[MS-SMTH]:
IIS Smooth Streaming Transport Protocol

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Revision Summary

Date	Revision history	Revision Class	Comments
9/8/2009	1.0		Initial Availability

Contents

1 Introduction

1.1 Glossary

The following terms are defined in [MS-GLOS]:

globally-unique identifier (GUID)
little-endian
Unicode
universally-unique identifier (UUID)

The following terms are defined in [RFC2616]:

Cache
Cacheable
Downstream
Explicit Expiration Time
Fresh
Freshness Lifetime
Gateway
Proxy
Request
Response
Stale
Upstream

The following terms are defined in [ISOFF]:

Composition Time (of a Sample)
Decode Time (of a Sample)

The following terms are defined in [XML]:

Attribute
Document
Document Type Definition (DTD)
Element
eXtensible Markup Language (XML)
XML Namespaces

The following terms are specific to this document:

Bit Rate: A measure of the average bandwidth required to deliver a **Track**, in bits per second (bps).

Cache Hit: A **Request** to an **HTTP Cache Proxy** that matches a **Fresh** stored **Response**.

Cache Miss: A **Request** to an **HTTP Cache Proxy** that does not match a **Fresh** stored **Response**.

Client: A role in the protocol, used to play back **Media** for viewers.

Decode: To decompress video or audio **Samples** for playback.

Encode: To compress raw video or audio into **Samples** in a **Media Format**.

Fragment: An independently downloadable unit of **Media** that comprises one or more **Samples**.

HTTP Cache Proxy: A **Proxy** that can deliver a stored copy of a **Response** to **Clients**.

Manifest: Metadata about the **Presentation** that allows a **Client** to make requests for **Media**.

Media: Compressed audio, video, and text data used by the **Client** to play a **Presentation**.

Media Format: A well-defined format for representing audio or video as a compressed **Sample**.

Packet: A unit of audio **Media** that defines natural boundaries for optimizing audio **Decoding**.

Presentation: The set of all **Streams** and related metadata needed to play a single movie.

Sample: The smallest fundamental unit (such as a frame) in which **Media** is stored and processed.

Server: A role in the protocol, used to deliver **Media** to **Clients**.

Stream: A set of interchangeable at the **Client** when playing **Media**.

Track: A time-ordered collection of **Samples** of a particular type (such as audio or video).

MAY, **SHOULD**, **MUST**, **SHOULD NOT**, **MUST NOT:** These terms (in all caps) are used as described in [RFC2119]. All statements of optional behavior use either MAY, SHOULD, or SHOULD NOT.

1.2   References

The normative references are those industry standard specifications which the IIS Smooth Streaming Transport Protocol references and/or builds upon. The informational references are for explanation or non-normative portions of the specification.

1.2.1   Normative References

[ISOFF] International Organization for Standardization, "ISO 14496-12: Information technology — Coding of audio-visual objects – Part 12: ISO Base Media File Format", ISO 14496-12, http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=51533

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels," BCP 14, RFC 2119, March 1997, http://www.ietf.org/rfc/rfc2119.txt

[RFC2396] Berners-Lee, T., *et al*, "Uniform Resource Identifier (URI): Generic Syntax", RFC 2396, August 1998, http://www.ietf.org/rfc/rfc2396.txt

[RFC2616] Fielding, R., *et al*, "Hypertext Transfer Protocol – HTTP/1.1", RFC 2616, June 1999, http://www.ietf.org/rfc/rfc2616.txt

[XML] World Wide Web Consortium, "Extensible Markup Language (XML) 1.0 (Fifth Edition)", W3C Recommendation, November 2008, http://www.w3.org/TR/REC-xml/

1.2.2 Informative References

[AAC] International Organization for Standardization, "ISO 14496-3: Information technology — Coding of audio-visual objects — Part 3: Audio", ISO 14496-3, http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=53943

[AVC] International Organization for Standardization, "ISO 14496-10: Information technology — Coding of audio-visual objects — Part 10: Advanced video coding", ISO 14496-10, http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=52974

[AVCFF] International Organization for Standardization, "ISO 14496-15: Information technology — Coding of audio-visual objects — Part 15: Advanced Video Coding (AVC) file format", ISO 14496-15, http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=38573

[ISOTXT] International Organization for Standardization, "ISO 14496-17: Information technology – Coding of audio-visual objects – Part 17: Streaming text format", ISO 14496-17, http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=39478

[MS-GLOS] Microsoft Corporation, "Windows Protocols Master Glossary," March 2007

[RFC2326] Schulzrinne, H., *et al*, "Real Time Streaming Protocol (RTSP)", RFC 2326, April 2008, http://www.ietf.org/rfc/rfc2326.txt

[RFC3548] S. Josefsson, *ed*., "The Base16, Base32, and Base64 Data Encodings", RFC 3548, July 2003, http://www.ietf.org/rfc/rfc3548.txt

[RFC5234] Crocker, D., *ed.*, "Augmented BNF Syntax for Specifications: ABNF", RFC 5234, January 2008, http://www.ietf.org/rfc/rfc5234.txt

[VC-1] Society of Motion Picture and Television Engineers, "VC-1 Compressed Video Bitstream Format and Decoding Process", SMPTE 421M-2006, April 2006, http://store.smpte.org/product-p/smpte%200421m-2006.htm

[VIH] Microsoft Corporation, "VIDEOINFOHEADER Structure", July 2009, http://msdn.microsoft.com/en-us/library/dd407325(VS.85).aspx

[WFEX] Microsoft Corporation, "Augmented Multiple Channel Audio Data and WAVE Files", March 2007, http://www.microsoft.com/whdc/device/audio/multichaud.mspx

1.3 Protocol Overview (Synopsis)

The IIS Smooth Streaming Transport Protocol provides a means of delivering Media from Servers to Clients in a way that can be Cached by standard HTTP Cache Proxies in the communication chain. Allowing standard HTTP Cache Proxies to respond to Requests on behalf of the Server increases the number of Clients that can be served by a single Server.

