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Information technology — Dynamic adaptive streaming over HTTP (DASH) —

Part 2: Conformance and reference software

Technologies de l'information — Diffusion en flux adaptatif dynamique sur HTTP (DASH) —
Partie 2: Conformité et logiciel de référence

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ISO copyright office
Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, SC 29, *Coding of audio, picture, multimedia and hypermedia information*.

This second edition cancels and replaces the first edition (ISO/IEC 23009-2:2014), which has been technically revised.

The main changes compared to the previous edition are as follows:

a) Conformance and reference software to cover all the features of ISO/IEC 23009-1:2014, including:
   - Dynamic MPD conformance;
   - Updates to MPEG-2 TS validator include:
     - Added tests for:
       - PES packet validity (complete access units);
       - SAP types when the video stream is MPEG-4 AVC;
       - Single segment index and representation indexes;
       - Subsegment indexes and subsegment validity;
       - Initialization segment information;
       - System-level tests of common encryption;
       - Bitstream switching segment;
       - Segment alignment if @segmentAlignment is true;
       - Subsegment alignment if @subsegmentAlignment is true;

- Simple profile tests.
- Changes made to usability:
  - The conformance checker runs against an MPD and all of its segments at once;
  - The build system has been replaced with Autotools.

b) Test vectors to cover the features of ISO/IEC 23009-1:2014.

c) Feature list and coverage for ISO/IEC 23009-1:2014 is provided in Annex F.

A list of all parts in the ISO/IEC 23009 series can be found on the ISO website.

Introduction

The conformance and reference software of ISO/IEC 23009 serves three main purposes:

— validation of the written specification of the parts of ISO/IEC 23009;

— clarification of the written specification of the parts of ISO/IEC 23009;

— conformance testing for checking interoperability for the various applications against the reference software which aims to be compliant with ISO/IEC 23009.

Information technology — Dynamic adaptive streaming over HTTP (DASH) —

Part 2: Conformance and reference software

1 Scope

This document specifies the conformance and reference software implementing the normative clauses of ISO/IEC 23009-1, that is test vectors comprising media presentation descriptions, segments, and combinations thereof that conform or do not conform to the normative clauses of ISO/IEC 23009-1 and corresponding software modules.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 19757-3, *Information technology — Document Schema Definition Languages (DSDL) — Part 3: Rule-based validation — Schematron*

ISO/IEC 23009-1:2014, *Information technology — Dynamic adaptive streaming over HTTP (DASH) — Part 1: Media presentation description and segment formats*

3 Terms, definitions, symbols and abbreviated terms

For the purpose of this document, the terms, definitions, symbols and abbreviated terms given in ISO/IEC 23009-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Media presentation conformance

4.1 Overview

A media presentation conforming to ISO/IEC 23009-1 obeys the rules for the media presentation description (MPD) and the segments referenced within the MPD. To verify the conformance of a media presentation, the following steps need to be completed:

— the conformance of the MPD according to Clause 5.

— the conformance of the segments, which includes the conformance of individual segments and representations, as well as the conformance of representations that are jointly provided in adaptation sets and periods. For details, refer to Clause 6.

The process of MPD and segment conformance checking is shown in Figure 1.

