., at most one MVC view-component subset may commence in the same PES packet;
- the PTS and, if applicable, the DTS value shall be provided in the PES header of each MVC view-component subset.

### DPB buffer management

The DPB buffer management for the re-assembled AVC video stream shall conform to 2.14.3.1 using AVC access unit timing values, as DTS or CPB removal time, and PTS or DPB removal time, associated with the MVC view-component subsets of the MVC video sub-bitstream in elementary stream  $ES_H$ .

### $TB_n$ , $MB_n$ , $EB_n$ buffer management

The following applies:

- There is exactly one transport buffer  $TB$ , as defined in 2.14.3.1, for each received elementary stream in the set of received MVC video sub-bitstreams, including AVC video sub-bitstream of MVC, contained in elementary streams as shown in Figure AMD4.1.
- There is exactly one multiplexing buffer  $MB_0$  for the AVC video sub-bitstream of MVC in elementary stream  $ES_0$ , where the size of the multiplexing buffer  $MBS_0$  is constrained as follows:

$$MBS_0 = BS_{\text{mux},0} + BS_{\text{oh},0} + 1200 \times \text{MaxCPB}[\text{level}]_0 - \text{cpb\_size}_0$$

where  $BS_{\text{mux},0}$ ,  $BS_{\text{oh},0}$  are defined in 2.14.3.1 for the AVC video sub-bitstream of MVC in elementary stream  $ES_0$ .

where  $\text{MaxCPB}[\text{level}]_0$  and  $\text{cpb\_size}_0$  for the elementary stream  $ES_0$  are defined, as in 2.14.3.1.

NOTE 1 – If HRD parameters are present in at least one of the MVC video sub-bitstreams, those parameters have to be carefully handled in order to not unnecessarily increase the multiplexing buffers allocation.

- There is exactly one multiplexing buffer  $MB_n$  for each received elementary stream associated to view order index value not equal to 0, where the size of each multiplexing buffer  $MBS_n$  in the set of received elementary streams is constrained as follows:

$$MBS_n = BS_{\text{mux},n} + BS_{\text{oh},n}$$

where  $BS_{\text{mux},n}$ ,  $BS_{\text{oh},n}$  are defined in 2.14.3.1 for the AVC video stream resulting from re-assembling (up to) the MVC video sub-bitstream in elementary stream  $ES_n$ .

- There is exactly one elementary stream buffer  $EB_H$  for all the elementary streams in the set of received elementary streams as shown in Figure AMD4.1, of which the size  $EBS_H$  has the following value:

$$EBS_H = \text{cpb\_size}_H$$

where  $\text{cpb\_size}_H$  is the  $\text{cpb\_size}$  for the MVC video sub-bitstream in elementary stream  $ES_H$  as defined in 2.14.3.1 for the re-assembled AVC video stream.

- There is exactly one view component subset buffer  $VSB_n$  for each elementary stream in the set of received elementary streams as shown in Figure AMD4.1, where each view component subset buffer  $VSB_n$  in the set of received elementary streams is allocated within  $EB_H$ . Even though the size  $VSBS_n$  of individual  $VSB_n$  is not constrained, the sum of the sizes  $VSBS_n$  is constrained as follows:

$$EBS_H = \sum_n (VSBS_n)$$

- Transfer from  $TB_n$  to  $MB_n$  is applied as follows:

Rate  $Rx_n$ :

when there is no data in  $TB_n$ , then  $Rx_n$  is equal to zero.

Otherwise:  $Rx_n = \text{bit\_rate}$

where  $\text{bit\_rate}$  is  $1.2 \times \text{BitRate}[\text{ SchedSelIdx }]$  of data flow into the CPB for the byte stream format and  $\text{BitRate}[\text{ SchedSelIdx }]$  is as defined in Annex E of ITU-T Rec. H.264 | ISO/IEC 14496-10 when  $\text{NAL\_hrd\_parameters}()$  is present in the VUI parameters of the MVC video sub-bitstream.

NOTE 2 – Annex E also specifies default values for BitRate[ SchedSelIdx] based on profile and level when NAL HRD parameters are not present in the VUI. The MVC video sub-bitstream level is determined by the level of AVC video stream resulting from re-assembling (up to) the associated MVC video sub-bitstream n in elementary stream ES<sub>n</sub>.

