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

**Part 1:
Media presentation description and
segment formats**

*Technologies de l'information — Diffusion en flux adaptatif
dynamique sur HTTP (DASH) —*

*Partie 1: Description de la présentation et formats de remise des
médias*



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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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 or www.iec.ch/members_experts/refdocs).

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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. In the IEC, see www.iec.ch/understanding-standards.

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

This fifth edition cancels and replaces the fourth edition (ISO/IEC 23009-1:2020), which has been technically revised.

The main changes are as follows:

- DASH profile for using Common Media Application Format (CMAF) are added;
- The concept Resynchronization is added in order to identify stream access points in Segments;
- MPD patching is updated to support explicit MPD updates of smaller size, not only as inband messages;
- A client processing model for Event Streams and Timed Metadata tracks is introduced;
- Extensions are added to content protection for efficient signalling and to support robustness levels.
- A descriptor is added in order to describe the minimum required device output protection security;
- More flexible bandwidth signalling is provided to signal variable bitrate encoding.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and <https://www.iec.ch/national-committees>.

Introduction

Dynamic adaptive streaming over HTTP (DASH) is intended to support a media-streaming model for delivery of media content in which control lies primarily with the client. Clients may request data using the HTTP protocol from standard web servers that have no DASH-specific capabilities. Consequently, this document focuses not on client or server procedures but on the data formats used to provide a DASH Media Presentation.

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

Part 1: Media presentation description and segment formats

1 Scope

This document primarily specifies formats for the Media Presentation Description and Segments for dynamic adaptive streaming delivery of MPEG media over HTTP. It is applicable to streaming services over the Internet.

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 13818-1, *Information technology — Generic coding of moving pictures and associated audio information — Part 1: Systems*

ISO/IEC 14496-12, *Information technology — Coding of audio-visual objects — Part 12: ISO base media file format*

ISO/IEC 23000-19, *Information technology — Multimedia application format (MPEG-A) — Part 19: Common media application format (CMAF) for segmented media*

ISO/IEC 23091-2, *Information technology — Coding-independent code points — Part 2: Video*

ISO/IEC 23091-3, *Information technology — Coding-independent code points — Part 3: Audio*

IETF RFC 2397, *The “data” URL scheme*

IETF RFC 3629, *UTF-8, a transformation format of ISO 10646*

IETF RFC 3986, *Uniform Resource Identifier (URI): Generic Syntax*

IETF RFC 4122, *A Universally Unique Identifier (UUID) URN Namespace*

IETF RFC 4337, *MIME Type Registration for MPEG-4*

IETF RFC 4648, *The Base16, Base32, and Base64 Data Encodings*

IETF RFC 5234, *Augmented BNF for Syntax Specifications: ABNF*

IETF RFC 5261, *An Extensible Markup Language (XML) Patch Operations Framework Utilizing XML Path Language (XPath) Selectors*

IETF RFC 5646, *Tags for Identifying Languages*

IETF RFC 6381, *The ‘Codecs’ and ‘Profiles’ Parameters for “Bucket” Media Types*



Documents

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IETF RFC 6838, *Media Type Specifications and Registration Procedures*

IETF RFC 7231, *Hypertext Transfer Protocol (HTTP/1.1): Semantics and Content*

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

IETF RFC 8141, *URN Syntax*

IETF RFC 8673, *HTTP Random Access and Live Content*

HTML 4.01 Specification, W3C Recommendation, 24 December 1999

W3C Canonical XML Version 1.1, W3C Recommendation, 2 May 2008

W3C Extensible Markup Language (XML) 1.0 (Fifth Edition), W3C Recommendation, 26 November 2008

W3C XLINK, XML Linking Language (XLink) Version 1.1, W3C Recommendation 06, May 2010

W3C Media Fragments URI 1.0 (basic), W3C Recommendation, 25 September 2012

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 23000-19 and the following apply.

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

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1.1

access unit

unit of a *media stream* (3.1.29) with an assigned Media Presentation time

3.1.2

accessibility

degree to which a media content or certain *media content components* (3.1.22) are available to as many people as possible

3.1.3

Adaptation Set

set of interchangeable encoded versions of one or several *media content components* (3.1.22)

3.1.4

asset

content including media and metadata together with the rights to use the content by the content provider

3.1.5**associated Representation**

Representation (3.1.38) which provides supplemental or descriptive information for at least one other *Representation*

3.1.6**available Segment**

Segment (3.1.40) that is accessible at its assigned *HTTP-URL* (3.1.17) and a possibly assigned byte range that is the request with an HTTP GET results in a reply of the *Segment* and 2xx status code

3.1.7**Bitstream Switching Segment**

Segment (3.1.40) that if present contains essential data to switch to the *Representation* (3.1.38) it is assigned to

3.1.8

complementary *Representation*

Representation (3.1.38) which complements at least one *dependent Representation* (3.1.12)

3.1.9**continuous media**

media with an inherent notion of time

EXAMPLES Speech, audio, video, timed text or timed metadata.

3.1.10**DASH metric**

metric computed by the DASH Client and uniquely identified by a key

3.1.11**data URL**

URL with a fixed scheme “data”

3.1.12**dependent Representation**

Representation (3.1.38) for which *Segments* (3.1.40) from its *complementary Representations* (3.1.8) are necessary for presentation and/or decoding of the contained *media content components* (3.1.22)

3.1.13**earliest presentation time**

smallest *presentation time* (3.1.36) of any *access unit* (3.1.1) of a *Media Segment* (3.1.28) Or *Subsegment* (3.1.50) for a *media stream* (3.1.29)

3.1.14**event**

aperiodic sparse media-time related auxiliary information to the DASH Client or to an application

3.1.15**event stream**

sequence of related *events* (3.1.14)

3.1.16**group**

collection of *Adaptation Sets* (3.1.3) that are not expected to be presented simultaneously

3.1.17

HTTP-URL

URL with a fixed scheme of “http” or “https”

3.1.18

Index Segment

Segment (3.1.40) that primarily contains indexing information for *Media Segments* (3.1.28)

3.1.19

Initialization Segment

Segment (3.1.40) containing metadata that is necessary to present the *media streams* (3.1.29) encapsulated in *Media Segments* (3.1.28)

3.1.20

Main Adaptation Set

Adaptation Set (3.1.3) In A *Preselection* (3.1.35) that contains the *Initialization Segment* (3.1.19) for the complete experience

3.1.21

media content

single *media content period* (3.1.24) or contiguous sequence of media content periods

3.1.22

media content component

single continuous component of the *media content* (3.1.21) with an assigned *media content component type* (3.1.23)

3.1.23

media content component type

single type of *media content* (3.1.21)

EXAMPLES Audio, video, or text.

3.1.24

media content period

set of *media content components* (3.1.22) that have a common timeline as well as relationships on how they can be presented

3.1.25

Media Presentation

collection of data that establishes a bounded or unbounded presentation of *media content* (3.1.21)

3.1.26

Media Presentation Description

MPD

formalized description for a *Media Presentation* (3.1.25) for the purpose of providing a streaming service

3.1.27

Media Presentation timeline

concatenation of the timeline of all *Periods* (3.1.34) which itself is common to all *Representations* (3.1.38) in the Period

3.1.28**Media Segment**

Segment (3.1.40) that complies with media format in use and enables playback when combined with zero or more preceding Segments and an *Initialization Segment* (3.1.19) (if any)

3.1.29**media stream**

encoded version of a *media content component* (3.1.22)

3.1.30**Media Subsegment**

Subsegment (3.1.50) that only contains media data but no *Segment Index* (3.1.44)

3.1.31**message**

part of an *event* (3.1.14) containing information that is exclusively handled by the event handler

3.1.32**MPD start time**

approximate presentation start time of a *Media Segment* (3.1.28) signalled in *MPD* (3.1.26)

3.1.33**MPD duration**

approximate presentation duration of a *Media Segment* (3.1.28) signalled in *MPD* (3.1.26)

3.1.34**Period**

interval of the *Media Presentation* (3.1.24), where a contiguous sequence of all Periods constitutes the Media Presentation

3.1.35**Preselection**

set of *media content components* (3.1.22) that are intended to be consumed jointly

3.1.36**presentation time**

time associated to an *access unit* (3.1.1) that maps it to the *Media Presentation timeline* (3.1.27)

3.1.37**remote element entity**

entity that contains one or more elements and is referenced in the *MPD* (3.1.26) with an *HTTP-URL* (3.1.17) contained in an @xlink:href attribute, referred to as "remote resource" by XLink

3.1.38**Representation**

collection and encapsulation of one or more *media streams* (3.1.29) in a delivery format and associated with descriptive metadata

3.1.39**Resynchronization Point**

point within a Segment from which it is possible to start processing the Representation

3.1.40

Segment

unit of data associated with an *HTTP-URL* (3.1.17) and optionally a byte range that are specified by an *MPD* (3.1.26), or with a *data URL* (3.1.11)

3.1.41

Segment availability start time

latest time instant in *wall-clock time* (3.1.53) at which a *Segment* (3.1.40) becomes an *available Segment* (3.1.6)

3.1.42

adjusted Segment availability start time

time instant in *wall-clock time* (3.1.53) at which a *Segment* (3.1.40) becomes an *available Segment* (3.1.6)

3.1.43

Segment availability end time

time instant in *wall-clock time* (3.1.53) at which a *Segment* (3.1.40) ceases to be an *available Segment* (3.1.6)

3.1.44

Segment Index

compact index of the time range to byte range mapping within a *Media Segment* (3.1.28) separately from the *MPD* (3.1.26)

3.1.45

Segment Sequence

sequence of *Segments* (3.1.40) that are sharing a common address prefix

3.1.46

Segment Track

concatenation of *Segments* (3.1.40) forming a track with potential conformance properties

3.1.47

spatial object

media content component (3.1.22) corresponding to a region in a coordinate system associated to this media content component

3.1.48

stream access point

SAP

position in a *Representation* (3.1.38) enabling playback of a *media stream* (3.1.29) to be started using only the information contained in *Representation* data starting from that position onwards preceded by initializing data in the *Initialization Segment* (3.1.19), if any

3.1.49

sub-asset

media content component (3.1.22) (or part thereof) identified as corresponding to a part of an *asset* (3.1.4)

3.1.50**Sub-Representation**

part of a *Representation* (3.1.38) described in the *MPD* (3.1.26) that is present in the entire *Period* (3.1.34)

3.1.51**Subsegment**

unit within *Media Segments* (3.1.28) that is indexed by a *Segment Index* (3.1.44)

3.1.52**valid Segment URL**

HTTP-URL (3.1.17) that is promised to reference a *Segment* (3.1.40) during its Segment availability period

3.1.53**wall-clock time**

time as stated by UTC

3.2 Symbols and abbreviated terms

4CC	four character code
ABNF	augmented Backus-Naur form
ACK	acknowledgement message in TCP
AEMS	application event or metadata streams
API	application programming interface
AVC	advanced video coding
CAT	conditional access table
CDN	content delivery network
CMAF	common media application format
DASH	dynamic adaptive streaming over HTTP
DM	DASH metrics
DOM	document object model
DRM	digital rights management
ECM	entitlement control message
EIDR	entertainment identifier registry
EME	encrypted media extensions
EMIO	event/metadata internal object
EMM	entitlement management message
EPT	earliest presentation time
GAA	generic authentication architecture
GBA	generic bootstrapping architecture
GDR	gradual decoding refresh
GMT	Greenwich Mean Time

GOP	group of pictures
GPS	global positioning system
HDCP	high-bandwidth digital content protection
HDMI	high definition multimedia interface
HEVC	high efficiency video coding
HTML	hypertext markup language
HTTP	hypertext transfer protocol
HTTPS	secure hypertext transfer protocol
IAB	interactive advertising bureau
IDR	instantaneous decoding refresh
IP	internet protocol
ISO BMFF	ISO base media file format
LAT	Latest Arrival Time
MBT	minimum buffer time
MIME	multipurpose internet mail extensions
MPD	media presentation description
MPP	MPD patch
MVC	multi-view video coding
NGA	next generation audio
NTP	network time protocol
OATC	open authentication technical committee
OAuth	open standard for authorization
OMAP	online multimedia authorization protocol
PAT	program association table
PCR	program clock reference
PES	packetized elementary stream
PID	packet identifier
PMT	program map table
PSI	program specific information
PTS	presentation time stamp
RAP	random access point
SAML	security assertion markup language
SAP	stream access point
SEI	supplementary enhancement information
SNTP	simple NTP
SPS	sequence parameter set

SRD	spatial relationship description
SVC	scalable video coding
TCP	transmission control protocol
TLS	transport layer security
TS	transport stream
URI	uniform resource identifier
URL	uniform resource locator
URN	uniform resource name
UTC	coordinated universal time
UUID	universally unique identifier
VAST	video ad serving template
VOD	video-on-demand
XML	extensible mark-up language

3.3 Conventions

The following naming conventions apply in this document.