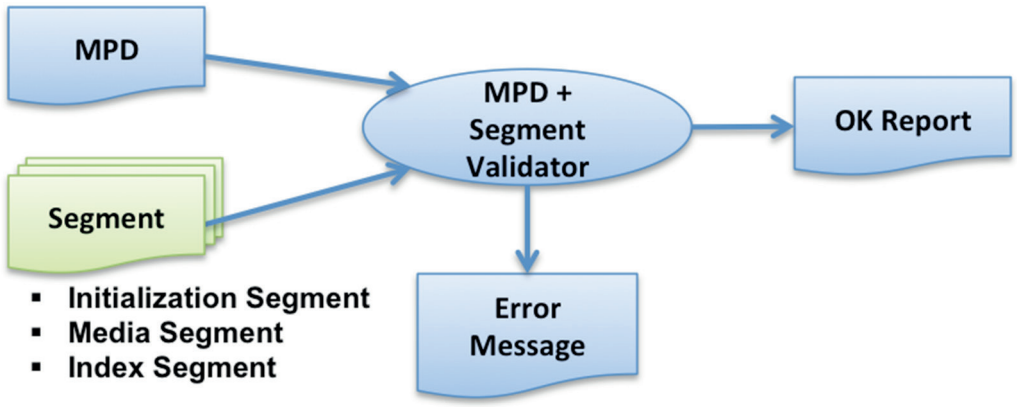

Figure 1 — MPD and segment validation

MPD + segment validator: gets as an input the MPD and segments referenced from within the MPD and performs the MPD and segment validation according to the rules defined in Annex B. On success, the output is an OK report; otherwise, an error message is provided.

4.2 Software tools

The following software tools are included:

— MPD conformance software;

— ISO BMFF segment validator;

— MPEG-2 TS segment validator;

— Conformance software for dynamic services.

All software tools are available through the MPEG SVN accessible via http://wg11.sc29.org/svn/repos/MPEG-DASH/ (requires username/password which can be obtained through the ISO/IEC JTC1 SC 29 mirror committee of each member country). A snapshot of the software is also available in http://standards.iso.org/ittf/PubliclyAvailableStandards/.

Additional supplamental software packages which may be used as sample DASH clients, sample segmentor and web-based conformace service are listed in Annex D.

5 MPD conformance

5.1 General

This clause specifies the MPD conformance checking and corresponding software modules which comprise the three steps depicted in Figure 2. Detailed means to perform MPD conformance checking are provided in Annex A.

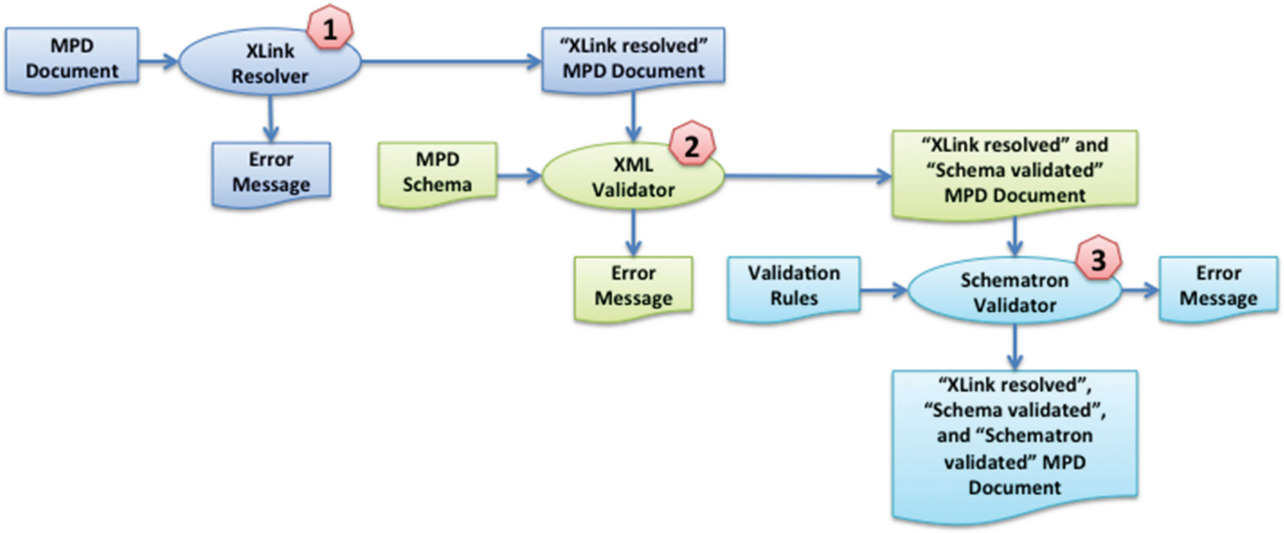

Figure 2 — MPD conformance checking

Step 1 (XLink Resolver): gets as an input an MPD document and resolves all W3C XLINK[10] attributes as defined in ISO/IEC 23009-1. If an error occurs, the corresponding error message shall be provided; otherwise, the XLink resolved MPD document is provided. The details for this step of the MPD conformance checking are defined in A.2.