- Transfer from MB<sub>n</sub> to VSB<sub>n</sub> is applied as follows:

If the AVC\_timing\_and\_HRD\_descriptor is present with the hrd\_management\_valid\_flag set to '1' for elementary stream ES<sub>H</sub>, then the transfer of data from MB<sub>n</sub> to VSB<sub>n</sub> shall follow the HRD defined scheme for data arrival in the CPB of elementary stream ES<sub>H</sub> as defined in Annex C of ITU-T Rec. H.264 | ISO/IEC 14496-10.

Otherwise, the leak method shall be used to transfer data from MB<sub>n</sub> to VSB<sub>n</sub> as follows:

Rate Rbx<sub>n</sub>:

$$Rbx_n = 1200 \times \text{MaxBR}[\text{level}]_n$$

where MaxBR[level]<sub>n</sub> is defined for the byte stream format in Table A.1 (Level limits) in ITU-T Rec. H.264 | ISO/IEC 14496-10 for the level of the AVC video stream resulting from re-assembling (up to) the associated MVC video sub-bitstream n in elementary stream ES<sub>n</sub>. If there is PES packet payload data in MB<sub>n</sub>, and buffer EB<sub>H</sub> is not full, the PES packet payload is transferred from MB<sub>n</sub> to VSB<sub>n</sub> at a rate equal to Rbx<sub>n</sub>. If EB<sub>H</sub> is full, data are not removed from MB<sub>n</sub>. When a byte of data is transferred from MB<sub>n</sub> to VSB<sub>n</sub>, all PES packet header bytes that are in MB<sub>n</sub> and precede that byte are instantaneously removed and discarded. When there is no PES packet payload data present in MB<sub>n</sub>, no data is removed from MB<sub>n</sub>. All data that enters MB<sub>n</sub> leaves it. All PES packet payload data bytes enter VSB<sub>n</sub> instantaneously upon leaving MB<sub>n</sub>.

### Access unit re-assembling and EB removal

The following specifies the access unit re-assembling that results in AVC access unit A<sub>H</sub>(j):

- Assemble the MVC view-component subsets for the j-th access unit A<sub>H</sub>(j) following the rule below:
  - For each two corresponding MVC view-component subsets VS<sub>y+1</sub>(j<sub>y+1</sub>) and VS<sub>y</sub>(j<sub>y</sub>) collected for access unit A<sub>H</sub>(j), where VS<sub>y</sub> is associated with a program element identified by the hierarchy\_layer\_index indicated in the associated hierarchy descriptor, and VS<sub>y+1</sub> indicates the hierarchy\_layer\_index of VS<sub>y</sub> as the hierarchy\_embedded\_layer\_index in the hierarchy descriptor associated to program element associated with VS<sub>y+1</sub>, the DTS value of td<sub>y+1</sub>(j<sub>y+1</sub>) of VS<sub>y+1</sub>(j<sub>y+1</sub>) shall be equal to DTS value td<sub>y</sub>(j<sub>y</sub>) of VS<sub>y</sub>(j<sub>y</sub>).
 

NOTE 3 – If no hierarchy descriptor is present, VS<sub>y</sub> is associated with the AVC sub-bitstream and VS<sub>y+1</sub> is associated with the MVC sub-bitstream.
- If SEI NAL units are present in any MVC view-component subset with view order index not equal to 0, these NAL units shall be re-ordered to the order of NAL units within an access unit, as defined in ITU-T Rec. H.264 | ISO/IEC 14496-10, before access unit re-assembling.

The following specifies the removal of access unit A<sub>H</sub>(j) from buffer EB<sub>H</sub>:

At the decoding time td<sub>H</sub>(j), the AVC access unit A<sub>H</sub>(j) shall be re-assembled and available for removal from buffer EB<sub>H</sub>. The decoding time td<sub>H</sub>(j) is specified by the DTS or by the CPB removal time that is associated to the MVC view-component subsets in elementary stream ES<sub>H</sub>, as derived from information in the re-assembled AVC video stream.

### STD delay

The STD delay for re-assembled AVC access units shall follow the constraints specified in 2.14.3.1.

