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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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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

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).

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Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of 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: 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 third edition cancels and replaces the second edition (ISO/IEC 23009-2:2017), which has been technically revised.

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

- a) Test vectors, conformance and reference software to cover all the features of ISO/IEC 23009-5, including:
 - SAND HTTP conformance client;
 - SAND HTTP conformance server;
 - SAND WebSocket conformance server.
- b) Test vectors, conformance and reference software to cover all the features of ISO/IEC 23009-6, including:
 - Command line tool to validate of ABNF grammars.

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 the ISO/IEC 23009 series serves three main purposes:

- validation of the written specification of the Parts of the ISO/IEC 23009 series;
- clarification of the written specification of the Parts of the ISO/IEC 23009 series;
- conformance testing for checking interoperability for the various applications against the reference software which aims to be compliant with the ISO/IEC 23009 series.

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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 test vectors comprising media presentation descriptions, segments and combinations thereof in ISO/IEC 23009-1, and the 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 23009-1:2019, *Information technology — Dynamic adaptive streaming over HTTP (DASH) — Part 1: Media presentation description and segment formats*

ISO 8601-1, *Date and time — Representations for information interchange — Part 1: Basic rules*

ISO/IEC 23009-5:2017, *Information technology — Dynamic adaptive streaming over HTTP (DASH) — Part 5: Server and network assisted DASH (SAND)*

IETF RFC 7233:2014, *Hypertext Transfer Protocol (HTTP/1.1): Range Requests*

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](#).

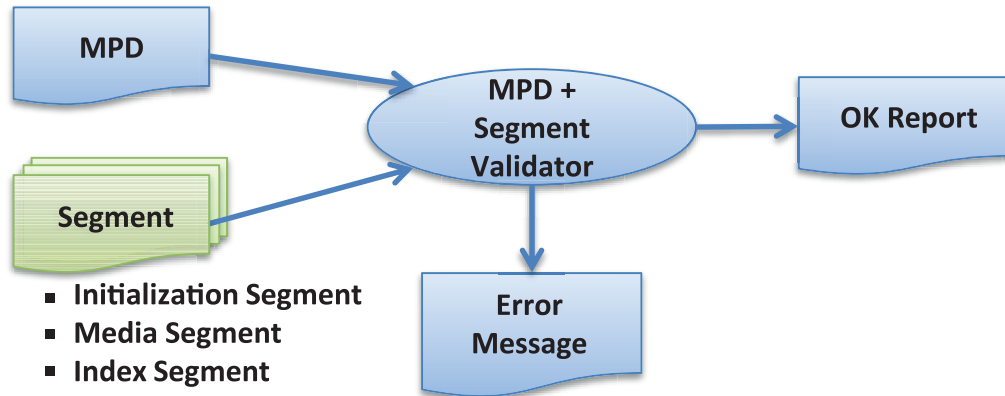


Figure 1 — MPD and segment validation

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 A](#). 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;
- Dynamic media presentation emulator in [Annex D](#).

All software tools are available at <https://standards.iso.org/iso-iec/23009-2/ed-3/en>.

Additional supplemental software packages which may be used as sample DASH clients, sample segmentor and web-based conformance service are listed in [Annex C](#).

Coverage of DASH features is discussed in [Annex E](#).

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 as specified in [Annex A](#).

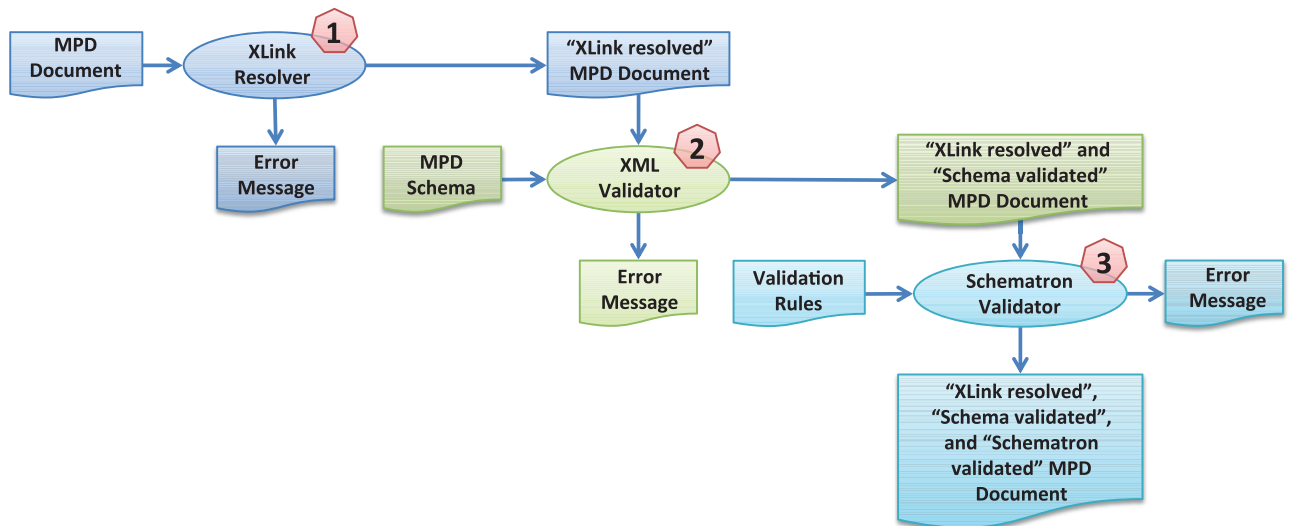


Figure 2 — MPD conformance checking

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^{TM1}[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 at <https://standards.iso.org/iso-iec/23009-2/ed-3/en>.

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.

1) Apache Ant is the trade name of a product supplied by The Apache Software Foundation. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO or IEC of the product named.

```
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^[4].

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 $WT \geq FT$, 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 $k=1,2,\dots$;
- 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 $AST + PS + MD(1) \leq WT$ 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; $SAST(k) \leq EPT(k) + MD(k)$.
- 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 23009-1:2019, 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 23009-1:2019, 5.4.
- all MPD timing aspects and segment availability times as documented in ISO/IEC 23009-1:2019, 5.3.
- the static conformance checks using the single MPD according to 5.2.

5.4 Conformance checks for spatial relationship description

The conformance rules that relate to the spatial relationship description are provided in [Table 1](#).

An MPD shall comply with the rules in [Table 1](#) in accordance with ISO/IEC 23009-1.

Table 1 — Spatial relationship description conformance rules

| Reference in ISO/IEC 23009-1: 2019, Annex H | Rule | Conformance check implementation |
|---|--|----------------------------------|
| H.1 | When every Adaptation Set in an MPD has an SRD descriptor, at least one such descriptor shall be a SupplementalProperty. | R19.1 |
| H.1 | An EssentialProperty or SupplementalProperty descriptor with @schemeIdUri equal to "urn:mpeg:dash:srd:2014" shall be the child element of an AdaptationSet or a SubRepresentation element. | R19.2 |
| H.2 | If an EssentialProperty or SupplementalProperty descriptor with @schemeIdUri equal to "urn:mpeg:dash:srd:2014" is present, then the @value attribute shall be present. | R19.3 |