Step 2 (XML Validator): gets as an input an XLink-resolved MPD document and performs XML validation (i.e. well-formed and valid) against the MPD schema defined in W3C XML[11] and W3C XML SCHEMA.[12] If an error occurs, the corresponding error message shall be provided; otherwise, the XLink-resolved and schema-validated MPD document is provided. The details for this step of the MPD conformance checking are defined in A.3.

Step 3 (Schematron Validator): gets as an input an XLink-resolved and schema-validated MPD document and performs Schematron validation as defined in ISO/IEC 19757-3 according to the rules defined in A.4.2. If an error occurs, the corresponding error message shall be provided; otherwise, the XLink-resolved, schema-validated, and Schematron-validated MPD document is provided. The details for this step of the MPD conformance checking are defined in A.4

The following command may be used to validate an MPD document with the chain depicted in Figure 2. This requires Apache Ant[3].

```
ant run -Dinput="filetovalidate.mpd"
```

The program outputs a message for each step. If an error occurs during one step, the following steps are not executed.

All conformance tools are available through the MPEG SVN and MPEG Conformance repository accessible via http://wg11.sc29.org/svn/repos/MPEG-DASH/ (requires username/password which can be obtained through the ISO/IEC JTC 1 SC 29 mirror committee of each member country). A snapshot of the tools is also available in http://standards.iso.org/ittf/PubliclyAvailableStandards/.

5.2 Static MPD conformance

An MPD with **MPD**`@type="static"` shall comply with the rules in 5.1.

In addition, the availability of all resources in the MPD during the **MPD**`@availabilityStartTime` and the **MPD**`@availabilityEndTime` shall be checked. A function `remoteFileExists($url)` may be executed for each segment that is documented in the MPD. This function shall return true for all Segments in the MPD during the time interval defined by the **MPD**`@availabilityStartTime` and the

MPD@availabilityEndTime. The following snippet shows an example for the remoteFileExists function written in PHP.

```
function remoteFileExists($url) {
    $curl = curl_init($url);

     //don't fetch the actual page, you only want to check the
    connection is ok curl_setopt($curl, CURLOPT_NOBODY, true);

     //do request
     $result = curl_exec($curl);

     $ret = false;

     //if request did not fail
     if ($result !== false) {
         //if request was ok, check response code
         $statusCode = curl_getinfo($curl, CURLINFO_HTTP_CODE);

         if ($statusCode == 200) {
         $ret = true;
         }
     }

         curl_close($curl);

         return $ret;
    }
```

5.3 Dynamic MPD conformance

5.3.1 General

To ensure that servers offering a dynamic DASH media presentation adhere to the timing requirements and that clients are able to properly consume the dynamic presentation without observing unavailable segments, the DASH conformance software is extended to include and address media presentations with **MPD**@type='dynamic'. In 5.3, the requirements which go beyond those for static DASH conformance are listed and a functional description of the conformance software implementation is provided.

The document is aligned with the guidelines for live services as documented in ISO/IEC/TR 23009-3[1].

5.3.2 Background and requirements

5.3.2.1 MPD-specific checks

Clients make use of the information in an MPD. Based on an MPD that is fetched at a certain fetch time FT the client can determine the following information:

a) At any time, WT where WT ≥ FT, a client can determine:

1) the latest available period on the server, denoted by its Period start time PS*;

2) the segment availability start time of any segment at position *k* within the Period, denoted as SAST(*k*);

3) the position of the latest segment that is available on server in the Period, referred to as *k**;

4) the URL of the latest segment that is available within this Period;

5) the time when to fetch a new MPD based on the current presentation time, or more specifically, the greatest segment position *k'* within this Period that can be constructed by this MPD;

6) the media presentation time within the Representation that synchronizes closest to the live edge, MPTL;

7) the media presentation time within the Representation that synchronizes to other clients, MPTS.

b) At any time, WT, all segments with availability start time at or before WT and availability end time at or before WT are accessible.

c) An updated MPD is made available on time, taking into account the minimum update period (MUP) of the MPD. Note that by not updating the MPD, the existing MPD is validated for another MUP time.