### Buffer management conditions

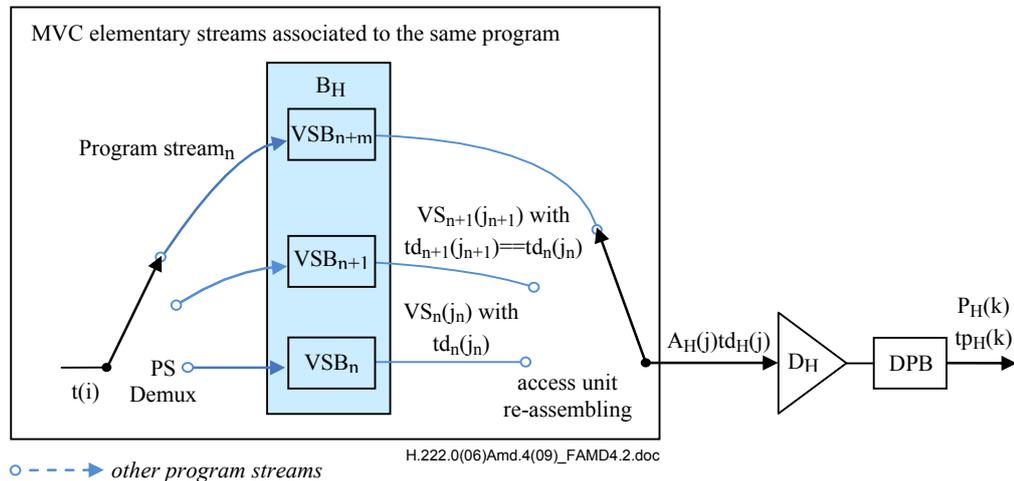
Transport streams shall be constructed so that the following conditions for buffer management are satisfied:

- Each TB<sub>n</sub> shall not overflow and shall be empty at least once every second.
- Each MB<sub>n</sub>, EB<sub>H</sub>, and DPB shall not overflow.
- EB<sub>H</sub> shall not underflow, except when VUI parameters are present for the AVC video sequence of the re-assembled AVC video stream with the low\_delay\_hrd\_flag set to '1'. Underflow of EB<sub>H</sub> occurs for AVC access unit A<sub>H</sub>(j) when one or more bytes of A<sub>H</sub>(j) are not present in EB<sub>H</sub> at the decoding time td<sub>H</sub>(j).

### 2.14.3.8 P-STD extensions for MVC

The P-STD model described in 2.14.3.2 is applied if the decoded elementary stream is a video sub-bitstream of stream\_type 0x1B, i.e., only the AVC video sub-bitstream of MVC or MVC base view sub-bitstream is decoded.

When there is a set of decoded MVC video sub-bitstreams in an ITU-T Rec. H.222.0 | ISO/IEC 13818-1 program, of which view order index values may be signalled in the MVC\_extension\_descriptor, as defined in 2.6.78, and when there is at least one of the MVC video sub-bitstreams in the set of decoded elementary streams having the value of stream\_type equal to 0x20, the P-STD model, as described in 2.14.3.2, is extended as illustrated in Figure AMD4.2 and as specified below.



**Figure AMD4.2 – P-STD model extensions for ITU-T Rec. H.264 | ISO/IEC 14496-10 Video with MVC video sub-bitstreams**

The following additional notations are used to describe the P-STD extensions and are illustrated in Figure AMD4.2 above.

- ES<sub>n</sub> is the received elementary stream associated to the n-th MVC video sub-bitstream, where n is the index to the MVC view\_id subsets starting with value 0 for the MVC view\_id subset containing the base view and ordered according to the minimum view order index contained in each MVC view\_id subset
- ES<sub>H</sub> is the received elementary stream associated to the H-th MVC video sub-bitstream which includes the view components with the highest view order index present in all MVC view\_id subsets of received elementary streams
- j is an index to the re-assembled access units
- j<sub>n</sub> is an index to the MVC view-component subsets of the elementary stream associated to the n-th MVC view\_id subset
- VS<sub>n</sub>(j<sub>n</sub>) is the j<sub>n</sub>-th MVC view-component subset of the MVC video sub-bitstream associated to ES<sub>n</sub>
- A<sub>H</sub>(j) is the j-th access unit resulting from re-assembling (up to) the H-th MVC view-component subset associated to ES<sub>H</sub>
- td<sub>n</sub>(j<sub>n</sub>) is the decoding time, measured in seconds, in the system target decoder of the MVC view-component subset VS<sub>n</sub>(j<sub>n</sub>)
- td<sub>H</sub>(j) is the decoding time, measured in seconds, in the system target decoder of the j-th access unit A<sub>H</sub>(j) resulting from re-assembling (up to) the MVC view-component subset VS<sub>H</sub>(j<sub>H</sub>)
- B<sub>H</sub> is the input buffer for all decoded MVC video sub-bitstreams
- BS<sub>H</sub> is the size of the input buffer B<sub>H</sub>, measured in bytes
- VSB<sub>n</sub> is the view component subset buffer for elementary stream ES<sub>n</sub>
- VSBS<sub>n</sub> is the size of view component subset buffer VSB<sub>n</sub>, measured in bytes