The following figure depicts a typical communication pattern for the protocol:
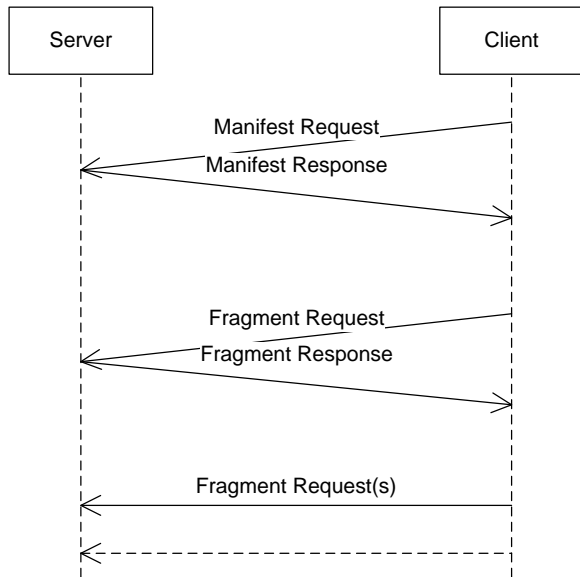
The first message in the communication pattern is a Manifest Request, to which the Server replies with a Manifest Response. The Client then makes one or more Fragment Requests, and the Server replies to each with a Fragment Response. Correlation between Requests and Responses is handled by the underlying Hypertext Transport Protocol (HTTP) [RFC2616] layer.

The Server role in the protocol is stateless, allowing each Request from the Client to be potentially handled by a different instance of the Server, or by one or more HTTP Cache Proxies. The following figure depicts the communication pattern for Requests for the same Fragment, indicated as "Fragment Request X", when an HTTP Cache Proxy is used:
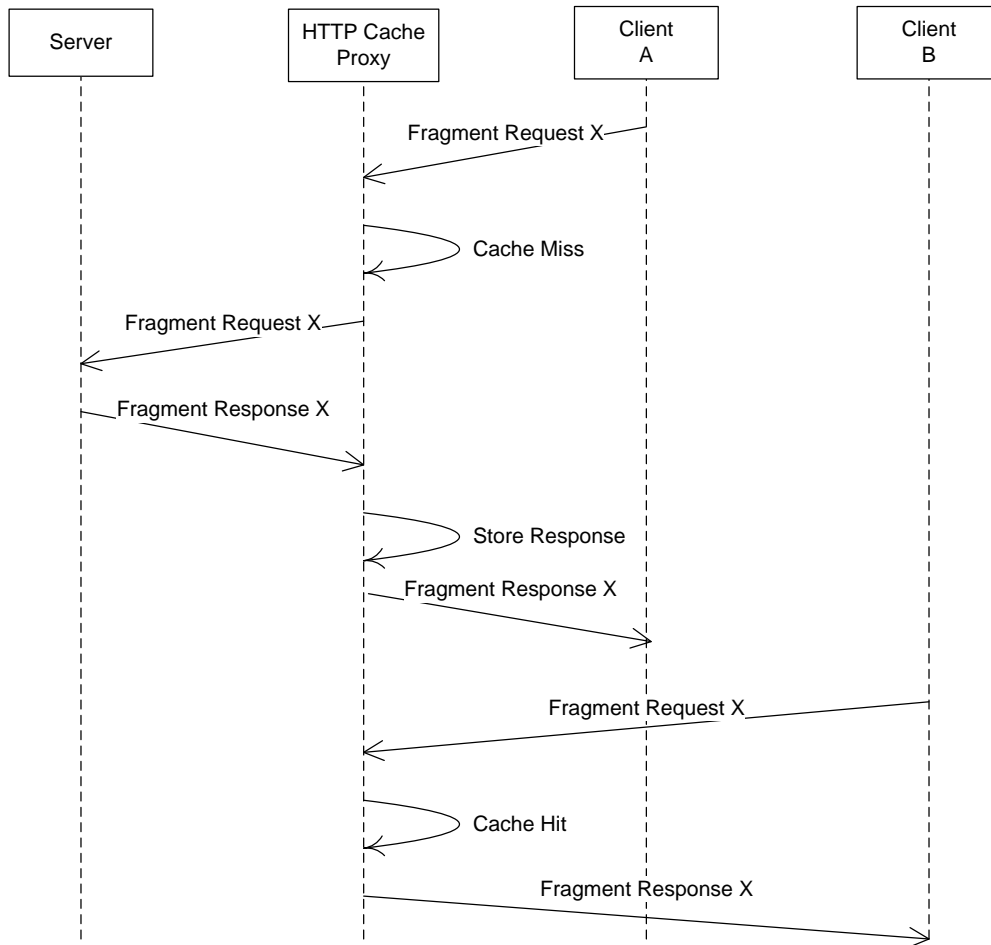
1.4 Relationship to other Protocols

The IIS Smooth Streaming Transport Protocol uses HTTP [RFC2616] as its underlying transport.

The IIS Smooth Streaming Transport Protocol fulfills a similar function to established stateful Media protocols, such as Real Time Streaming Protocol (RTSP) [RFC2326], with significantly greater scalability in World Wide Web scenarios due to effective use of HTTP Cache Proxies.

1.5 Prerequisites/Preconditions

This protocol assumes HTTP [RFC2616] connectivity from the Client to the Server.

It is also assumed that the Client is integrated with a higher-layer implementation that supports any Media Format(s) used and is otherwise able to play the Media transmitted by the Server.

1.6 Applicability Statement

This protocol is most appropriate for delivering Media over the World Wide Web or environments where HTTP Cache Proxies can be used to maximize scalability. It can be used on any network where HTTP [RFC2616] connectivity to the Server is available.

1.7 Versioning and Capability Negotiation

This document covers versioning issues in the following areas:

- **Protocol Versions:** The IIS Smooth Streaming Transport Protocol is explicitly versioned using the MajorVersion and MinorVersion fields specified in section 2.2.2.1 .