- Elements in an XML document are identified by an upper-case first letter and in bold face as **Element**. To express that an element **Element1** is contained in another element **Element2**, the following format is used: **Element2.Element1**. If an element's name consists of two or more combined words, camel-casing is typically used, e.g. **ImportantElement**. Elements may be present either exactly once, or the minimum and maximum occurrence is defined by `<minOccurs> ... <maxOccurs>`.
- Attributes in an XML document are identified by a lower-case first letter as well as they are preceded by an '@'-sign, e.g. `@attribute`. To point to a specific attribute `@attribute` contained in an element **Element**, one may write **Element@attribute**. If an attribute's name consists of two or more combined words, camel-casing is typically used after the first word, e.g. `@veryImportantAttribute`. Attributes may have assigned a status in the XML as mandatory (M), optional (O), optional with default value (OD) and conditionally mandatory (CM).
- Namespace qualification of elements and attributes is used as per XML standards, in the form of **namespace:Element** or `@namespace:attribute`. The fully qualified namespace is provided in the schema fragment associated with the declaration. External specifications extending the namespace of DASH are expected to document the element name in the semantic table with an extension namespace prefix.
- Variables defined in the context of this document are specifically highlighted with *italics*, e.g. *InternalVariable*.
- Structures that are defined as part of the hierarchical data model are identified by an upper-case first letter, e.g. Period, Adaptation Set, Representation, Segment, etc.
- The term "this clause" refers to the entire clause included within the same first heading number. The term "this subclause" refers to all text contained in the subclause with the lowest hierarchy heading.

- For improved interoperability, this document uses ABNF notation according to IETF RFC 5234 to specify certain underdefined values of XML attributes and elements.

4 Overview

4.1 System description

Dynamic adaptive streaming over HTTP (DASH) specifies XML and binary formats that enable delivery of continuous media content from standard HTTP servers to HTTP clients and enable caching of content by standard HTTP caches.

This document primarily defines two formats:

- The Media Presentation Description (MPD) describes a *Media Presentation*, i.e. a bounded or unbounded presentation of continuous media content. In particular, it defines formats to announce resource identifiers for *Segments* and to provide the context for these identified resources within a Media Presentation. These resource identifiers are HTTP-URLs possibly combined with a byte range, or with a data URL.
- The Segment formats specify the formats of the entity body of the HTTP response to an HTTP GET request or a partial HTTP GET with the indicated byte range using HTTP/1.1 as defined in IETF RFC 7233 to a resource identified in the MPD. Segments typically contain efficiently coded media data and metadata conforming to or at least closely aligned with common media formats.

The MPD provides sufficient information for a client to provide a streaming service to the user by accessing the Segments through the protocol specified in the scheme of the defined resources. In the context of this document, the assumed protocol is HTTP/1.1. Such a client is referred to as a DASH Client in the remainder of this document. However, this document does not provide a normative specification for such a client.

Figure 1 shows a possible deployment architecture in which the formats defined in this document may be used. Boxes with solid lines indicate devices that are mentioned in this document as they host or process the formats defined in this document whereas dashed boxes are conceptual or transparent. This document deals with the definition of formats that are accessible on the interface to the DASH Client, indicated by the solid lines. Any other formats or interfaces are outside the scope of this document. In the considered deployment scenario, it is assumed that the DASH Client has access to an MPD. The MPD provides sufficient information for the DASH Client to provide a streaming service to the user by requesting Segments from an HTTP server and demultiplexing, decoding and rendering the included media streams.

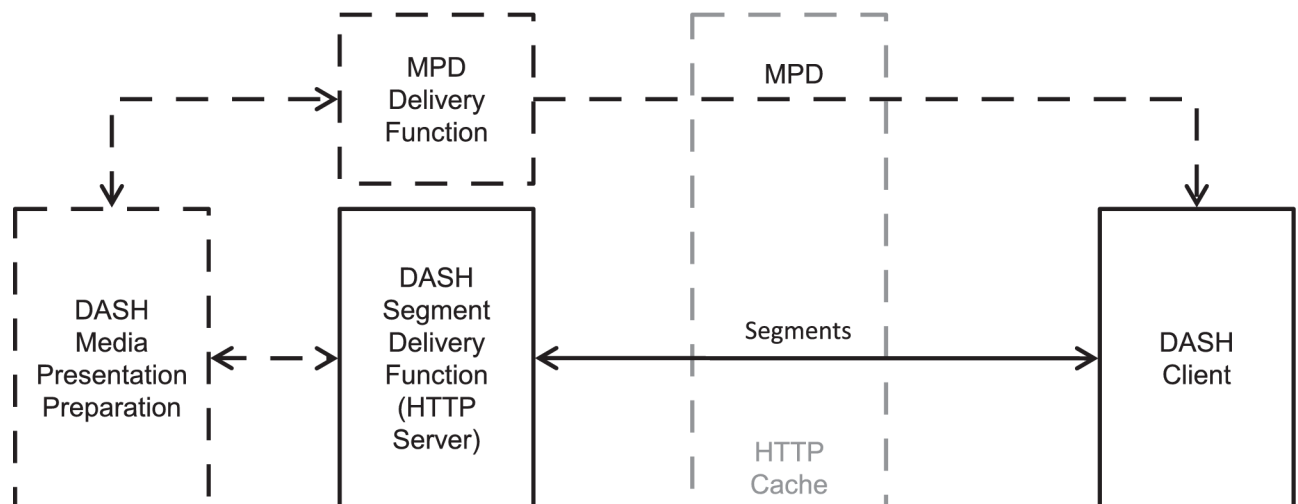


Figure 1 — Example system for DASH formats

Although the formats are initially designed to be used in the above deployment scenario, their application is obviously not restricted to this scenario. The particular aspect on "HTTP" in DASH is the usage of HTTP-URLs in the MPD for the purpose to refer to Segments. The usage of HTTP-URLs enables unique location information and it provides well-defined methods to access the resources, in particular HTTP GET and HTTP partial GET.

4.2 DASH Client model

The design of the formats defined in this document is based on the informative client model as shown in Figure 2. The figure illustrates the logical components of a conceptual DASH Client model and the relation to other components in a media streaming application. In this figure, the DASH access engine receives the Media Presentation Description (MPD), constructs and issues requests and receives Segments or parts of Segments. The DASH Client may use metadata provided in the MPD for the selection of media components by communication with the media streaming application. Such metadata may for example include codec capability information, language codes, accessibility information and other information for the selection of media components. In the context of this document, the output of the DASH access engine consists of media in MPEG container formats (ISO/IEC 14496-12 ISO base media file format or ISO/IEC 13818-1 MPEG-2 Transport Stream), or parts thereof, together with timing information that maps the internal timing of the continuous media to the timeline of the Media Presentation. In Annex F, guidance on enabling the use of this document with other container formats is provided. In addition, the DASH access engine may also receive and extract Events that are related to the media time. The events may be processed in the DASH Client or may be forwarded to an event processing application in the execution environment of the DASH Client.

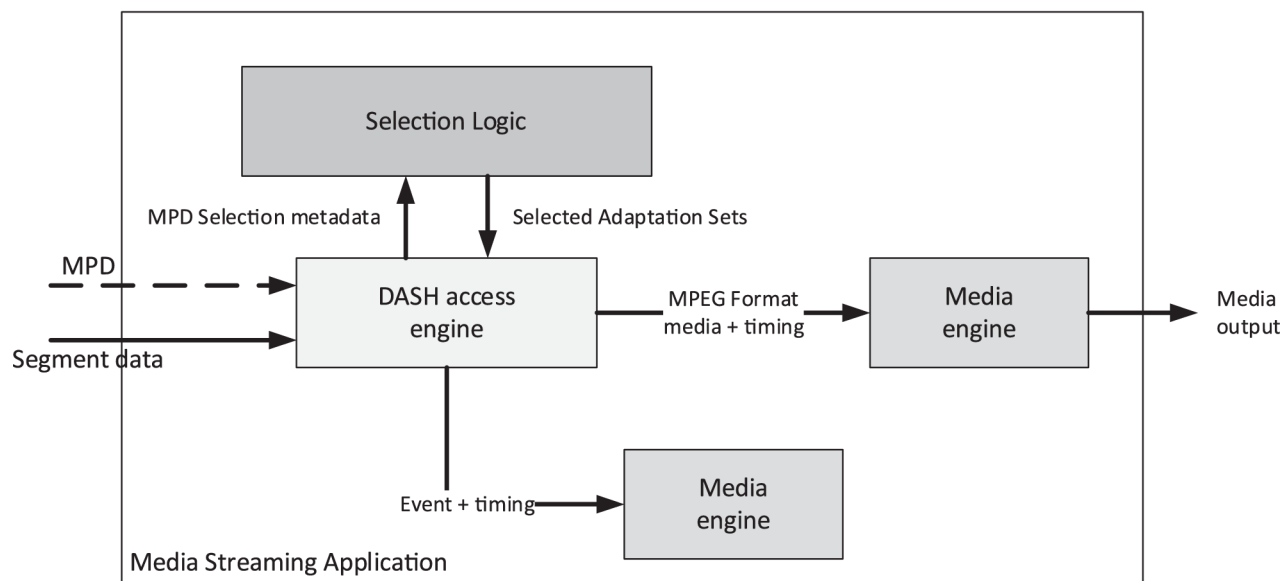


Figure 2 — DASH Client model

Furthermore, Annex K defines the Service Description to support and guide DASH Client operations.

4.3 DASH data model overview

DASH is intended to support a media-streaming model for delivery of continuous media content in which control lies primarily with the client. Clients may request data using the HTTP protocol from standard web servers that have no DASH-specific capabilities. Consequently, this document focuses not on client or server procedures but on the data formats used to provide a DASH Media Presentation.

The collection of encoded and deliverable versions of continuous media content and the appropriate description of these form a Media Presentation. Media content is composed of a single or multiple contiguous media content **periods** in time. Content in different media content periods may be completely independent or certain periods of a Media Presentation may belong to the same Asset, for example a Media Presentation is a collection of main program composed of multiple periods, each assigned to the same Asset, and interleaved with inserted advertisement periods. Each media content period is composed of one or multiple **media content components**, for example audio components in various languages, different video components providing different views of the same program, subtitles in different languages, etc. Each media content component has an assigned **media content component type**, for example audio or video. The same asset over multiple periods may be identified by a DASH descriptor enabling DASH Clients to maintain the continuity across periods' boundaries. Furthermore, sub-assets composing the same asset may also be identified using a similar method. For instance, if an asset is composed of multiple video components, sub-assets enable selecting the previously selected video component after an ad insertion.