### Carriage in PES packets

For correct re-assembling of the MVC view-component subsets to an AVC access unit, the following applies:

- a PES packet per MVC view-component subset start shall be present, i.e., at most one MVC view-component subset may commence in the same PES packet;
- the PTS and, if applicable, the DTS value shall be provided in the PES header of each MVC view-component subset.

### DPB buffer management

The DPB buffer management for the re-assembled AVC video stream shall conform to 2.14.3.1 using AVC access unit timing values, as DTS or CPB removal time, and PTS or DPB removal time, associated with the MVC view-component subsets of the MVC video sub-bitstream in elementary stream  $ES_H$ .

### $B_n$ buffer management

The following applies:

- There is exactly one elementary stream buffer  $B_H$  for all the elementary streams in the set of decoded elementary streams as shown in Figure AMD4.2, where the size of  $BS_H$  is defined by the P-STD\_buffer\_size field in the PES packet header of elementary stream  $ES_H$ .
- There is exactly one view component subset buffer  $VSBS_n$  for each elementary stream in the set of decoded elementary streams as shown in Figure AMD4.2, where each view component subset buffer  $VSBS_n$  in the set of decoded elementary streams is allocated within  $BS_H$ . Even though the size  $VSBS_n$  of individual  $VSBS_n$  is not constrained, the sum of the sizes  $VSBS_n$  is constrained as follows:

$$BS_H = \sum_n (VSBS_n)$$

where  $BS_H$  is the size of the input buffer for the MVC video sub-bitstream in elementary stream  $ES_H$ , as defined in 2.14.3.2, for the re-assembled AVC video stream.

### Access unit re-assembling and B removal

The following specifies the access unit re-assembling that results in AVC access unit  $A_H(j)$ :

- Assemble the MVC view-component subsets for the  $j$ -th access unit  $A_H(j)$  following the rule below:
  - For each two corresponding MVC view-component subsets  $VS_{y+1}(j_{y+1})$  and  $VS_y(j_y)$  collected for access unit  $A_H(j)$ , where  $VS_y$  is associated with a program element identified by the hierarchy\_layer\_index indicated in the associated hierarchy descriptor, and  $VS_{y+1}$  references  $VS_y$  by the hierarchy\_embedded\_layer\_index indicated in the hierarchy descriptor associated to program element associated with  $VS_{y+1}$ , the DTS value of  $td_{y+1}(j_{y+1})$  of  $VS_{y+1}(j_{y+1})$  shall be equal to DTS value  $td_y(j_y)$  of  $VS_y(j_y)$ .  
NOTE – If no hierarchy descriptor is present,  $VS_y$  is associated with the AVC sub-bitstream and  $VS_{y+1}$  is associated with the MVC sub-bitstream.
- If SEI NAL units are present in any MVC view-component subset with view order index not equal to 0, these NAL units shall be re-ordered to the order of NAL units within an access unit, as defined in ITU-T Rec. H.264 | ISO/IEC 14496-10, before access unit re-assembling.

The following specifies the removal of access unit  $A_H(j)$  from buffer  $B_H$ :

At the decoding time  $td_H(j_H)$ , the AVC access unit  $A_H(j_H)$  shall be re-assembled and available for removal from buffer  $B_H$ . The decoding time  $td_H(j)$  is specified by the DTS or by the CPB removal time that is associated to the MVC view-component subsets in elementary stream  $ES_H$ , as derived from information in the re-assembled AVC video stream.

### STD delay

The STD delay for the re-assembled AVC access units shall follow the constraints specified in 2.14.3.2.

**Buffer management conditions**

Program streams shall be constructed so that the following conditions for buffer management are satisfied:

- $B_H$  shall not overflow.
- $B_H$  shall not underflow, except when VUI parameters are present for the AVC video sequence of the re-assembled AVC video stream with the `low_delay_hrd_flag` set to '1', or when `trick_mode` status is true. Underflow of  $B_H$  occurs for AVC access unit  $A_H(j)$  when one or more bytes of  $A_H(j)$  are not present in  $B_H$  at the decoding time  $td_H(j)$ .





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