Detailed equations to derive segment availability times are provided in ISO/IEC 23009-1 and ISO/IEC/TR 23009-3[1]. When providing an MPD, the content author ensures that the segment availability times can be derived.

5.3.2.2 MPD times

In order to use the same concepts with different timing and addressing schemes, the following values are introduced according to ISO/IEC 23009-1:

— the position of the segment in the Period denoted as k with k=1,2,...;

— the MPD start time of the segment at position k, referred to as MST(k);

— the MPD duration of a segment at position k, referred to as MD(k).

Assuming that the wall-clock time at the client is denoted as WT, the client can derive the following information.

5.3.2.3 General derivation

Using these times, the values from above can be derived as follows.

— The latest Period is the Period for which AST + PS + MD(1) ≤ WT where AST is the value of the `MPD@availabilityStartTime` and PS is the *PeriodStart* as defined in ISO/IEC 23009-1.

— The segment availability start time is obtained as

$$SAST(k) = AST + PS + MST(k) + MD(k)$$

— Within this Period, the latest segment available on the server is the segment at the position k^* which results in the greatest value for SAST(k^*) and at the same time is smaller than WT.

— The address of the latest segment can be derived using the position information k^*. The exact value depends on the addressing method.

— Within this Period, the greatest segment position k' that can be constructed by this MPD is the one that results in the greatest value for SAST(k') and at the same time is smaller than FT + MUP.

The media presentation time in a Period is determined for each Representation as the presentation time value of the media segments minus the value of the `@presentationTimeOffset`, if present, for each Representation.

It is further assumed that a segment at position k has an assigned earliest media presentation time EPT(k).

5.3.2.4 Requirements

When receiving an MPD, the DASH client is guaranteed that:

— Each segment at position k in this Period is available prior to the sum of its earliest presentation time and its duration; SAST(k) ≤ EPT(k) + MD(k).

— If each segment with segment number k is delivered starting at SAST(k) over a constant bitrate channel with bitrate equal to the value of the `@bandwidth` attribute, then each sample with presentation time *PT* shall be available at the client by the time given by PT + (AST + PS) + MBT + MD(k).

— Each segment in this Period shall be available at least until SAST(k) + TSB + MD(k).

— The MPD can be used to construct and request segments until media time FT + MUP. The greatest segment position k' that can be constructed by this MPD shall be the one that results in the greatest value for SAST(k') and at the same time is smaller than FT + MUP. Note that the latest segment may be significantly shorter in duration than MD(k).

In addition, updates of the MPD shall be consistent according to ISO/IEC 23009-1:2014, 5.4.

5.3.3 Dynamic conformance software design

5.3.3.1 Overview

The implementation of the conformance software for dynamic services requires the implementation of the requirements in 5.3.2.4. The process is split into two parts:

— the creation of a data set by recording/monitoring a dynamic service;

— the actual conformance checks implementing the checks of the requirements.

5.3.3.2 Data set creation

Two different cases are considered depending on the access bandwidth to the server.

In case 1, it is assumed that the conformance checker is operating with a very high (infinite) access bandwidth and minimal delay. Then the initial part is as follows.

a) Download and store the MPD, and record the fetch time FT of the MPD.

b) Determine the following information.

   1) The smallest segment availability start time greater than FT of any Segment in any Representation referred to as $SAST_{min}$.