Each media content component may have several encoded versions, referred to as **media streams**. Each media stream inherits the properties of the media content, the media content period, the media content component from which it was encoded and, in addition, it gets assigned the properties of the encoding process such as sub-sampling, codec parameters, encoding bitrate, etc. This descriptive metadata is relevant for static and dynamic selection of media content components and media streams.

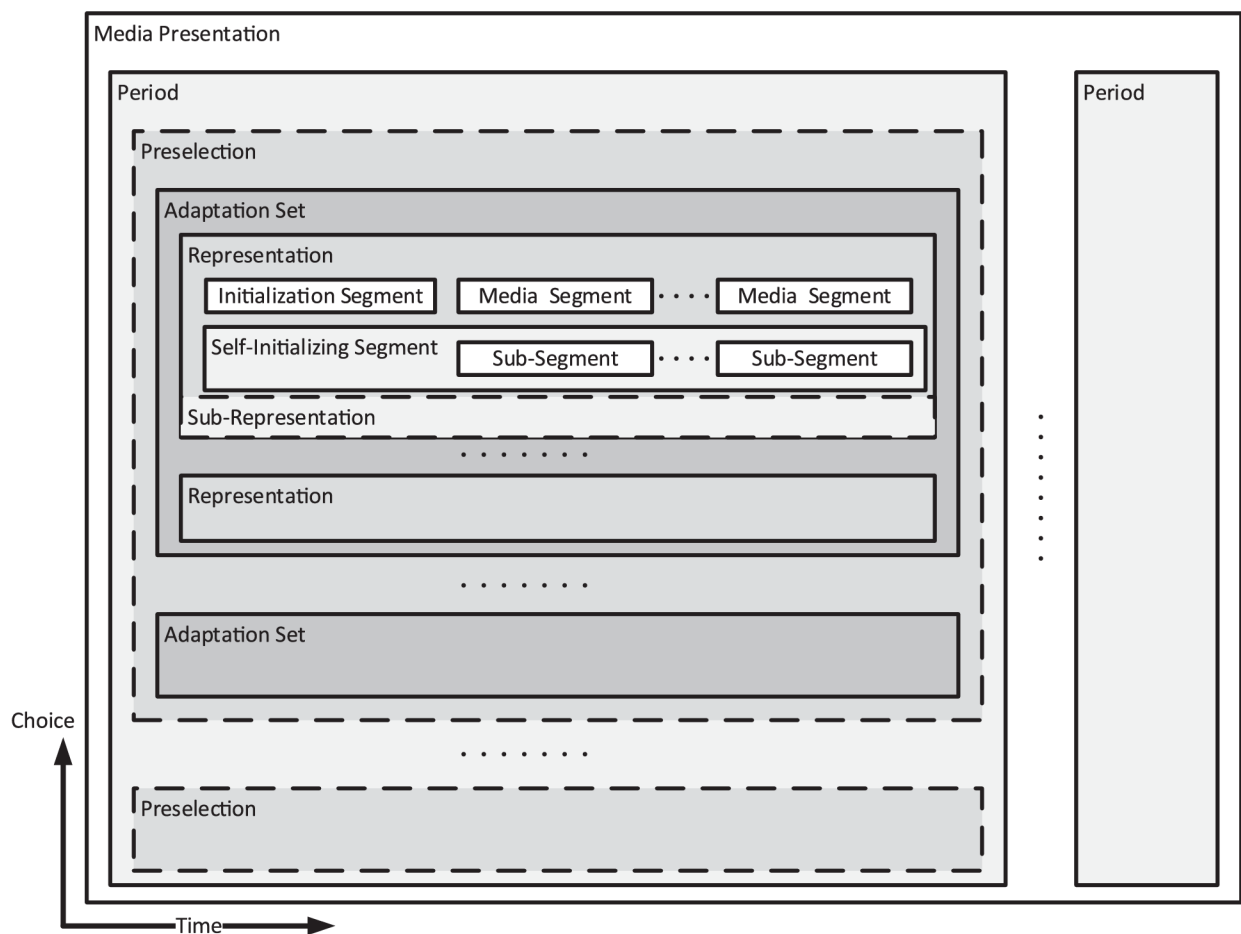


Figure 3 — DASH High-Level Data Model

DASH is based on a hierarchical data model aligned with the presentation in Figure 3. In the horizontal domain, this shows the sequence in time of the Media Presentation, and in the vertical domain it shows the choices offered in a Media Presentation, to be selected by the DASH Client in a static and dynamic manner. A DASH **Media Presentation** is described by a Media Presentation Description document. This describes the sequence of **Periods** (see subclause 5.3.2) in time that make up the Media Presentation. A Period typically represents a media content period during which a consistent set of encoded versions of the media content is available i.e. the set of available bitrates, languages, captions, subtitles etc. does not change during a Period.

Within a Period, material is arranged into **Adaptation Sets** (see subclause 5.3.3). An Adaptation Set represents a set of interchangeable encoded versions of one or several media content components (see subclause 5.3.4). For example, there may be one Adaptation Set for the main video component and a separate one for the main audio component. If there is other material available, for example captions or audio descriptions, then these may each have a separate Adaptation Set. Material may also be provided in multiplexed form, in which case interchangeable versions of the *multiplex* may be described as a single Adaptation Set, for example an Adaptation Set containing both the main audio and main video for a Period. Each of the multiplexed components may be described individually by a media content component description. In the third edition, the concept of **Preselections** (see subclause 5.3.11) was added in order to enable the combination of different Adaptation Sets into a single decoding instance and user experience.

An Adaptation Set contains a set of **Representations** (see subclause 5.3.5). A Representation describes a *deliverable encoded version* of one or several media content components. A Representation includes one or more media streams (one for each media content component in the multiplex). Any single Representation within an Adaptation Set is sufficient to render the contained media content components. By collecting different Representations in *one* Adaptation Set, the Media Presentation author expresses that the Representations represent perceptually equivalent content. Typically, this means that clients may switch dynamically from Representation to Representation within an Adaptation Set in order to adapt to network conditions or other factors. Switching refers to the presentation of decoded data up to a certain time t , and presentation of decoded data of another Representation from time t onwards. If Representations are included in one Adaptation Set, and the client switches properly, the Media Presentation is expected to be perceived seamless across the switch. DASH Clients may ignore Representations containing unsupported codecs or rendering technologies, or that are otherwise unsuitable.

Within a Representation, the content may be divided in time into **Segments** (see subclause 5.3.9 and Clause 5.15) for proper accessibility and delivery. In order to access a Segment, a URL is provided for each Segment. Consequently, a Segment is the largest unit of data that can be retrieved with a single HTTP request. For segmented Representations, two types of Segments are differentiated: **Initialization Segments** contain static metadata for the Representation, **Media Segments** contain media samples and advance the timeline. Representations may also be organized by a single self-initializing Segment which contains both initialization information as well as media data.

NOTE The MPD can also include a byte range with the URL, meaning that the Segment is contained in the provided byte range of some larger resource. An intelligent client can in principle construct a single request for multiple Segments, but this is not the typical case.

DASH defines different timelines. One of the key features in DASH is that encoded versions of different media content components share a common timeline. The presentation time of each access unit within the media content is mapped to the global common presentation timeline for synchronization of different media components and to enable seamless switching of different coded versions of the same media components. This timeline is referred to as Media Presentation timeline. The Media Segments themselves contain accurate Media Presentation timing information enabling synchronization of components and seamless switching.

A second timeline is used to signal to clients the availability time of Segments at the specified HTTP-URLs. These times are referred to as **Segment availability times** and are provided in wall-clock time. Clients typically compare the wall-clock time to Segment availability times before accessing the Segments at the specified HTTP-URLs in order to avoid erroneous HTTP request responses. For static Media Presentations, the availability times of all Segments are identical. For dynamic Media Presentations, the availability times of segments depend on the position of the Segment in the Media Presentation timeline, i.e. the Segments get available over time. Whereas static Media Presentations are suitable to offer On-Demand content, dynamic Media Presentations are mostly suitable to offer live services.

Segments are assigned a duration, which is the duration of the media contained in the Segment when presented at normal speed. Typically, all Segments in a Representation have the same or a roughly similar duration. However, Segment duration may differ from Representation to Representation. A DASH presentation can be constructed with relative short segments (for example a few seconds), or longer Segments including a single Segment for the whole Representation.

Short Segments are usually required in the case of live content, where there are restrictions on end-to-end latency. The duration of a Segment is typically a lower bound on the end-to-end latency. DASH does not support the possibility for Segments to be extended over time: a Segment is treated as an object as a complete and discrete unit that is made available in its entirety. However, this does not prevent from applying advanced HTTP transfer modes such as chunked transfer to optimize deployments and reduce end-to-end latency.

In particular, self-initializing Segments may be further subdivided into **Subsegments** each of which contains a number of complete access units. There may also be media-format-specific restrictions on Subsegment boundaries; for example, in the ISO base media file format, a Subsegment contains a number of complete movie fragments. If a Segment is divided into Subsegments, they are described by a compact **Segment index**, which provides the presentation time range in the Representation and corresponding byte range in the Segment occupied by each Subsegment. Clients may download this index in advance and then issue requests for individual Subsegments.

Clients may switch from Representation to Representation within an Adaptation Set at any point in the media. However, switching at arbitrary positions can be complex because of coding dependencies within Representations and other factors, potentially requiring parallel download and decoding in the DASH Client. It is also desirable to avoid downloading 'overlapping' data i.e. media for the same time period from multiple Representations. Usually, switching is simplest at a stream access point (SAP) in the new stream. In order to formalize requirements related to switching, DASH defines a codec-independent concept of stream access points and identifies various types of stream access points.

Segmentation and Subsegmentation may be performed in ways that make switching simpler. For example, in the very simplest cases, each Segment or Subsegment begins with a SAP and the boundaries of Segments or Subsegments are aligned across the Representations of one Adaptation Set. In this case, switching Representation involves playing to the end of a (Sub)Segment of one Representation and then playing from the beginning of the next (Sub)Segment of the new Representation. The Media Presentation Description and Segment Index provide various indications, which describe properties of the Representations that may make switching simpler. Profiles of this document can then require these indicators to be set in certain ways, making implementation of clients for those profiles simpler at the cost of requiring the media data to obey the indicated constraints.

For On-Demand services, the Media Presentation Description is typically a static document describing the various aspects of the Media Presentation. All Segments of the Media Presentation are available on the server once any Segment is available. For live services, however, Segments become available with time as the content is produced and therefore, dynamic Media Presentations are suitable. The Media Presentation Description may be updated regularly to reflect changes in the presentation over time, for example Segment URLs for new segments may be added to the MPD and those for old, no longer available Segments may be removed. However, if Segment URLs are described using a template, this updating may not be necessary except for some redundancy/failover cases.

Events may be provided in the MPD or within a Representation in order to signal aperiodic information to the DASH Client or to an application. Events are timed, i.e. each event starts at a specific media presentation time and typically has a duration. Events include DASH-specific signalling or application-specific events. Examples for events are indication of MPD updates on the server, possibly providing the detailed update as part of the messages. The event mechanisms may also be used to deliver media time related application events, for example information about ad insertion opportunities, etc.

4.4 Protocols

This document may be deployed in a system according Figure 1 for which

- the DASH Client includes a *client* as specified in IETF RFC 7230^[22], IETF RFC 7231, IETF RFC 7232^[23], IETF RFC 7233, IETF RFC 7234^[24] and IETF RFC 7235^[25], and
- the HTTP Server hosting the DASH Segments complies with a *server* as specified in IETF RFC 7230, IETF RFC 7231, IETF RFC 7232, IETF RFC 7233, IETF RFC 7234 and IETF RFC 7235.