- **Security and Authentication Methods:** Security and authentication for the IIS Smooth Streaming Transport Protocol is performed at the underlying transport layer (HTTP) and does not restrict which of the mechanisms supported by HTTP can be used.

1.8 Vendor-Extensible Fields

The following fields in this protocol can be extended by vendors:

- **Custom Attributes in the Manifest Response:** This capability is provided by the VendorExtensionAttributes field, as specified in section 2.2.2 . Implementers can ensure that extensions do not conflict by assigning extensions an XML Namespace unique to their implementation.

- **Custom Data Elements in the Manifest Response:** This capability is provided by the VendorExtensionDataElement fields, as specified in section 2.2.2.6.1 . Implementers can ensure that extensions do not conflict by assigning extensions an XML Namespace unique to their implementation.

- **Custom Boxes in the Fragment Response:** This capability is provided by the VendorExtensionUUID field, as specified in section 2.2.4 .

- **Custom Media Formats for Audio:** This capability is provided by the AudioTag and CodecPrivateData fields, as specified in section 2.2.2.5 . Implementers can ensure that extensions do not conflict by assigning extensions a unique GUID embedded in the CodecPrivateData field, as specified in [WFEX].

- **Custom Descriptive Codes for Media Formats:** This capability is provided by the FourCC field, as specified in section 2.2.2.5 . Implementers can ensure that extensions do not conflict by registering extension codes with the MPEG4-RA, as specified in [ISOFF].

- **Custom HTTP Headers in the Manifest Response:** This capability is provided by the underlying transport layer (HTTP), as specified in section 6 of [RFC2616].

- **Custom HTTP Headers in the Fragment Response:** This capability is provided by the underlying transport layer (HTTP), as specified in section 6 of [RFC2616].

- **Custom HTTP Headers in the Fragment Request:** This capability is provided by the underlying transport layer (HTTP), as specified in section 5 of [RFC2616].

- **Custom HTTP Headers in the Manifest Request:** This capability is provided by the underlying transport layer (HTTP), as specified in section 5 of [RFC2616].

1.9 Standards Assignments

There are no applicable Standards Assignments.

2 Messages

2.1 Transport

The Manifest Request and Fragment Request messages MUST be represented as HTTP Request messages, as specified by the Request rule of [RFC2616], subject to the following constraints:

- The Method MUST be "GET"

- For the Manifest Request message, the RequestURI MUST adhere to the syntax of the ManifestRequest field, specified in section 2.2.1

- For the Fragment Request message, the RequestURI MUST adhere to the syntax of the FragmentRequest field, specified in section 2.2.3

- The HTTP-Version SHOULD be HTTP/1.1

The Manifest Response and Fragment Response messages MUST be represented as HTTP Response messages, as specified by the Response rule of [RFC2616], subject to the following constraints:

- The Status-Code SHOULD be 200

- For the Manifest Response message, the message-body MUST adhere to the syntax of the ManifestResponse field, specified in section 2.2.2

- For the Fragment Response message, the message-body MUST adhere to the syntax to the FragmentResponse field, specified in section 2.2.4

- The HTTP-Version SHOULD be HTTP/1.1

2.2 Message Syntax

The IIS Smooth Streaming Transport Protocol defines four types of messages:

- **Manifest Request**

- **Manifest Response**

- **Fragment Request**

- **Fragment Response**

The following fields are commonly used across the message set. The syntax of each field is specified in ABNF [RFC5234].

STRING_UINT64: An unsigned decimal integer less than 2^{64}, written as a string.

```
STRING_UINT64 = 1*DIGIT
```

STRING_UINT32: An unsigned decimal integer less than 2^{32}, written as a string.

```
STRING_UINT32 = 1*DIGIT
```

STRING_UINT16: An unsigned decimal integer less than 2^{16}, written as a string.

```
STRING_UINT16 = 1*DIGIT
```

S: Whitespace legal inside an XML Document, as defined in [XML].

```
S = 1* ( %x20 / %x09 / %x0D / %x0A )
```

Eq: An equality expression used for Attributes, as defined in [XML].

```
Eq = S? "=" S?
```

SQ: A single-quote character that contains Attributes, as defined in [XML].

```
SQ = %x27
```

DQ: A double-quote character that contains Attributes, as defined in [XML].

```
DQ = %x22
```

URL_SAFE_CHAR: A character that can safely appear in a URI, as specified in [RFC2396].

```
URL_SAFE_CHAR = <URL-safe character as defined in [RFC2616]>
```

URL_ENCODED_CHAR: A character encoded to safely appear in a URI, as specified in [RFC2396].

```
URL_ENCODED_CHAR = "%" HEXDIGIT HEXDIGIT
```

HEXDIGIT: A character in a hexadecimal representation.

```
HEXDIGIT = DIGIT / "a" / "b" / "c" / "d" / "e" / "f"
                 / "A" / "B" / "C" / "D" / "E" / "F"
```

HEXCODED_BYTE: A hexadecimal coding of a byte, with the first character for the four high bits and the second character for the four low bits.

```
HEXCODED_BYTE = HEXDIGIT HEXDIGIT
```

XML_CHARDATA: XML data without Elements, as specified by the CharData field in [XML].

```
XML_CHARDATA = <XML character data as defined by CharData in [XML]>
```

IDENTIFIER: An identifier safe for use in data fields.

```
IDENTIFIER = *URL_SAFE_CHAR
```

IDENTIFIER_NONNUMERIC: A non-numeric identifier safe for use in data fields.

```
IDENTIFIER = ALPHA / UNDERSCORE *URL_SAFE_CHAR

UNDERSCORE = "_"
```

URISAFE_IDENTIFIER: An identifier safe for use in data fields part of a URI [RFC2396].

```
IDENTIFIER = *(URL_SAFE_CHAR / URL_ENCODED_CHAR)
```

URISAFE_IDENTIFIER_NONNUMERIC: A non-numeric identifier safe for use in data fields part of a URI [RFC2396].

```
IDENTIFIER = ALPHA / UNDERSCORE *(URL_SAFE_CHAR / URL_ENCODED_CHAR)

UNDERSCORE = "_"
```

2.2.1 Manifest Request

ManifestRequest and related fields contain data required to request a Manifest from the Server.