   2) The URLs of all segments available at $SAST_{min}$. If multiple segments are available at the same time, determine all of them.

c) For all segments with segment availability, end time greater than FT and smaller than $SAST_{min}$, generate the URL, issue an HTTP HEAD request, and record the HTTP header.

d) At time $SAST_{min}$ issue HTTP GET requests for all segments that become available at this time, record the HTTP headers and store the segments.

e) Go to a) and download the next MPD at FT = $SAST_{min}$.

f) Continue the process until manually stopped or the media presentation is ended.

In case 2, if the bandwidth connection is restricted, apply the following.

a) Download and store the MPD, and record the fetch time FT of the MPD.

b) Determine the following information.

   1) The smallest segment availability start time greater than FT of any segment in any Representation referred to as $SAST_{min}$.

   2) The URLs of all segments available at $SAST_{min}$. If multiple segments are available at the same time, determine all of them.

c) For all segments with segment availability end time greater than FT and smaller than $SAST_{min}$, generate the URL, issue an HTTP HEAD request, and record the HTTP headers.

d) For selected representations, issue an HTTP GET for segments that are available at this time.

e) At time $SAST_{min}$ issue HTTP HEAD for all segments that become available at this time and record the HTTP headers.

f) Go to a) and download the next MPD at FT = $SAST_{min}$.

g) Continue the process until manually stopped or the media presentation is ended.

This initial operation results in a data set as follows:

a) a sequence of MPDs, each with a FT;

b) a set of Segment URLs with associated:

   1) SAST;

   2) fetch time for segment availability start time request (typically SAST);

   3) HTTP headers for segment availability start time request;

   4) segment availability end time (SAET);

   5) fetch time for segment availability end time request (typically just slightly before the SAET);

   6) HTTP headers for segment availability end time request;

c) at least for a selected set of representations, the corresponding segments.

From the sequence of the MPDs, a single new MPD can be generated with **`MPD`**`@type=static` that includes all segments.

5.3.3.3 Conformance checks

The conformance checks operate on the stored data set and include the following checks:

— the correctness of the sequence of MPDs as documented in ISO/IEC 23009-1:2014, 5.4.

— all MPD timing aspects and segment availability times as documented in ISO/IEC 23009-1:2014, 5.3.

— the static conformance checks using the single MPD according to 5.2.

6 Segment conformance

6.1 Overview

Segment conformance requirements verify that the segments offered in the MPD conform to the DASH specification.

This includes the conformance requirements for:

— segments offered within one representation (for details, refer to 6.2);

— representations offered within one adaptation set (for details, refer to 6.3);

— segments offered in a dynamic media presentation (for details, refer to 6.4).

All conformance tools are available through the MPEG SVN and MPEG conformance repository accessible via http://wg11.sc29.org/svn/repos/MPEG-DASH/ (requires username/password which can be obtained through the ISO/IEC JTC 1 SC 29 mirror committee of each member country). A snapshot of the tools is also available in http://standards.iso.org/ittf/PubliclyAvailableStandards/.

6.2 Representation conformance

6.2.1 ISO base media file format

The representation conformance rules, as well as the implementation status of the conformance rules for ISO base media file format segments, are provided in Table 1.