DASH Clients typically use the HTTP GET method or the HTTP partial GET method, as specified in IETF RFC 7231:2014, subclause 4.3, to access Segments or parts thereof.

The use of HTTP as a transport protocol inherently provides many advanced features such as caching (IETF RFC 7233), redirection (IETF RFC 7231) or authentication (IETF RFC 7235). As another example,

transport security in HTTP-based delivery may be achieved by using HTTP over TLS as specified in IETF RFC 2818. Yet another example is the use of HTTP state management mechanisms (also known as Cookies) as defined in IETF RFC 6265^[21].

However, the formats defined in this document may also be used with other protocols. In particular, the objects may be delivered with any object delivery protocol that provides a binding between an HTTP-URL and the delivered object.

4.5 Media stream and Representation properties

4.5.1 Switching and Random Access Support

The formats defined in this document are designed to provide a good user experience even in cases where the access bandwidth between the DASH segment delivery function or the cache varies. A key functionality is the ability of the DASH Client to seamlessly switch across different Representations of the same media component without severely impacting the user experience.

Assume two Representations A and B. A switch from Representation A to Representation B at media time t is considered seamless, if the result of the presentation after this switch is applied is the same as if Representation A was decoded from the beginning and presented up to time t and Representation B is decoded from the beginning and presented from time t onwards.

Media Presentations may provide different Representations in one Adaptation Set representing the same media component. If such Representations are properly time-aligned (as expected by the Media Presentation), then DASH Clients may apply seamless switching across different Representations provided in one Adaptation Set at any time t to obtain a perceptually continuous experience.

However, in practical implementations, the operation of seamless switching can be complex, as switching at time t can require parallel download and decoding of two Representations. Therefore, providing suitable switching opportunities in regular time intervals simplifies client implementations. This document provides means for providing suitable switching opportunities and in addition provides abilities to signal the position and media time of the switching opportunities.

For this purpose, this subclause defines three relevant concepts to support seamless switching:

- Media stream access points in subclause 4.5.2 to signal positions where to easily switch to a Representation, and in addition where to suitable access a Representation at start-up or seek.
- Non-overlapping Segments and Subsegments in subclause 4.5.3 to signal that, at the signalled stream access points, no overlap decoding of Representations is necessary in order to provide a continuous switch.
- Segment concatenation in subclause 4.5.4 to signal that the concatenation of two Representations at a switch point results in a conforming bitstream.

These three properties are neither sufficient nor necessary for seamless switching, but certain implementation or profiles may use these properties in order to simplify practical implementations.

4.5.2 Media stream access points

To be able to access a Representation, each of the media streams that are contained in the Representation requires media stream access points (SAPs). SAPs in the context of this document refer to the SAP definition in ISO/IEC 14496-12. ISO/IEC 14496-12 SAP types defines different types of SAPs that provide a relationship between the position where a stream can be accessed, relative to the start of a Segment or Subsegment, its presentation time and the presentation times and position of other access unit in the stream. The same SAP type definitions shall apply for this document.

A SAP is a position in a Representation that enables playback of a media stream to be started using only the information contained in Representation data starting from that position onwards (preceded by initializing data in the Initialization Segment, if any).

For each SAP, the properties, I_{SAP} , T_{SAP} , I_{SAU} , T_{DEC} , T_{EPT} , and T_{PTF} , are identified and defined in ISO/IEC 14496-12 SAP properties.

In particular, T_{SAP} is defined to be the earliest presentation time of any access unit of the media stream such that all access units of the media stream with presentation time greater than or equal to T_{SAP} can be correctly decoded using data in the Representation starting at byte position I_{SAP} and no data before I_{SAP} .

NOTE The type of SAP is dependent only on which access units are correctly decodable and their arrangement in presentation order. The types informally correspond with some common terms:

- Type 1 corresponds to what is known in some coding schemes as a “Closed GoP random access point” (in which all access units, in decoding order, starting from I_{SAP} can be correctly decoded, resulting in a continuous time sequence of correctly decoded access units with no gaps) and in addition the access unit in decoding order is also the first access unit in presentation order.
- Type 2 corresponds to what is known in some coding schemes as a “Closed GoP random access point”, for which the first access unit in decoding order in the media stream starting from I_{SAU} is not the first access unit in presentation order.
- Type 3 corresponds to what is known in some coding schemes as an “Open GoP random access point”, in which there are some access units in decoding order following I_{SAU} that cannot be correctly decoded and have presentation times less than T_{SAP} .
- Type 4 corresponds to what is known in some coding schemes as a “gradual decoder refresh (GDR) random access point”, in which there are some access units in decoding order starting from and following I_{SAU} that cannot be correctly decoded and have presentation times less than T_{SAP} .
- Type 5 corresponds to the case for which there is at least one access unit in decoding order starting from I_{SAP} that cannot be correctly decoded and has presentation time greater than T_{DEC} and where T_{DEC} is the earliest presentation time of any access unit starting from I_{SAU} .
- Type 6 corresponds to the case for which there is at least one access unit in decoding order starting from I_{SAP} that cannot be correctly decoded and has presentation time greater than T_{DEC} and where T_{DEC} is not the earliest presentation time of any access unit starting from I_{SAU} .

SAPs are mostly relevant for two purposes in this document:

- 1) For randomly accessing a Media Presentation, for example at the startup of the Media Presentation, after a seeking operation or after an error event especially in live cases.
- 2) To permit switching between two Representations whereby for seamless switching each media stream i in the switch-from Representation is presented up to $T_{SAP}(i)$ and each media stream i in the switch-to Representation is presented from the media stream access point starting from $T_{SAP}(i)$.

There are obvious benefits for the client to be able to identify SAPs and one or several of their properties, in particular I_{SAP} and T_{SAP} for each media stream without requiring to access data at positions following I_{SAP} . DASH provides functionalities to explicitly signal such information by using signals in the MPD or the Segment Index or combinations of the two.

4.5.3 Non-overlapping Segments and Subsegments

Segments and Subsegments represent units for which the client has an exact map on how to access and download the unit using HTTP GET or HTTP partial GET methods.

Segments (respectively Subsegments) are typically generated by segmenting encoded media streams into appropriate units. If the generation of Segments (respectively Subsegments) adheres to certain rules,

then the sequential decoding and presentation of Media Segments (respectively Subsegments) results in a correct presentation of all contained media streams. To define such rules the notion of “non-overlapping” segments (respectively Subsegments) is defined as follows.

Let

- $T_E(S,i)$ be the earliest presentation time of any access unit in stream i of a Segment or Subsegment S , and
- $T_L(S,i)$ be the latest presentation time of any access unit in stream i of a Segment or Subsegment S .

Then two segments (respectively Subsegments), A and B , which may or may not be of different Representations, are *non-overlapping* if $T_L(A,i) < T_E(B,i)$ for all media streams i in A and B or if $T_L(B,i) < T_E(A,i)$ for all streams i in A and B where i refers to the same media component.

The property of “non-overlapping” segments (respectively Subsegments) is used to define the terms Segment alignment and Subsegment alignment.

4.5.4 Conforming Segment track

A sequence of Segments (respectively Subsegments) is a “conforming Segment (respectively Subsegment) track” if the concatenation of all Segments (respectively Subsegments) in the sequence of Segments (respectively Subsegments) results in a bitstream that conforms to the media formats in use (including container and codecs).

NOTE This implies that a player conforming to the media format can play the resulting bitstream.

4.6 Brands

The ISO base media file format, ISO/IEC 14496-12, defines the concept of brands; brand values identify specifications or conformance points. This document specifies several brands, as listed in Table 1.

Table 1 — Brands defined in this document

Brand identifier	Clause in this document	Informative description
emsg	5.10.3.3	Event message box.
miss	6.2.6	Missing content segment
msdh	6.3.4.2	Media Segment conforming to the general format type for ISO base media file format.
msix	6.3.4.3	Media Segment conforming to the Indexed Media Segment format type for ISO base media file format.
dsms	6.3.5.1	Media Segment conforming to the DASH Self-Initializing Media Segment format type for ISO base media file format.
dash	6.3.5.2	ISO base media file format file specifically designed for DASH including movie fragments and Segment Index.
sims	6.4.4.4	Media Segment conforming to the Sub-Indexed Media Segment format type for ISO base media file format.
sisx	6.4.6.2	Single Index Segment used to index MPEG-2 TS based Media Segments.
risx	6.4.6.3	Representation Index Segment used to index MPEG-2 TS based Media Segments.

ssss	6.4.6.4	Subsegment Index Segment used to index MPEG-2 TS based Media Segments.
lmsg	7.3.1	Last Media Segment indicator for ISO base media file format.
dums	8.11.3	Segment sequence indicator in ISO base media file format broadcast TV profile.

4.7 Schemes

This document specifies several schemes as listed in Table 2.

Table 2 — Schemes defined in this document

Scheme identifier	Clause in this document	Informative description
urn:mpeg:dash:schema:mpd:2011	Annex B	The namespace of the XML schema for the MPD.
urn:mpeg:dash:period-continuity:2015	5.3.2.4	Period continuity signalling.
urn:mpeg:dash:period-connectivity:2015	5.3.2.4	Period connectivity signalling.
urn:mpeg:dash:adaptation-set-switching:2016	5.3.3.5	Scheme Identifier for switching across Adaptation Sets.
urn:mpeg:dash:preselection:2016	5.3.11.2	Preselection descriptor.
urn:mpeg:dash:reset:2016	5.4.2	MPD reset indicator.
urn:mpeg:dash:resolve-to-zero:2013	5.5.3	xlink resolution to zero element.
urn:mpeg:dash:mp4protection:2011	5.8.5.2	Protection schemes identified by the Scheme Type within the Scheme Type Box of the Protection Scheme Information Box of ISO/IEC 14496-12.
urn:mpeg:dash:13818:1:CA_descriptor:2011	5.8.5.2	Conditional Access System used for ISO/IEC 13818-1 (MPEG-2 Transport Stream).
urn:mpeg:dash:14496:10:frame_packing_arrangement_type:2011	5.8.5.3	Frame-packing arrangement.
urn:mpeg:dash:13818:1:stereo_video_format_type:2011	5.8.5.3	Frame-packing arrangement.
urn:mpeg:dash:23003:3:audio_channel_configuration:2011	5.8.5.4	Channel configuration. Legacy format for backward-compatibility, it is recommended to use the signalling as defined in ISO/IEC 23091-3 instead.
urn:mpeg:dash:outputChannelPositionList:2012	5.8.5.4	A list of output channel position to signal individual speaker positions as defined in ISO/IEC 23001-8. Legacy format for backward-compatibility, it is recommended to use

Scheme identifier	Clause in this document	Informative description
		the signalling as defined in ISO/IEC 23091-3 instead.
urn:mpeg:dash:role:2011	5.8.5.5	DASH role scheme.
urn:mpeg:dash:stereoid:2011	5.8.5.6	Scheme for multiple views media content description.
urn:mpeg:dash:utc:ntp:2014	5.8.5.7	UTC Timing scheme for NTP servers.
urn:mpeg:dash:utc:sntp:2014	5.8.5.7	UTC Timing scheme for SNTP servers.
urn:mpeg:dash:utc:http-head:2014	5.8.5.7	UTC Timing scheme for HTTP date headers.
urn:mpeg:dash:utc:http-xsdate:2014	5.8.5.7	UTC Timing scheme for HTTP server with xsdate format.
urn:mpeg:dash:utc:http-iso:2014	5.8.5.7	UTC Timing scheme for HTTP server with ISO timing format.
urn:mpeg:dash:utc:http-ntp:2014	5.8.5.7	UTC Timing scheme for HTTP server with NTP format.
urn:mpeg:dash:utc:direct:2014	5.8.5.7	UTC Timing scheme for direct inclusion of time.
urn:mpeg:dash:audio-receiver-mix:2014	5.8.5.8	Scheme identifier for receiver mix.
urn:mpeg:dash:mpd-as-linking:2015	5.8.5.9	MPD Adaptation Set Linking scheme.
urn:mpeg:dash:sai:2015	5.8.5.10	Sub-Asset Scheme Identifier.
urn:mpeg:dash:client-authentication:2015	5.8.5.11	Client Authentication scheme.
urn:mpeg:dash:content-authorization:2015	5.8.5.11	Content Access Authorization scheme.
urn:mpeg:dash:audio-interactivity:2016	5.8.5.12	Scheme to indicate content interactivity.
urn:mpeg:dash:qr-equivalence:2019	5.8.5.13	Quality Equivalence Descriptor
urn:mpeg:dash:output-protection:hdc:2020	5.8.5.14.2	Scheme to indicate the HDCP output protection
urn:mpeg:dash:event:2012	5.10.4	DASH event signalling scheme.
urn:mpeg:dash:event:callback:2015	5.10.4.5	DASH call back event.
urn:mpeg:dash:event:ttfn:2016	5.10.4.6	Presentation Termination Event.
urn:mpeg:dash:mpd-chaining:2016	5.11.1	MPD chaining descriptor.
urn:mpeg:dash:fallback:2016	5.11.2	MPD fallback descriptor.
urn:mpeg:dash:profile:full:2011	8.2	Identifier for Full profile.
urn:mpeg:dash:profile:isoff-on-demand:2011	8.3	Identifier for ISO Base media file format On Demand profile.