ManifestRequest (variable): The URI [RFC2396] of the Manifest resource.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
ManifestRequest = PresentationURI "/" "Manifest"

PresentationURI = [ "/" VirtualPath ] "/" PublishingPointName "." FileExtension

VirtualPath = URISAFE_IDENTIFIER

PublishingPointName = URISAFE_IDENTIFIER

FileExtension = "ism" / VendorExtensionFileExtension

VendorExtensionFileExtension = ALPHA *( ALPHA / DIGIT )
```

2.2.2 Manifest Response

ManifestResponse and related fields contain metadata required by the Client to construct subsequent FragmentRequest messages and play back data received.

ManifestResponse (variable): Metadata required by the Client to play back the Presentation. This field MUST be a Well-Formed XML Document [XML] subject to the following constraints:

- The Document's root Element is a SmoothStreamingMedia field.

- The Document's XML Declaration's major version is 1.

- The Document's XML Declaration's minor version is 0.

- The Document does not use a Document Type Definition (DTD).

- The Document uses an encoding that is supported by the Client implementation.

- The XML Elements specified in this document do not use XML Namespaces.

Prolog (variable): The prolog field, as specified in [XML].

Misc (variable): The Misc field, as specified in [XML].

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
ManifestResponse = prolog SmoothStreamingMedia Misc
```

2.2.2.1 SmoothStreamingMedia

SmoothStreamingMedia and related fields encapsulate metadata required to play the Presentation.

SmoothStreamingMedia (variable): An XML Element that encapsulates all metadata required by the Client to play back the Presentation.

SmoothStreamingMediaAttributes (variable): The collection of XML attributes for the SmoothStreamingMedia Element. Attributes can appear in any order. However, the following fields are required and MUST be present in SmoothStreamingMediaAttributes: MajorVersionAttribute, MinorVersionAttribute, DurationAttribute.

MajorVersion (variable): The major version of the Manifest Response message. MUST be 2.

MinorVersion (variable): The minor version of the Manifest Response message. MUST be 0.

TimeScale (variable): The time scale of the Duration attribute, specified as the number of increments in one second. The default value is 10000000.

Duration (variable): The duration of the presentation, specified as the number of time increments indicated by the value of the TimeScale field.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
SmoothStreamingMedia = "<" SmoothStreamingMediaElementName S
                       SmoothStreamingMediaAttributes S? ">"
                       S? SmoothStreamingMediaContent S?
                       "</" SmoothStreamingMediaElementName ">"

SmoothStreamingMediaElementName = "SmoothStreamingMedia"

SmoothStreamingMediaAttributes = *(
                                    MajorVersionAttribute
                                    / MinorVersionAttribute
                                    / TimeScaleAttribute
                                    / DurationAttribute
                                    / VendorExtensionAttribute
                                  )

MajorVersionAttribute = S? MajorVersionAttributeName S? Eq S?
                        (DQ MajorVersion DQ) / (SQ MajorVersion SQ) S?

MajorVersionAttributeName = "MajorVersion"

MajorVersion = "2"

MinorVersionAttribute = S? MinorVersionAttributeName S? Eq S?
                        (DQ MinorVersion DQ) / (SQ MinorVersion SQ) S?

MinorVersionAttributeName = "MinorVersion"
```

```
MinorVersion = "0"

TimeScaleAttribute = S? TimeScaleAttributeName S? Eq S?
                     (DQ TimeScale DQ) / (SQ TimeScale SQ) S?

TimeScaleAttributeName = "TimeScale"

TimeScale = STRING_UINT64

DurationAttribute = S? DurationAttributeName S? Eq S?
                    (DQ Duration DQ) / (SQ Duration SQ) S?

DurationAttributeName = "Duration"

Duration = STRING_UINT64

SmoothStreamingMediaContent = [ ProtectionElement S?] 1* StreamElement
```

2.2.2.2 ProtectionElement

ProtectionElement and related fields encapsulate metadata required to play back Protected Content.

ProtectionElement (variable): An XML Element that encapsulates metadata required by the **Client** to play back protected content.

ProtectionHeaderElement (variable): An XML Element that encapsulates content protection metadata for a specific content protection system.

SystemID (variable): A UUID that uniquely identifies the Content Protection System to which this ProtectionElement pertains.

ProtectionHeaderContent (variable): Opaque data that the Content Protection System identified in the SystemID field can use to enable playback for authorized users, encoded using Base 64 Encoding [RFC3548].

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
ProtectionElement = "<" ProtectionElementName S? ">"
                    S? 1*( ProtectionHeaderElement S?)
                    "</" ProtectionElementName ">"

ProtectionElementName = "Protection"

ProtectionHeaderElement = "<" ProtectionHeaderElementName S
                          ProtectionHeaderAttributes S? ">"
                          S? ProtectionHeaderContent S?
                          "</" ProtectionHeaderElementName ">"

ProtectionHeaderAttributes = SystemIDAttribute
```

```
SystemIDAttribute = S? SystemIDAttributeName S? Eq S?
                        (DQ SystemID DQ) / (SQ SystemID SQ) S?

SystemIDAttributeName = "SystemID"

SystemID = "{"
            4*4 HEXCODED_BYTE "-"
            2*2 HEXCODED_BYTE "-"
            2*2 HEXCODED_BYTE "-"
            2*2 HEXCODED_BYTE "-"
            6*6 HEXCODED_BYTE "-"
            "}"

ProtectionHeaderContent = STRING_BASE64
```

2.2.2.3   StreamElement

StreamElement and related fields encapsulate metadata required to play a specific Stream in the Presentation.