Table 1 — Representation conformance rules for ISO base media file format

	Clause in ISO/IEC 23009-1	Rule	Conformance check implementation
1	6.1	Media Segment formats shall comply with the respective container formats (ISO BMFF and MPEG-2 TS).	Implemented
2	6.2.1	The Initialization Segment shall not contain any media data with an assigned presentation time	Implemented
3	6.2.1	A Media Segment shall contain a number of complete access units.	Implemented
4	6.2.1	If it is the first Media Segment in the Representation, it shall contain only media streams that start with a SAP of type 1 or 2.	Implemented
5	6.2.1	A Media Segment shall contain sufficient information to time-accurately present each contained media component in the Representation without accessing any previous Media Segment in this Representation provided that the Media Segment contains a SAP for each media stream.	Implemented
6	6.2.3.2	A Media Segment shall specify all Media Presentation times relative to the start of the Period and compensated with the value of the @presentationTimeOffset. The presentation time in Media Segments shall be accurate to ensure accurate alignment of all Representations in one Period. a) earliest_presentation_time shall be equal to the sum of all temporally preceding subsegments in the representation. b) The duration of a subsegment indexed by an 'sidx' shall be equal to the sum of the durations of all the subsegments it indices.	Implemented
7	6.3.2.1	A media data box containing data referenced by a movie fragment ('moof') box shall follow that movie fragment box and precede the next movie fragment box, if any, containing information about the same track.	Implemented
8	6.3.2.1	For a Media Subsegment, the value of the reference_type field in the describing Segment Index ('sidx') box shall be set to 0.	Implemented
9	6.3.2.3	If the Segment Index is provided, the Segment Index ('sidx') box in ISO/IEC 14496-12 shall be used.	Implemented
10	6.3.2.4	If the Subsegment Index is provided, the Subsegment Index ('ssix') box in ISO/IEC 14496-12 shall be used.	Implemented
11	6.3.3	The Initialization Segment shall contain an "ftyp" box, and a "moov" box.	Implemented
12	6.3.3	It shall not contain any "moof" boxes.	Implemented
13	6.3.3	The tracks in the "moov" box shall contain no samples (i.e. the entry_count in the "stts", "stsc", and "stco" boxes shall be set to 0).	Implemented

Table 1 *(continued)*

	Clause in ISO/IEC 23009-1	Rule	Conformance check implementation
14	6.3.3	The "mvex" box shall be contained in the "moov" box. The "mvex" box also sets default values for the tracks and samples of the following movie fragments.	Implemented
15	6.3.4.2	'styp' box, if present, shall carry 'msdh' as a compatible brand.	Implemented
16	6.3.4.2	Each Media Segment shall contain one or more whole self-contained movie fragments. A whole, self-contained movie fragment is a movie fragment ('moof') box and a media data ('mdat') box that contains all the media samples that do not use external data references referenced by the track runs in the movie fragment box.	Implemented
17	6.3.4.2	Each 'moof' box shall contain at least one track fragment.	Implemented
18	6.3.4.2	The 'moof' boxes shall use movie-fragment relative addressing for media data that does not use external data references, the flag 'default-base-is-moof' shall be set, and data-offset shall be used, i.e. base-data-offset-present shall not be used.	Implemented
19	6.3.4.2	Each 'traf' box shall contain a 'tfdt' box.	Implemented
20	6.3.4.2	Each Media Segment may contain one or more 'sidx' boxes. If 'sidx' is present in a Media Segment, the first 'sidx' box shall be placed before any 'moof' box and the first Segment Index box shall document the entire Segment.	Implemented
21	6.3.4.3	In each self-contained movie fragment, the movie fragment ('moof') box is immediately followed by its corresponding media data ('mdat').	Implemented
22	6.3.4.3	Each Media Segment shall contain one or more 'sidx' boxes.	Implemented
23	6.3.4.3	The first 'sidx' box shall be placed before any 'moof' box and shall document Subsegments that span the composition time of the entire Segment.	Implemented
24	6.3.4.3	Each Media Segment shall carry 'msix' as a compatible brand.	Implemented
25	6.3.4.4	The Subsegment Index box ('ssix') shall be present and shall follow immediately after the 'sidx' box that documents the same Subsegment. This immediately preceding 'sidx' shall only index Media Subsegments.	Implemented
26	6.3.4.4	It shall carry 'sims' in the Segment Type box ('styp') as a compatible brand.	Implemented
27	6.3.5.2	The Indexed Self-Initializing Media Segment shall carry 'dash' as a compatible brand.	Implemented
28	5.3.5.2	If the Representation is continuously delivered at this bitrate, starting at any SAP that is indicated either by @startWithSAP or by any Segment Index box, a client can be assured of having enough data for continuous playout providing playout begins after @minBufferTime * @bandwidth bits have been received (i.e. at time @minBufferTime after the first bit is received).	Implemented

6.2.2 MPEG-2 transport stream

The representation conformance rules, as well as the implementation status of the conformance rules for MPEG-2 transport stream based segments, are provided in Table 2.