Scheme identifier	Clause in this document	Informative description
urn:mpeg:dash:profile:isoff-live:2011	8.4	Identifier for ISO Base media file format live profile.
urn:mpeg:dash:profile:isoff-main:2011	8.5	Identifier for ISO Base media file format main profile.
urn:mpeg:dash:profile:mp2t-main:2011	8.6	Identifier for MPEG-2 TS main profile.
urn:mpeg:dash:profile:mp2t-simple:2011	8.7	Identifier for MPEG-2 TS simple profile.
urn:mpeg:dash:profile:isoff-ext-live:2014	8.8	Identifier for ISO Base media file format extended live profile.
urn:mpeg:dash:profile:isoff-ext-on-demand:2014	8.9	Identifier for ISO Base media file format extended On Demand profile.
urn:mpeg:dash:profile:isoff-common:2014	8.10	Identifier for ISO Base media file format common profile.
urn:mpeg:dash:profile:isoff-broadcast:2015	8.11	Identifier for ISO Base media file format broadcast TV profile
urn:mpeg:dash:profile:cmaf:2019	8.12	Identifier for DASH core profile for CMAF content
urn:mpeg:dash:profile:cmaf-extended:2019	8.12	Identifier for DASH extended profile for CMAF content
urn:mpeg:dash:event:catchall:2020	A.13	URI for subscribing to all application event and timed metadata received by DASH Client
urn:mpeg:dash:srd:2014	H.1	Scheme identifier for Spatial Relationship Description. If signalled in an Adaptation Set, the Adaptation Set shall follow the description in Annex H.
urn:mpeg:dash:srd:dynamic:2016	H.1	Scheme to signal dynamic SRD. If signalled in an Adaptation Set, the Adaptation Set shall follow the description in Annex H.
urn:mpeg:dash:urlparam:2014	I.2	Scheme identifier for indicating usage of the flexible insertion of URL query parameters. If signalled in an Adaptation Set, the Adaptation Set shall follow the description in Annex I.
urn:mpeg:dash:urlparam:2016	I.3	Scheme identifier for indicating usage of the extended parameterization scheme. If signalled in an Adaptation Set, the Adaptation Set shall follow the description in Annex I.
urn:mpeg:dash:resolutionSwitching:2016	Annex J	Descriptor for Open GOP resolution change

5 Media Presentation

5.1 General

A Media Presentation is a collection of data that is accessible to a DASH Client to provide a streaming service to the user.

A Media Presentation is described by an MPD including possible updates of the MPD. The MPD is defined in subclause 5.2 and the MPD update mechanism is defined in subclause 5.4. Assembly of a fragmented MPD is defined in subclause 5.5. The data model that constitutes a Media Presentation is defined in subclause 5.2.3.5. In subclause 5.6, the formats and processing of URLs in the MPD is introduced. Program information is defined in subclause 5.7. Descriptors associated to Representations or collections thereof are provided in subclause 5.8. DASH metric collection description is specified in subclause 5.9. Subclause 5.10 defines Events and Event Streams. Subclause 5.11 defines MPD chaining. Subclause 5.12 defines the Producer Reference Time. Subclause 5.13 defines how to deal with leap seconds. Subclause 5.14 defines content popularity rates.

5.2 Media Presentation Description

5.2.1 General

The Media Presentation Description (MPD) is a document that contains metadata required by a DASH Client to construct appropriate HTTP-URLs to access Segments and to provide the streaming service to the user.

NOTE 1 Actual playback of the media streams included in the Representations is not controlled by the MPD information. Playback is controlled by the media engine operating on the media streams contained in the Representations in the usual way.

The format of URLs in the MPD and the process to generate HTTP GET and partial GET requests from URLs provided in the MPD is defined in subclause 5.6.

The MPD is an XML document that shall be formatted according to the XML schema provided in Annex B. Some context on the schema is provided in subclause 5.2.2.

The extension of the DASH XML schema (as provided in Annex B), in particular the addition of XML attributes or elements in the DASH namespace, is reserved to ISO/IEC. Elements and attributes that have been added to the namespace compared to earlier revisions of this document are documented in subclause 5.2.3.

The MPD shall be authored such that, after XML attributes or elements in the DASH namespace but not in the XML schema documented in Annex B are removed, the result is a valid XML document formatted according to that schema and that conforms to this document.

In addition, the MPD shall be authored such that, after XML attributes or elements in the other namespaces than the DASH namespace are removed, the result is a valid XML document formatted according to that schema and that conforms to this document.

NOTE 2 Based on the last two paragraphs, if DASH Clients remove all XML attributes and elements from the MPD in the DASH namespace and in other namespaces that are not in the XML schema documented in Annex B, the MPD results in a valid XML document which complies with this document. The DASH Client can use such a resulting MPD for presentation of a conforming Media Presentation.

In addition, rules for authoring of MPDs conforming to a specific profile are provided in 8. Certain profiles as defined in 8 may permit ignoring certain elements and attributes. However, this has no effect on the general MPD conformance rules defined in this subclause.

Following XML rules, the MPD document shall contain exactly one **MPD** element as specified in subclause 5.2.3.5.

The MIME type of the MPD document is defined in Annex C.

The encoding of the MPD shall be UTF-8 as defined in IETF RFC 3629. All data provided in extension namespaces shall be UTF-8 as defined in IETF RFC 3629. If binary data needs to be added, it shall be included in Base64 as described in IETF RFC 4648 within a UTF-8 encoded element with a proper name space or identifier, such that an XML parser knows how to process or ignore it.

The delivery of the MPD is outside the scope of this document. However, if the MPD is delivered over HTTP, then the MPD document may be transfer encoded for transport, as described in IETF RFC 7230.

NOTE 3 As an example, the GZip algorithm as defined in IETF RFC 1952^[3] can be used for Transfer-encoding.

NOTE 4 MPD encryption is not a normative part of this document. However, if operating in an insecure environment and required by the content/service provider, elements and attributes of MPD can be encrypted to protect their confidentiality by using the syntax and processing rules specified in the “XML Encryption Syntax and Processing” by W3C^[8].

NOTE 5 MPD integrity protection is not a normative part of this document. However, if operating in an insecure environment and required by the content/service provider, the digital signing and verification procedures specified in the “XML Signature Syntax and Processing” by W3C^[9] can be used to protect data origin authenticity and integrity of the MPD.

Selected MPD examples are provided in Annex G.

5.2.2 Schema

The initial part of the XML schema of the MPD is provided below, including namespace and other definitions. Specific types, elements and attributes are introduced in the remainder of this subclause. The complete normative MPD schema is provided in Annex B. In case of inconsistencies, the schema in Annex B takes precedence both over the XML syntax snippets provided in this clause and all prose text in this document.

Implementors are supported by files available at: <https://standards.iso.org/iso-iec/23009/-1/ed-5/en>. These files include the schema as well as all examples provided in Annex G.

```
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns="urn:mpeg:dash:schema:mpd:2011" targetNamespace="urn:mpeg:dash:schema:mpd:2011"
  elementFormDefault="qualified" attributeFormDefault="unqualified">
  <xs:import
    schemaLocation="http://www.w3.org/XML/2008/06/xlink.xsd" namespace="http://www.w3.org/1999/xlink"
    <xs:annotation>
      <xs:documentation xml:lang="en">
        xlink import. URL is per https://www.w3.org/TR/xlink/ Users are encouraged to store
        a local copy
      </xs:documentation>
    </xs:annotation>
  </xs:import>
  <xs:annotation>
    <xs:appinfo>Media Presentation Description</xs:appinfo>
    <xs:documentation xml:lang="en">
      This Schema defines the Media Presentation Description for MPEG-DASH.
    </xs:documentation>
  </xs:annotation>
  <xs:element name="MPD" type="MPDtype">
    <xs:annotation>
      <xs:documentation xml:lang="en">
        MPD: main element
      </xs:documentation>
    </xs:annotation>
  </xs:element>
  <xs:complexType name="MPDtype">
    <xs:annotation>
      <xs:documentation xml:lang="en">
        MPD Type
      </xs:documentation>
    </xs:annotation>
    ...
  </xs:complexType>
</xs:schema>
```

```
</xs:complexType>
</xs:schema>
```

5.2.3 Elements and Attributes added in revisions and amendments

5.2.3.1 Overview

In amendments and revisions of this document, the schema defined in Annex B may have been extended. In order to track this, subclause 5.2.3 tracks the addition of elements and attributes.

By following the rules in subclause 5.2.1, a single MPD can be authored for clients that implement different versions of this document.