StreamElement (variable): An XML Element that encapsulates all metadata required by the Client to play back a Stream.

StreamAttributes (variable): The collection of XML Attributes for the SmoothStreamingMedia Element. Attributes can appear in any order. However, the following field is required and MUST be present in StreamAttributes: TypeAttribute. The following additional fields are required and MUST be present in StreamAttributes unless an Embedded Track is used in the StreamContent field: NumberOfFragmentsAttribute, NumberOfTracksAttribute, UrlAttribute.

StreamContent (variable): Metadata describing available Tracks and Fragments.

Type (variable): The type of the Stream: video, audio, or text. If the type specified is text, the following field is required and MUST appear in StreamAttributes: SubtypeAttribute. Unless the type specified is video, the following fields MUST NOT appear in StreamAttributes: StreamMaxWidthAttribute, StreamMaxHeightAttribute, DisplayWidthAttribute, DisplayHeightAttribute.

StreamTimeScale (variable): The time scale for duration and time values in this Stream, specified as the number of increments in one second.

Name (variable): The name of the Stream.

NumberOfFragments (variable): The number of Fragments available for this Stream.

NumberOfTracks (variable): The number of Tracks available for this Stream.

Subtype (variable): A four-character code that identifies the intended use category for each Sample in a text Track. However, the FourCC field, specified in section 2.2.2.5 , is used to identify

the Media Format for each Sample. The following range of values is reserved, with the following semantic meanings:

- "SCMD": Triggers for actions by the higher-layer implementation on the Client

- "CHAP": Chapter markers

- "SUBT": Subtitles used for foreign-language audio

- "CAPT": Closed captions for the hearing-impaired

- "DESC": Media descriptions for the hearing-impaired

- "CTRL": Events the control application business logic

- "DATA": Application data that does not fall into any of the above categories

Url (variable): A pattern used by the Client to generate Fragment Request messages.

SubtypeControlEvents (variable): Control events for applications on the Client.

StreamMaxWidth (variable): The maximum width of a video Sample, in pixels.

StreamMaxHeight (variable): The maximum height of a video Sample, in pixels.

DisplayWidth (variable): The suggested display width of a video Sample, in pixels.

DisplayHeight (variable): The suggested display height of a video Sample, in pixels.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
StreamElement = "<" StreamElementName S
                StreamAttributes S? ">"
                S? StreamContent S?
                "</" StreamElementName ">"

Name = "StreamIndex"

StreamAttributes = *(
                    TypeAttribute
                    / SubtypeAttribute
                    / StreamTimeScaleAttribute
                    / NameAttribute
                    / NumberOfFragmentsAttribute
                    / NumberOfTracksAttribute
                    / UrlAttribute
                    / StreamMaxWidthAttribute
                    / StreamMaxHeightAttribute
                    / DisplayWidthAttribute
                    / DisplayHeightAttribute
                    / VendorExtensionAttribute
                  )
```

```
TypeAttribute = S? TypeAttributeName S? Eq S?
               (DQ Type DQ) / (SQ Type SQ) S?


TypeAttributeName = "Type"


Type = "video" / "audio" / "text"


SubtypeAttribute = S? SubtypeAttributeName S? Eq S?
                   (DQ Subtype DQ) / (SQ Subtype SQ) S?


SubtypeAttributeName = "Subtype"


Subtype = 4*4 ALPHA


StreamTimeScaleAttribute = S? StreamTimeScaleAttributeName S? Eq S?
                           (DQ StreamTimeScale DQ) / (SQ StreamTimeScale SQ) S?


StreamTimeScaleAttributeName = "TimeScale"


StreamTimeScale = STRING_UINT64


NameAttribute = S? NameAttributeName S? Eq S?
               (DQ Name DQ) / (SQ Name SQ) S?


NameAttributeName = "Name"


Name = ALPHA *( ALPHA / DIGIT / UNDERSCORE / DASH )


NumberOfFragmentsAttribute = S? NumberOfFragmentsAttributeName S? Eq S?
                             (DQ NumberOfFragments DQ) / (SQ NumberOfFragments SQ)
                             S?


NumberOfFragmentsAttributeName = "Chunks"


NumberOfFragments = STRING_UINT32


NumberOfTracksAttribute = S? NumberOfTracksAttributeName S? Eq S?
                          (DQ NumberOfTracks DQ) / (SQ NumberOfTracks SQ) S?


NumberOfTracksAttributeName = "QualityLevels"


NumberOfTracks = STRING_UINT32


UrlAttribute = S? UrlAttributeName S? Eq S?
               (DQ Url DQ) / (SQ Url SQ) S?


UrlAttributeName = "Url"


Url = UrlPattern
```

```
StreamMaxWidthAttribute = S? StreamMaxWidthAttributeName S? Eq S?
                          (DQ StreamMaxWidth DQ) / (SQ StreamMaxWidth SQ) S?


StreamMaxWidthAttributeName = "MaxWidth"


StreamMaxWidth = STRING_UINT32


StreamMaxHeightAttribute = S? StreamMaxHeightAttributeName S? Eq S?
                           (DQ StreamMaxHeight DQ) / (SQ StreamMaxHeight SQ) S?


StreamMaxHeightAttributeName = "MaxHeight"


StreamMaxHeight = STRING_UINT32


DisplayWidthAttribute = S? DisplayWidthAttributeName S? Eq S?
                        (DQ DisplayWidth DQ) / (SQ DisplayWidth SQ) S?


DisplayWidthAttributeName = "DisplayWidth"


DisplayWidth = STRING_UINT32


DisplayHeightAttribute = S? DisplayHeightAttributeName S? Eq S?
                         (DQ DisplayHeight DQ) / (SQ DisplayHeight SQ) S?