5.2.3.2 Elements and Attributes added in the second edition of this document (ISO/IEC 23009-1:2014)

ISO/IEC 23009-1:2014 added the following elements and attributes to the schema defined in Annex B compared to the 2012 edition (ISO/IEC 23009-1:2012/Cor 1:2013):

- **MPD@publishTime**
- **MPD.EssentialProperty**
- **MPD.SupplementalProperty**
- **Period.AssetIdentifier**
- **Period.EventStream**
- **Period.SupplementalProperty**
- **RepresentationBase.InbandEventStream**
- **SegmentBase@availabilityTimeOffset**
- **SegmentBase@availabilityTimeComplete**
- **BaseURL@availabilityTimeOffset**
- **BaseURL@availabilityTimeComplete**
- **Subset@id**
- **SegmentTimeline.S@n**

5.2.3.3 Elements and Attributes added in the third edition of this document (ISO/IEC 23009-1:2019)

ISO/IEC 23009-1:2019 added the following elements and attributes to the schema defined in Annex B compared to the 2014 revision (ISO/IEC 23009-1:2014) of this document:

- **MPD.UTCTiming**
- **Period.GroupLabel**
- **Period.Preselection**
- **Period.EmptyAdaptationSet**

- **RepresentationBase.Switching**
- **RepresentationBase.RandomAccess**
- **RepresentationBase.GroupLabel**
- **RepresentationBase.Label**
- **RepresentationBase@selectionPriority**
- **Representation@tag**
- **Representation@associationId**
- **Representation@associationType**
- **SegmentBase@presentationDuration**
- **SegmentBase@timeShiftBufferDepth**
- **SegmentTimeline.S@n**
- **SegmentTimeline.S@k**

5.2.3.4 Elements and Attributes added in the fourth edition (ISO/IEC 23009-1)

This revision adds the following elements and attributes to the schema defined in Annex B compared to the 2019 revision (ISO/IEC 23009-1:2019) of this document:

- **MPD.ServiceDescription**
- **MPD.InitializationSet**
- **MPD.InitializationGroup**
- **MPD.InitializationPresentation**
- **MPD.LeapSecondInformation**
- **Period.ServiceDescription**
- **EventStream@presentationTimeOffset**
- **Event@contentEncoding**
- **AdaptationSet@initializationSetRef**
- **RepresentationBase.ProducerReferenceTime**
- **RepresentationBase.ContentPopularityRate**
- **Preselection@order**

- **SegmentBase.FailoverContent**
- **SegmentBase@eptDelta**
- **MultiSegmentBase@endNumber**
- **BaseURL@timeShiftBufferDepth**

5.2.3.5 Elements and Attributes added in the fifth edition (ISO/IEC 23009-1:2021)

This revision adds the following elements and attributes to the schema defined in Annex B compared to the 2020 revision (ISO/IEC 23009-1:2020) of this document:

- **MPD.ContentProtection**
- **MPD.PatchLocation**
- **Period.ContentProtection**
- **AdaptationSet@initializationPrincipal**
- **RepresentationBase.Resync**
- **RepresentationBase@containerProfiles**
- **Representation.ExtendedBandwidth**
- **ContentProtection@ref**
- **ContentProtection@refId**
- **ContentProtection@robustness**
- **RepresentationBase.OutputProtection**

5.3 Hierarchical data model

5.3.1 General

5.3.1.1 Overview

A Media Presentation as described in the **MPD** consists of a sequence of one or more Periods as described in subclause 5.3.2.

- Each Period contains one or more Adaptation Sets as described in subclause 5.3.3. In case an Adaptation Set contains multiple media content components, then each media content component is described individually as defined in subclause 5.3.4.
- Each Adaptation Set contains one or more Representations as described in subclause 5.3.5.
- Adaptation Sets, Representations and Sub-Representations share common attributes and elements that are described in subclause 5.3.7.
- Preselections may be used to select experiences as defined in subclause 5.3.11. Each Preselection references to one or more media content components within one or multiple Adaptation Sets.

- Each Period may contain one or more Subsets that restrict combination of Adaptation Sets for presentation. Subsets are described in subclause 5.3.8.
- Each Representation consists of one or more Segments described in subclause 5.15. Segment Information is introduced in subclause 5.3.9. Segments contain media data and/or metadata to access, decode and present the included media content. Representations may also include Sub-Representations as defined in subclause 5.3.5.6 to describe and extract partial information from a Representation.
- Each Segment consists of one or more Subsegments. Subsegments are described in subclause 6.2.3.2.
- Labels for annotation of different hierarchies are defined in subclause 5.3.10.

The summary of the semantics of the attributes and elements within an **MPD** element are provided in Table 3, subclause 5.3.1.2. The XML syntax of the **MPD** element is provided in subclause 5.3.1.3.

5.3.1.2 Semantics

Table 3 — Semantics of MPD element

Element or Attribute Name	Use	Description
MPD		The root element that carries the Media Presentation Description for a Media Presentation.
@id	0	specifies an identifier for the Media Presentation. It is recommended to use an identifier that is unique within the scope in which the Media Presentation is published. If not specified, no MPD-internal identifier is provided. However, for example the URL to the MPD may be used as an identifier for the Media Presentation.
@profiles	M	specifies a list of Media Presentation profiles as described in 8. The contents of this attribute shall conform to either the <code>pro-simple</code> or <code>pro-fancy</code> productions of IETF RFC 6381:2011, Section 4.5, without the enclosing <code>DQUOTE</code> characters, i.e. including only the <code>unencodedv</code> or <code>encodedv</code> elements respectively. As profile identifier a restricted URI format as defined in 8.1 shall be used.

Element or Attribute Name	Use	Description
@type	OD default: static	specifies the type of the Media Presentation. For static Media Presentations (@type="static"), all Segments are available between the @availabilityStartTime and the @availabilityEndTime. For dynamic Media Presentations (@type="dynamic"), Segments typically have different availability times. For details, refer to subclause 5.3.9.5.3. In addition, the Media Presentation Description may be updated in dynamic Media Presentations, i.e. the @minimumUpdatePeriod may be present. NOTE Static Media Presentations are typically used for On-Demand services, whereas dynamic Media Presentations are used for live services.
@availabilityStartTime	CM shall be present for @type='dynamic'	For @type='dynamic', this attribute shall be present. In this case, it specifies the anchor for the computation of the earliest availability time (in UTC) for any Segment in the Media Presentation. For @type="static" if present, it specifies the Segment availability start time for all Segments referred to in this MPD. If not present, all Segments described in the MPD shall become available at the time the MPD becomes available.
@publishTime	OD shall be present for @type='dynamic'	specifies the wall-clock time when the MPD was generated and published at the origin server. MPDs with a later value of @publishTime shall be an update as defined in subclause 5.4 to MPDs with earlier @publishTime.
@availabilityEndTime	0	specifies the latest Segment availability end time for any Segment in the Media Presentation. When not present, the value is unknown.
@mediaPresentationDuration	0	specifies the duration of the entire Media Presentation. If the attribute is not present, the duration of the Media Presentation is unknown. This attribute shall be present when neither the attribute MPD@minimumUpdatePeriod nor the Period@duration of the last Period are present.

Element or Attribute Name	Use	Description
@minimumUpdatePeriod	0	If this attribute is present, it specifies the smallest period between potential changes to the MPD. This can be useful to control the frequency at which a client checks for updates. From a client perspective, after a client fetches an MPD, it specifies the minimum period during which the MPD remains valid. Validity is defined in subclause 5.4. If this attribute is not present, it indicates that the MPD does not change. If MPD@type is not 'dynamic', @minimumUpdatePeriod shall not be present. Details on the use of the value of this attribute are specified in subclause 5.4.
@minBufferTime	M	specifies a common duration used in the definition of the Representation data rate (see @bandwidth attribute in subclauses 5.3.5.2 and 5.3.5.4).
@timeShiftBufferDepth	0	specifies the duration of the smallest time shifting buffer for any Representation in the MPD that is guaranteed to be available for a Media Presentation with type 'dynamic'. When not present, the value is infinite. This value of the attribute is undefined if the type attribute is equal to 'static'.
@suggestedPresentationDelay	0	When @type is 'dynamic', it specifies a fixed delay offset in time from the presentation time of each access unit that is suggested to be used for presentation of each access unit. For more details, refer to subclause 7.2.1. When not specified, then no value is provided and the client is expected to choose a suitable value. When @type is 'static' the value of the attribute is undefined and may be ignored.
@maxSegmentDuration	0	specifies the maximum duration of any Segment in any Representation in the Media Presentation, i.e. documented in this MPD and any future update of the MPD. If not present, then the maximum Segment duration shall be the maximum duration of any Segment documented in this MPD.
@maxSubsegmentDuration	0	specifies the maximum duration of any Media Subsegment in any Representation in the Media Presentation. If not present, the same value as for the maximum Segment duration is implied.

Element or Attribute Name	Use	Description
ProgramInformation	0...N	specifies descriptive information about the program. For more details, refer to the description in subclause 5.7.
BaseURL	0...N	specifies a Base URL that can be used for reference resolution and alternative URL selection. For more details, refer to the description in subclause 5.6.
Location	0...N	specifies a location at which the MPD is available. A reference processing model is provided in Annex A.11.
PatchLocation	0 ... N	specifies a location at which the MPD patch document is available. Details on the MPD patch document, this element, and expected processing models are available in subclause 5.15. If this element is present, the MPD@id attribute and the MPD@publishTime shall be present. When @type is 'static' or the @minimumUpdatePeriod attribute is not present, then value of the element is undefined and may be ignored. If this element is not present, no MPD patch document is available. If multiple elements are present, any PatchLocation element may be used.
ServiceDescription	0 ... N	specifies the service description detailing how the service provider expects the service is to be consumed. It shall provide a valid service description as described by Annex K.3 and Annex K.4. For details refer to Annex K.
InitializationSet	0 ... N	specifies a suitable initialization for a specific media type for the presentation. If present, at least one Period of the Media Presentation shall include at least one Adaptation Set that can be played when initialized by this Initialization Set. For details see subclause 5.3.12.
InitializationGroup	0 ... N	Specifies a white space separated list of ids of Initialization Sets of the same content type. This indicates that any Period in the Media Presentation has at least one Adaptation Set that conforms to one of the Initialization Sets referenced in this element. For details see subclause 5.3.12.

Element or Attribute Name	Use	Description
@id	M	specifies an unsigned integer identifier for this Initialization Group. The attribute shall be unique among all Initialization Set and Initialization Group ids in the MPD.
@profiles	0	specifies the profiles which the listed Initialization Groups conform to. The value shall be a subset of the value in the MPD@profiles attribute. If not present the value is inferred to be the same as the MPD@profiles attribute. The same syntax is used as defined for the MPD@profiles attribute.
@contentType	0	specifies the content type of Initialization Sets listed in the element.
InitializationPresentation	0 ... N	specifies a white space separated list of ids of Initialization Sets and Initialization Groups to indicate a combination which creates a complete presentation. A client supporting all listed Initialization Sets and Initialization Groups of an Initialization Presentation is expected to be able to play the entire Media Presentation as intended by the service provider. For details see subclause 5.3.12.
@id	M	specifies a unique unsigned integer identifier for this Initialization Presentation. The attribute shall be unique among all Initialization Presentation ids in the MPD.
@profiles	0	specifies the profiles which the listed Initialization Groups conform to. The value shall be a subset of the value in the MPD@profiles attribute. If not present the value is inferred to be the same as the MPD@profiles attribute. The same syntax is used as defined for the MPD@profiles attribute.
@contentType	0	specifies the content type of initialization Groups listed in the element.
ContentProtection	0 ... N	specifies information about content protection and encryption schemes used in this Media Presentation. If present on this level, it shall include the @refId attribute. For details, see subclauses 5.8.1 and 5.8.4.1.
Period	1...N	specifies the information of a Period. For more details, refer to the description in subclause 5.3.2.

Element or Attribute Name	Use	Description
Metrics	0 ... N	specifies the DASH Metrics. For more details, see subclause 5.9.
EssentialProperty	0 ... N	specifies information about the containing element that is considered essential by the Media Presentation author for processing the containing element. For details, see subclause 5.8.4.8.
SupplementalProperty	0 ... N	specifies supplemental information about the containing element that may be used by the DASH Client optimizing the processing. For details, see subclause 5.8.4.9.
UTCTiming	0 ... N	specifies information on ways to obtain a synchronization to wall-clock time as used in this Media Presentation. The order of the elements expresses a preference of choice by the Media Presentation author. For more details, refer to subclause 5.8.4.11.
LeapSecondInformation	0 ... 1	specifies leap second information affecting MPD timing calculations. For details refer to clause 5.13.
Key For attributes: M=mandatory, O=optional, OD=optional with default value, CM=conditionally mandatory For elements: <minOccurs>...<maxOccurs> (N=unbounded) Elements are bold ; attributes are non- bold and preceded with an @ .		

5.3.1.3 XML syntax

```

<xs:complexType name="MPDtype">
  <xs:annotation>
    <xs:documentation xml:lang="en">
      MPD Type
    </xs:documentation>
  </xs:annotation>
  <xs:sequence>
    <xs:element name="ProgramInformation" type="ProgramInformationType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="BaseURI" type="BaseURIType" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="Location" type="xs:anyURI" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="PatchLocation" type="PatchLocationType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="ServiceDescription" type="ServiceDescriptionType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="InitializationSet" type="InitializationSetType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="InitializationGroup" type="UIntVWithIDType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="InitializationPresentation" type="UIntVWithIDType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="ContentProtection" type="ContentProtectionType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="Period" type="PeriodType" maxOccurs="unbounded"/>
    <xs:element name="Metrics" type="MetricsType" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="EssentialProperty" type="DescriptorType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="SupplementalProperty" type="DescriptorType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="UTCTiming" type="DescriptorType" minOccurs="0"

```

```

maxOccurs="unbounded"/>
<xs:element name="LeapSecondInformation" type="LeapSecondInformationType"
minOccurs="0"/>
<xs:any namespace="##other" processContents="lax" minOccurs="0"
maxOccurs="unbounded"/>
</xs:sequence>
<xs:attribute name="id" type="xs:string"/>
<xs:attribute name="profiles" type="ListOfProfilesType" use="required"/>
<xs:attribute name="type" type="PresentationType" default="static"/>
<xs:attribute name="availabilityStartTime" type="xs:dateTime"/>
<xs:attribute name="availabilityEndTime" type="xs:dateTime"/>
<xs:attribute name="publishTime" type="xs:dateTime"/>
<xs:attribute name="mediaPresentationDuration" type="xs:duration"/>
<xs:attribute name="minimumUpdatePeriod" type="xs:duration"/>
<xs:attribute name="minBufferTime" type="xs:duration" use="required"/>
<xs:attribute name="timeShiftBufferDepth" type="xs:duration"/>
<xs:attribute name="suggestedPresentationDelay" type="xs:duration"/>
<xs:attribute name="maxSegmentDuration" type="xs:duration"/>
<xs:attribute name="maxSubsegmentDuration" type="xs:duration"/>
<xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>
<xs:simpleType name="PresentationType">
<xs:annotation>
<xs:documentation xml:lang="en">
Presentation Type enumeration
</xs:documentation>
</xs:annotation>
<xs:restriction base="xs:string">
<xs:enumeration value="static"/>
<xs:enumeration value="dynamic"/>
</xs:restriction>
</xs:simpleType>
<xs:complexType name="UIntVWithIDType">
<xs:annotation>
<xs:documentation xml:lang="en">
UInt Vector With ID
</xs:documentation>
</xs:annotation>
<xs:simpleContent>
<xs:extension base="UIntVectorType">
<xs:attribute name="id" type="xs:unsignedInt" use="required"/>
<xs:attribute name="profiles" type="ListOfProfilesType"/>
<xs:attribute name="contentType" type="RFC6838ContentTypeType"/>
<xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:extension>
</xs:simpleContent>
</xs:complexType>
<xs:simpleType name="UIntVectorType">
<xs:annotation>
<xs:documentation xml:lang="en">
Whitespace-separated list of unsigned integers
</xs:documentation>
</xs:annotation>
<xs:list itemType="xs:unsignedInt"/>
</xs:simpleType>
<xs:simpleType name="ListOfProfilesType">
<xs:annotation>
<xs:documentation xml:lang="en">
List of Profiles
</xs:documentation>
</xs:annotation>
<xs:restriction base="xs:string">
<xs:pattern value="(&URN;|&URL;)(&comma_sep;(&URN;|&URL;))*"/>
</xs:restriction>
</xs:simpleType>

```

5.3.2 Period

5.3.2.1 Overview

A Media Presentation consists of one or more Periods. A Period is defined by a **Period** element in the **MPD** element.

Three types of Periods are defined:

- Regular Period,
- Early Available Period,
- Early Terminated Period.

The type of the Period, as well as the *PeriodStart* time of a regular Period or early terminated Period is determined as follows:

- If the attribute `@start` is present in the **Period**, then the Period is a regular Period or an early terminated Period and the *PeriodStart* is equal to the value of this attribute.
- If the `@start` attribute is absent, but the previous **Period** element contains a `@duration` attribute then this new Period is also a regular Period or an early terminated Period. The start time of the new Period *PeriodStart* is the sum of the start time of the previous Period *PeriodStart* and the value of the attribute `@duration` of the previous Period.
- If (i) `@start` attribute is absent, and (ii) the **Period** element is the first in the MPD, and (iii) the **MPD@type** is 'static', then the *PeriodStart* time shall be set to zero.
- If (i) `@start` attribute is absent, and (ii) the previous **Period** element does not contain a `@duration` attribute or the **Period** element is the first in the MPD, and (iii) the **MPD@type** is 'dynamic', then this Period is an Early Available Period (see below for details).
- If (i) `@duration` attribute is present, and (ii) the next **Period** element contains a `@start` attribute or the `@minimumUpdatePeriod` is present, then this Period is an Early Terminated Period (see below for details).

For any regular Period and early terminated Period, the following holds: *PeriodStart* reflects the actual time that should elapse after playing the media of all prior Periods in this Media Presentation relative to the *PeriodStart* time of the first Period in the Media Presentation. The Period extends until the *PeriodStart* of the next Period, or until the end of the Media Presentation in the case of the last Period. For regular Periods, the difference between the *PeriodStart* time of a Period and either the *PeriodStart* time of the following Period, if this is not the last Period, or the value of the **MPD@mediaPresentationDuration** if this is the last one, is the presentation duration in Media Presentation time of the media content represented by the Representations in this Period. For Early Terminated Periods, the value of the **Period@duration** is the presentation duration in Media Presentation time of the media content represented by the Representations in this Period.

Early Available Periods may be used to advertise initialization of other non-media data before the media data itself is available. **Period** elements documenting early available Periods shall not occur before any **Period** element documenting a regular Period. For Early Available Periods, any resources that are announced in such a **Period** element shall be available. The data contained in such a **Period** element does not represent a Period in the Media Presentation. Only when the *PeriodStart* time becomes known through an update of the MPD, such a **Period** element represents a regular Period. However, an update of the MPD may even remove a **Period** element representing an Early Available Period in later updates of the MPD as long as no *PeriodStart* time is associated with the Period. To avoid dereferencing of a remote element entity containing a **Period** element solely to determine the Period timeline, e.g. in case of seeking, **Period@start** or previous Period's **Period@duration** should be present in the MPD.

The semantics of the attributes and elements within a **Period** element are provided in Table 4 of subclause 5.3.2.2. The XML syntax of the **Period** element is provided in subclause 5.3.2.3.

5.3.2.2 Semantics

Table 4 — Semantics of **Period** element

Element or Attribute Name	Use	Description
Period		specifies the information of a Period.
@xlink:href	0	specifies a reference to a remote element entity that is either empty or contains one or multiple top-level elements of type Period .
@xlink:actuate	OD default: onRequest	specifies the processing instructions, which can be either "onLoad" or "onRequest". This attribute shall not be present if the @xlink:href attribute is not present.
@id	0	specifies an identifier for this Period. The identifier shall be unique within the scope of the Media Presentation. If the MPD@type is "dynamic", then this attribute shall be present and shall not change in case the MPD is updated. If not present, no identifier for the Period is provided. In case of a remote period element, every Period@id within the remote entity has to be unique within the media presentation. If the generator of the remote entity is unaware of the Period@id values used within the media presentation, it can use unique identifiers (such as UUIDs) as values for Period@id . If the xlink resolver maintains the same generated id for every client and for each time that the remote period is requested, the remote element is cacheable.
@start	0	if present, specifies the <i>PeriodStart</i> time of the Period. The <i>PeriodStart</i> time is used as an anchor to determine the MPD start time of each Media Segment as well as to determine the presentation time of each access unit in the Media Presentation timeline. If not present, refer to the details in subclause 5.3.2.1. The value of <i>PeriodStart</i> , together with the value of the MPD@availabilityStartTime enables to derive the Segment availability times for dynamic media presentations. For details, refer to subclause 5.3.9.
@duration	0	if present, specifies the duration of the Period to determine the <i>PeriodStart</i> time of the next Period. If not present, refer to the details in subclause 5.3.2.1.
@bitstreamSwitching	OD Default: false	When set to 'true', this is equivalent as if the AdaptationSet@bitstreamSwitching for each Adaptation Set contained in this Period is set to 'true'. In this case, the AdaptationSet@bitstreamSwitching attribute shall not be set to 'false' for any Adaptation Set in this Period.

Element or Attribute Name	Use	Description
BaseURL	0...N	specifies a base URL that can be used for reference resolution and alternative URL selection. For more details, refer to the description in subclause 5.6.
SegmentBase	0...1	specifies default Segment Base information. Information in this element is overridden by information in AdaptationSet.SegmentBase and Representation.SegmentBase , if present. For more details, see subclause 5.3.9.
SegmentList	0...1	specifies default Segment List information. Information in this element is overridden by information in AdaptationSet.SegmentList and Representation.SegmentList , if present. For more details, see subclause 5.3.9.
SegmentTemplate	0...1	specifies default Segment Template information. Information in this element is overridden by information in AdaptationSet.SegmentTemplate and Representation.SegmentTemplate , if present. For more details, see subclause 5.3.9.
AssetIdentifier	0...1	specifies that this Period belongs to a certain asset. For more details, see subclause 5.8.5.7.
EventStream	0...N	specifies an event stream. For more details, see subclause 5.10.2.
ServiceDescription	0 ... N	specifies the service description that is intended by the service provider on how the service is expected to be consumed in this Period. For details refer to Table 3 in subclause 5.3.1.3. If any element is present in the Period, then this information overrides all Service Description information provided on MPD level with the same scope.
ContentProtection	0 ... N	specifies information about content protection and encryption schemes used in this Media Presentation. If present on this level, it shall include the @refId attribute. For details, see subclauses 5.8.1 and 5.8.4.1.
AdaptationSet	0...N	specifies an Adaptation Set. At least one Adaptation Set shall be present in each Period unless the value of the @duration attribute of the Period is set to zero. For more details, see 5.3.3.
Subset	0...N	specifies a Subset. For more details, see subclause 5.3.8.

Element or Attribute Name	Use	Description
SupplementalProperty	0...N	specifies supplemental information about the containing element that may be used by the DASH Client optimizing the processing. For details, see subclause 5.8.4.9.
EmptyAdaptationSet	0...N	specifies an Adaptation Set that does not contain any Representation element. The empty Adaptation Set is of the same type as a regular Adaptation Set but shall neither contain an xlink nor contain any Representation element. This element shall only be present, if an Essential Descriptor is present with @schemeIDURI set to "urn:mpeg:dash:mpd-as-linking:2015". For more details, see subclause 5.8.5.8.
GroupLabel	0 ... N	A summary label for a group of Labels. For more details, refer to subclause 5.3.10.
Preselection	0 ... N	specifies a preselection, i.e. a combination of Adaptation Sets that form a specific experience and can be selected for joint decoding and rendering. For more details, refer to subclause 5.3.11.
Key For attributes: M=mandatory, O=optional, OD=optional with default value, CM=conditionally mandatory For elements: <minOccurs>...<maxOccurs> (N=unbounded) The conditions only hold without using xlink:href. If linking is used, then all attributes are "optional" and <minOccurs=0>. Elements are bold ; attributes are non-bold and preceded with an @.		