DisplayHeightAttributeName = "DisplayHeight"


DisplayHeight = STRING_UINT32

StreamContent = 1*(TrackElement S?) *(StreamFragment S?)
```

2.2.2.4 UrlPattern

UrlPattern and related fields define a pattern that can be used by the Client to make semantically valid Fragment Requests for the Presentation.

UrlPattern (variable): Encapsulates a pattern for constructing Fragment Requests.

BitrateSubstitution (variable): A placeholder expression for the Bit Rate of a Track.

CustomAttributesSubstitution (variable): A placeholder expression for the Attributes used to disambiguate a Track from other Tracks in the Stream.

TrackName (variable): A unique identifier that applies to all Tracks in a Stream.

BitrateSubstitution (variable): A placeholder expression for the time of a Fragment.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
UrlPattern = QualityLevelsPattern "/" FragmentsPattern
```

```
QualityLevelsPattern = QualityLevelsNoun "(" QualityLevelsPredicatePattern ")"

QualityLevelsNoun = "QualityLevels"

QualityLevelsPredicate = BitrateSubstitution ["," CustomAttributesSubstitution ]

Bitrate = "{bitrate}" / "{Bitrate}"

CustomAttributesSubstitution = "{CustomAttributes}"

FragmentsPattern = FragmentsNoun "(" FragmentsPatternPredicate ")";

FragmentsNoun = "Fragments"

FragmentsPatternPredicate = TrackName "=" StartTimeSubstitution;

TrackName = URISAFE_IDENTIFIER_NONNUMERIC

StartTimeSubstitution = "{start time}" / "{start_time}"
```

2.2.2.5   TrackElement

TrackElement and related fields encapsulate metadata required to play a specific Track in the Stream.

TrackElement (variable): An XML Element that encapsulates all metadata required by the Client to play a Track.

TrackAttributes (variable): The collection of XML Attributes for the TrackElement. Attributes can appear in any order. However, the following fields are required and MUST be present in TrackAttributes: IndexAttribute, BitrateAttribute. If the Track is contained in a Stream whose Type is video, the following additional fields are also required and MUST be present in TrackAttributes: MaxWidthAttribute, MaxHeightAttribute, CodecPrivateDataAttribute. If the Track is contained in a Stream whose Type is audio, the following additional fields are also required and MUST be present in TrackAttributes: MaxWidthAttribute, MaxHeightAttribute, CodecPrivateDataAttribute, SamplingRateAttribute, ChannelsAttribute, BitsPerSampleAttribute, PacketSizeAttribute, AudioTagAttribute, FourCCAttribute.

Index (variable): An ordinal that identifies the Track and MUST be unique for each Track in the Stream. The Index SHOULD start at 0 and increment by 1 for each subsequent Track in the Stream.

Bitrate (variable): The average bandwidth consumed by the track, in bits-per-second (bps). The value 0 MAY be used for Tracks whose Bit Rate is negligible relative to other Tracks in the Presentation.

MaxWidth (variable): The maximum width of a video Sample, in pixels.

MaxHeight (variable): The maximum height of a video Sample, in pixels.

SamplingRate (variable): The Sampling Rate of an audio Track, as defined in [ISOFF].

Channels (variable): The Channel Count of an audio Track, as defined in [ISOFF].

AudioTag (variable): An numeric code that identifies which Media Format and variant of the Media Format is used for each Sample in an audio Track. The following range of values is reserved with the following semantic meanings:

- "1": The sample Media Format is Linear 8 or 16 bit Pulse Code Modulation

- "353": Microsoft Windows Media Audio v7, v8 and v9.x Standard (WMA Standard)

- "353": Microsoft Windows Media Audio v9.x and v10 Professional (WMA Professional)

- "85": ISO MPEG-1 Layer III (MP3)

- "255": ISO Advanced Audio Coding (AAC)

- "65534": Vendor-extensible format. If specified, the CodecPrivateData field SHOULD contain a hex-encoded version of the WAVE_FORMAT_EXTENSIBLE structure [WFEX].

BitsPerSample (variable): The Sample Size of an audio Track, as defined in [ISOFF].

PacketSize (variable): The size of each audio Packet, in bytes.

FourCC (variable): A four-character code that identifies which Media Format is used for each Sample. The following range of values is reserved with the following semantic meanings:

- "H264": Video Samples for this Track use Advanced Video Coding, as specified in [AVCFF]

- "WVC1": Video Samples for this Track use VC-1, as specified in [VC-1]

- "AACL": Audio Samples for this Track use AAC (Low Complexity), as specified in [AAC]

- "WMAP": Audio Samples for this Track use WMA Professional

- A vendor extension value containing a registered with MPEG4-RA, as specified in [ISOFF]

CodecPrivateData (variable): Data that specifies parameters specific to the Media Format and common to all Samples in the Track, represented as a string of hex-coded bytes. The format and semantic meaning of byte sequence varies with the value of the FourCC field as follows:

- FourCC field equals "H264": The CodecPrivateData field contains a hex-coded string representation of the following byte sequence, specified in ABNF [RFC5234]:

  - `%x00 %x00 %x00 %x01 SPSField %x00 %x00 %x00 %x01 SPSField`

  - SPSField contains the Sequence Parameter Set (SPS)

  - PPSField contains the Slice Parameter Set (PPS)

- FourCC field equals "WVC1": The CodecPrivateData field contains a hex-coded string representation of the VIDEOINFOHEADER structure, specified in [VIH].

- FourCC field equals "AACL": The CodecPrivateData field SHOULD be empty.

- FourCC field equals "WMAP": The CodecPrivateData field contains the WAVEFORMATEX structure, specified in [WFEX], if the AudioTag field equals "65534" equals, and SHOULD be empty otherwise.

- FourCC is a vendor extension value: The format of the CodecPrivateData field is also vendor-extensible. Registration of the FourCC field value with MPEG4-RA, as specified in [ISOFF], to can be used to avoid collision between extensions.