5.3.2.3 XML syntax

```

<xs:complexType name="PeriodType">
  <xs:annotation>
    <xs:documentation xml:lang="en">
      Period
    </xs:documentation>
  </xs:annotation>
  <xs:sequence>
    <xs:element name="BaseURL" type="BaseURLType" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="SegmentBase" type="SegmentBaseType" minOccurs="0"/>
    <xs:element name="SegmentList" type="SegmentListType" minOccurs="0"/>
    <xs:element name="SegmentTemplate" type="SegmentTemplateType" minOccurs="0"/>
    <xs:element name="AssetIdentifier" type="DescriptorType" minOccurs="0"/>
    <xs:element name="EventStream" type="EventStreamType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="ServiceDescription" type="ServiceDescriptionType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="ContentProtection" type="ContentProtectionType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="AdaptationSet" type="AdaptationSetType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="Subset" type="SubsetType" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="SupplementalProperty" type="DescriptorType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="EmptyAdaptationSet" type="AdaptationSetType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:element name="GroupLabel" type="LabelType" minOccurs="0" maxOccurs="unbounded"/>
    <xs:element name="Preselection" type="PreselectionType" minOccurs="0"
maxOccurs="unbounded"/>
    <xs:any namespace="##other" processContents="lax" minOccurs="0"

```

```

maxOccurs="unbounded"/>
</xs:sequence>
<xs:attribute ref="xlink:href"/>
<xs:attribute ref="xlink:actuate" default="onRequest"/>
<xs:attribute ref="xlink:type" fixed="simple"/>
<xs:attribute ref="xlink:show" fixed="embed"/>
<xs:attribute name="id" type="xs:string"/>
<xs:attribute name="start" type="xs:duration"/>
<xs:attribute name="duration" type="xs:duration"/>
<xs:attribute name="bitstreamSwitching" type="xs:boolean" default="false"/>
<xs:anyAttribute namespace="##other" processContents="lax"/>
</xs:complexType>

```

5.3.2.4 Content offering with multiple Periods

Content with multiple Periods may be created for different reasons, for example:

- to enable splicing of content, for example for ad insertion,
- to provide synchronization in segment numbering, e.g. compensate non-constant segment durations,
- to remove or add certain Representations in an Adaptation Set,
- to remove or add certain Adaptation Sets,
- to remove or add content offering on certain CDNs,
- to enable signalling of shorter segments, if produced by the encoder.

Periods provide opportunities for resync, for ad insertion, for adding and removing Representations. However, in certain circumstances, the content across Period boundaries is continuous and, in this case, continuous playout of the client is expected.

In certain circumstances, the Media Presentation is offered such that the next Period is a continuation of the content in the previous Period, possibly the immediately following Period or in a later Period (e.g. after an advertisement Period had been inserted).

The content provider may express that the media components contained in two Adaptation Sets in two different Periods are associated by assigning equivalent Asset Identifiers to both Periods and by identifying both Adaptation Sets with identical value for the attribute `@id`. Association expresses a logical continuation of the media component in the next Period and may for example be used by the client to continue playing an associated Adaptation Set in the new Period.

In addition, two Adaptation Sets in one MPD are period-continuous if all the following holds:

- The Adaptation Sets are associated.
- The sum of the value of the `@presentationTimeOffset` and the presentation duration of all Representations in one Adaptation Set are identical to the value of the `@presentationTimeOffset` of the associated Adaptation Set in the next Period.
- If Representations in both Adaptation Sets have the same value for `@id`, then they shall have functionally equivalent Initialization Segments, i.e. the Initialization Segment may be used to continue the play-out of the Representation. The concatenation of the Initialization Segment of the first Period, if present, and all consecutive Media Segments in the Representation in the first Period and subsequently the concatenation with all consecutive Media Segments in the Representation of the second Period shall represent a conforming Segment track as defined in subclause 4.5.4 conforming to the media type as specified in the `@mimeType` attribute for the Representation in the

first Period. Additionally, the @mimeType attribute for the Representation in the next Period shall be the same as one of the first Period.

Media Presentations should signal period-continuous Adaptation Sets by using a supplemental descriptor on Adaptation Set level with @schemeIdUri set to "urn:mpeg:dash:period-continuity:2015" with

- the @value of the descriptor matching the value of an @id of a Period that is contained in the MPD, and
- the value of the **AdaptationSet**@id being the same in both Periods.

MPD should signal period-continuous Adaptation Sets if the MPD contains Periods with identical Asset Identifiers.

There exist special cases for which the media in one Adaptation Set is a continuation of the previous one, but the timestamps are not continuous. Examples are timestamp wrap around, encoder reset, splicing, or other aspects. Two Adaptation Sets in one MPD are period-connected if all conditions from period-continuity from above hold, except that the timestamps across Period boundaries may be non-continuous but adjusted by the value of the @presentationTimeOffset at the Period boundary. However, for example the Initialization Segment is equivalent within the two Adaptation Sets. Media Presentations should signal period-connected Adaptation Sets by using a supplemental descriptor on Adaptation Set level with @schemeIdUri set to "urn:mpeg:dash:period-connectivity:2015".

Period continuity implies period connectivity.

For appropriate client behaviour, please refer to A.9.

5.3.2.5 Special Periods in Live Services

In order to address live services for which Periods are extended into the future and Periods are gradually removed due to the timeshift buffer depth, special types of Periods are defined as follows:

- *Partially Unavailable Period*: any Period in a dynamic Media Presentation for which the sum of the **MPD**@availabilityStartTime and the value of **Period**@start is smaller than the value of @publishTime minus the value of **MPD**@timeShiftBufferDepth. For this Period, some Segments may no longer be available as they have been fallen out of the time shift buffer window.
- *Live-Edge Period*: newest regular Period in a dynamic Media Presentation, for which the Period duration is unknown, and Segment availability start time of at least one Segment is greater than the value of **MPD**@publishTime. For such Periods, the exact duration of Segments that are not yet available, may be unknown.

Note that an MPD may contain both types of Periods, and further, a single Period may be both at the same time, a Partially Unavailable Period and a Live-Edge Period.

5.3.3 Adaptation Sets

5.3.3.1 Overview

Each Period consists of one or more Adaptation Sets. An Adaptation Set is described by an **AdaptationSet** element. **AdaptationSet** elements are contained in a **Period** element.

An Adaptation Set contains alternate Representations, i.e. only one Representation within an Adaptation Set is expected to be presented at a time. All Representations contained in one Adaptation Set represent the same media content components and therefore contain media streams that are considered to be perceptually equivalent. The Adaptation Set and the contained Representations shall be prepared and

contain sufficient information such that seamless switching (as defined in subclause 4.5.1) across different Representations in one Adaptation Set is enabled. If an Adaptation Set is expected to be consumed by DASH Clients with restrictions in terms of switching, then the Media Presentation author should provide sufficient means to enable seamless switching under these restrictions.

Representations are arranged into Adaptation Sets according to the media content component properties of the media content components present in the Representations, namely:

- the language as described by the `@lang` attribute,
- the media content component type described by the `@contentType` attribute,
- the picture aspect ratio as described by the `@par` attribute,
- the role property as described by the **Role** elements,
- the accessibility property as described by the **Accessibility** elements,
- the viewpoint property as described by the **Viewpoint** elements,
- the rating property as described by the **Rating** elements.

Representations shall appear in the same Adaptation Set if and only if they have identical values for all of these media content component properties for each media content component.

The values for the elements **Role**, **Accessibility**, **Viewpoint** and **Rating** are generally not provided within the scope of this document. However, a number of simple schemes are defined in subclause 5.8.5.

If there exist multiple media content components, then the properties of each media content component shall be described by a separate **ContentComponent** element as defined in subclause 5.3.4. The **ContentComponent** element shares common elements and attributes with the **AdaptationSet** element. Default values, or values applicable to all media content components, may be provided directly in the **AdaptationSet** element. Attributes present in the **AdaptationSet** shall not be repeated in the **ContentComponent** element.

The **AdaptationSet** element may contain default values for elements and attributes associated to the contained Representations. The list of possible present elements and attributes that are common to **AdaptationSet** and **Representation** (and also **SubRepresentation**) are collected in subclause 5.3.7. Any of the common attributes shall only be present either in the **AdaptationSet** element or in the **Representation** element, but not in both.

The **AdaptationSet** element also supports the description of ranges for the `@bandwidth`, `@width`, `@height` and `@frameRate` attributes associated to the contained Representations, which provide a summary of all values for all the Representations within this Adaptation Set. The Representations contained within an Adaptation Set shall not contain values outside the ranges documented for that Adaptation Set.

Adaptation Sets may be further arranged into groups using the `@group` attribute. The semantics of this grouping is that the media content within one Period is represented by:

- 1) either one Representation from group 0, if present,
- 2) or the combination of at most one Representation from each non-zero group.

If the **AdaptationSet**@group attribute is not present, then all Representations in this Adaptation Set are assigned to a non-zero group specific to this Adaptation Set.

The semantics of the attributes and elements within an **AdaptationSet** element are provided in Table 5 in subclause 5.3.3.2. The XML syntax of the **AdaptationSet** element is provided in subclause 5.3.3.3.

5.3.3.2 Semantics

Table 5 — Semantics of AdaptationSet element

Element or Attribute Name	Use	Description
AdaptationSet		Adaptation Set description.
@xlink:href	0	specifies a reference to a remote element entity that shall contain exactly one element of type AdaptationSet .
@xlink:actuate	OD default: 'onRequest'	specifies the processing instructions, which can be either "onLoad" or "onRequest".
@id	0	specifies a unique identifier for this Adaptation Set in the scope of the Period. The attribute shall be a unique unsigned integer value in the scope of the containing Period. The attribute shall not be present in a remote element entity. If not present, no identifier for the Adaptation Set is specified.
@group	0	specifies an identifier for the group that is unique in the scope of the containing Period. The value is an unsigned integer. For details, refer to subclause 5.3.3.1.
CommonAttributesElements	—	specifies the common attributes and elements (attributes and elements from base type RepresentationBaseType). For details, see subclause 5.3.7.
@lang	0	Declares the language code for this Adaptation Set. The syntax and semantics according to IETF RFC 5646 shall be used. If not present, the language code may be defined for each media component or it may be unknown. If the language is unknown, the 'und' code for undetermined primary language or the 'zxx' (Non-Linguistic, Not Applicable) code can be used.

Element or Attribute Name	Use	Description
@contentType	0	specifies the media content component type for this Adaptation Set. A value of the top-level Content-type 'type' value as defined in 4 of IETF RFC 6838:2013 shall be taken. If not present, the media content component type may be defined for each media content component or it may be unknown.
@par	0	specifies the picture aspect ratio of the video media component type, in the form of a string consisting of two integers separated by ':', e.g. "16:9". When this attribute is present, and the attributes @width and @height for the set of Representations are also present, the picture aspect ratio as specified by this attribute shall be the same as indicated by the values of @width, @height, and @sar, i.e. it shall express the same ratio as $(@width * sar_x) : (@height * sar_y)$, with sar_x the first number in @sar and sar_y the second number. If not present, the picture aspect ratio may be defined for each media component or it may be unknown.
@minBandwidth	0	specifies the minimum @bandwidth value in all Representations in this Adaptation Set. This value has the same units as the @bandwidth attribute. If not present, the value is unknown.
@maxBandwidth	0	specifies the maximum @bandwidth value in all Representations in this Adaptation Set. This value has the same units as the @bandwidth attribute. If not present, the value is unknown.
@minWidth	0	specifies the minimum @width value in all Representations in this Adaptation Set. This value has the same units as the @width attribute. If not present, the value is unknown.
@maxWidth	0	specifies the maximum @width value in all Representations in this Adaptation Set. This value has the same units as the @width attribute. If not present, the value is unknown.
@minHeight	0	specifies the minimum @height value in all Representations in this Adaptation Set. This value has the same units as the @height attribute. If not present, the value is unknown.
@maxHeight	0	specifies the maximum @height value in all Representations in this Adaptation Set. This value has the same units as the @height attribute. If not present, the value is unknown.