NALUnitLengthField (variable): The number of bytes that specify the length of each Network Abstraction Layer (NAL) unit. This field SHOULD be omitted unless the value of the FourCC field is "H264". The default value is 4.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
Track = TrackWithoutContent / TrackWithContent

TrackWithoutContent = "<" TrackElementName S TrackAttributes S? "/>"

TrackWithContent = "<" TrackElementName S TrackAttributes S? ">"
                   S? TrackContent S? "</" TrackElementName ">"

TrackElementName = "QualityLevel"

TrackAttributes = *(
                    IndexAttribute
                    / BitrateAttribute
                    / CodecPrivateDataAttribute
                    / MaxWidthAttribute
                    / MaxHeightAttribute
                    / SamplingRateAttribute
                    / ChannelsAttribute
                    / BitsPerSampleAttribute
                    / PacketSizeAttribute
                    / AudioTagAttribute
                    / FourCCAttribute
                    / NALUnitLengthFieldAttribute
                    / VendorExtensionAttribute
                  )

IndexAttribute = S? IndexAttributeName S? Eq S?
                 (DQ Index DQ) / (SQ Index SQ) S?

IndexAttributeName = "Index"

Index = STRING_UINT32

BitrateAttribute = S? BitrateAttributeName S? Eq S?
                   (DQ Bitrate DQ) / (SQ Bitrate SQ) S?

BitrateAttributeName = "Bitrate"
```

```
Index = STRING_UINT32

MaxWidthAttribute = S? MaxWidthAttributeName S? Eq S?
                    (DQ MaxWidth DQ) / (SQ MaxWidth SQ) S?

MaxWidthAttributeName = "MaxWidth"

MaxWidth = STRING_UINT32

MaxHeightAttribute = S? MaxHeightAttributeName S? Eq S?
                     (DQ MaxHeight DQ) / (SQ MaxHeight SQ) S?

MaxHeightAttributeName = "MaxHeight"

MaxHeight = STRING_UINT32

CodecPrivateDataAttribute = S? CodecPrivateDataAttributeName S? Eq S?
                            (DQ CodecPrivateData DQ) / (SQ CodecPrivateData SQ) S?

CodecPrivateDatatAttributeName = "CodecPrivateData"

CodecPrivateData = *HEXCODED_BYTE

SamplingRateAttribute = S? SamplingRateAttributeName S? Eq S?
                        (DQ SamplingRate DQ) / (SQ SamplingRate SQ) S?

SamplingRateAttributeName = "SamplingRate"

SamplingRate = STRING_UINT32

ChannelsAttribute = S? ChannelsAttributeName S? Eq S?
                    (DQ Channels DQ) / (SQ Channels SQ) S?

ChannelsAttributeName = "Channels"

Channels = STRING_UINT16

BitsPerSampleAttribute = S? BitsPerSampleAttributeName S? Eq S?
                         (DQ BitsPerSample DQ) / (SQ BitsPerSample SQ) S?

BitsPerSampleAttributeName = "BitsPerSample"

BitsPerSample = STRING_UINT16

PacketSizeAttribute = S? PacketSizeAttributeName S? Eq S?
                      (DQ PacketSize DQ) / (SQ PacketSize SQ) S?

PacketSizeAttributeName = "PacketSize"

PacketSize = STRING_UINT32
```

```
AudioTagAttribute = S? AudioTagAttributeName S? Eq S?
                        (DQ AudioTag DQ) / (SQ AudioTag SQ) S?


PacketSizeAttributeName = "AudioTag"


AudioTag = STRING_UINT32


FourCCAttribute = S? FourCCAttributeName S? Eq S?
                        (DQ FourCC DQ) / (SQ FourCC SQ) S?


FourCCAttributeName = "AudioTag"


FourCC = 4*4 ALPHA


NALUnitLengthFieldAttribute = S? NALUnitLengthFieldAttributeName S? Eq S?
                                (DQ NALUnitLengthField DQ)
                                / (SQ NALUnitLengthField SQ) S?


NALUnitLengthFieldAttributeName = "NALUnitLengthField"


NALUnitLengthField = STRING_UINT16


TrackContent = CustomAttributes?
```

2.2.2.5.1 CustomAttributesElement

CustomAttributesElement and related fields are used to specify metadata that disambiguates Tracks in a Stream.

CustomAttributes (variable): Metadata expressed as key/value pairs that disambiguates Tracks.

AttributeName (variable): The name of a custom Attribute for a Track.

AttributeValue (variable): The value of a custom Attribute for a Track.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
CustomAttributesElement = S? "<" CustomAttributesElementName S? ">"
                            S? 1*(AttributeElement S?)
                            "</" CustomAttributesElementName ">"


AttributeElement = "<" AttributeElementName S AttributeAttributes S? "/>"


AttributeAttributes = (AttributeNameAttribute S AttributeValueAttribute)
                    / (AttributeValueAttribute S AttributeNameAttribute)


AttributeNameAttribute = S? AttributeNameAttributeName S? Eq S?
                            (DQ AttributeName DQ) / (SQ AttributeName SQ) S?


AttributeNameAttributeName = "Name"
```

```
AttributeName = IDENTIFIER

AttributeValueAttribute = S? AttributeValueAttributeName S? Eq S?
                          (DQ AttributeValue DQ) / (SQ AttributeValue SQ) S?

AttributeValueAttributeName = "Value"

AttributeValue = IDENTIFIER
```

2.2.2.6 StreamFragmentElement

StreamFragmentElement and related fields are used to specify metadata for one set of Related Fragments in a Stream. The order of repeated StreamFragmentElement fields in a containing StreamElement is significant for the correct function of the IIS Smooth Streaming Transport Protocol. To this end, the following make use of the terms "preceding" and "subsequent" StreamFragmentElement in reference to the order of these fields.

StreamFragmentElement (variable): An XML Element that encapsulates metadata for a set of Related Fragments. Attributes can appear in any order. However, either one or both of the following fields is required and MUST be present in StreamFragmentAttributes: FragmentDuration, FragmentTime.

FragmentNumber (variable): The ordinal of the StreamFragmentElement in the Stream. If FragmentNumber is specified, its value MUST monotonically increase with the value of FragmentTime.

FragmentDuration (variable): The duration of the Fragment, specified as a number of increments defined by the implicit or explicit value of the containing StreamElement's StreamTimeScale field. If the FragmentDuration field is omitted, its implicit value MUST be computed by the Client by subtracting the value of the preceding StreamFragmentElement's FragmentTime field from the value of this StreamFragmentElement's FragmentTime field. If no subsequent StreamFragmentElement exists, the implicit value of FragmentTime is 0.

FragmentTime (variable): The time of the Fragment, specified as a number of increments defined by the implicit or explicit value of the containing StreamElement's StreamTimeScale field. If the FragmentDuration field is omitted, its implicit value MUST be computed by the Client by adding the value of the preceding StreamFragmentElement's FragmentTime field to the value of this StreamFragmentElement's FragmentDuration field. If no preceding StreamFragmentElement exists, the implicit value of FragmentTime is 0.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
StreamFragmentElement = "<" StreamFragmentElementName S
                        StreamFragmentAttributes S? ">"
                        S? StreamFragmentContent S?
                        "</" StreamFragmentElementName ">"

StreamFragmentElementname = "c"

StreamFragmentAttributes = *(
                              FragmentNumberAttribute
```

```
                              / FragmentDurationAttribute
                              / FragmentTimeAttribute
                          )

FragmentNumberAttribute = S? FragmentNumberAttributeName S? Eq S?
                          (DQ FragmentNumber DQ) / (SQ FragmentNumber SQ) S?

FragmentNumberAttributeName = "n"

FragmentNumber = STRING_UINT32

FragmentDurationAttribute = S? FragmentDurationAttributeName S? Eq S?
                          (DQ FragmentDuration DQ) / (SQ FragmentDuration SQ) S?

FragmentDurationAttributeName = "d"

FragmentDuration = STRING_UINT64

FragmentTimeAttribute = S? FragmentTimeAttributeName S? Eq S?
                      (DQ FragmentTime DQ) / (SQ FragmentTime SQ) S?

FragmentTimeAttributeName = "t"

FragmentTime = STRING_UINT64

StreamFragmentContent = *( TrackFragment S? )

TrackFragment = "<" TrackFragmentElementName S
                TrackFragmentAttributes S? ">"
                S? 1*(TrackFragmentContent S?)
                "</" TrackFragmentElementName ">"

TrackFragmentAttributes = *(
                             TrackFragmentIndexAttribute
                             / VendorExtensionAttribute
                          )

TrackFragmentIndexAttribute = S? TrackFragmentIndexAttribute S? Eq S?
                             (DQ TrackFragmentIndex DQ)
                             / (SQ TrackFragmentIndex SQ) S?

TrackFragmentIndexAttribute = "i"

TrackFragmentIndex = STRING_UINT32

TrackFragmentContent = VendorExtensionTrackData

VendorExtensionTrackData = XML_CHARDATA
```

2.2.2.6.1 TrackFragmentElement

TrackFragmentElement and related fields are used to specify metadata pertaining to a Fragment for a specific Track, rather than all versions of a Fragment for a Stream.

TrackFragmentElement (variable): An XML Element that encapsulates informative Track-specific metadata for a specific Fragment. Attributes can appear in any order. However, the following field is required and MUST be present in TrackFragmentAttributes: TrackFragmentIndexAttribute.

TrackFragmentIndex (variable): An ordinal that MUST match the value the Index field for the Track to which this TrackFragment field pertains.

VendorExtensionTrackData (variable): A string of custom data containing no XML Elements.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
TrackFragmentElement = "<" TrackFragmentElementName S
                       TrackFragmentAttributes S? ">"
                       S? TrackFragmentContent S?
                       "</" TrackFragmentElementName ">"

TrackFragmentElementName = "f"

TrackFragmentAttributes = *(
                            TrackFragmentIndexAttribute
                            / VendorExtensionAttribute
                          )

TrackFragmentIndexAttribute = S? TrackFragmentIndexAttribute S? Eq S?
                              (DQ TrackFragmentIndex DQ)
                              / (SQ TrackFragmentIndex SQ) S?

TrackFragmentIndexAttribute = "i"

TrackFragmentIndex = STRING_UINT32

TrackFragmentContent = VendorExtensionTrackData

VendorExtensionTrackData = XML_CHARDATA
```

2.2.3 Fragment Request

FragmentRequest and related fields contain data required to request a Fragment from the Server.

FragmentRequest (variable): The URI [RFC2616] of the Fragment resource.

BitratePredicate (variable): The Bit Rate of the Requested Fragment.

CustomAttributesPredicate (variable): An Attribute of the Requested Fragment used to disambiguate Tracks.

CustomAttributesKey (variable): The name of the Attribute specified in the CustomAttributesPredicate.

CustomAttributesValue (variable): The value of the Attribute specified in the CustomAttributesPredicate.

StreamName (variable): The name of the Stream that contains the Requested Fragment.

Time (variable): The time of the Requested Fragment.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
FragmentRequest = PresentationURI "/" QualityLevelsSegment "/" FragmentsSegment
                ; PresentationURI is specified in section 2.2.1

QualityLevelsSegment = QualityLevelsNoun "(" QualityLevelsPredicate ")"

QualityLevelsNoun = "QualityLevels"

QualityLevelsPredicate = BitratePredicate *( "," CustomAttributesPredicate )

BitratePredicate = STRING_UINT32

CustomAttributesPredicate = CustomAttributesKey "=" CustomAttributesValue

CustomAttributesKey = URISAFE_IDENTIFIER_NONNUMERIC

CustomAttributesValue = URISAFE_IDENTIFIER

FragmentsSegment = FragmentsNoun "(" FragmentsPredicate ")"

FragmentsNoun = "Fragments"

FragmentsPredicate = StreamName "=" Time

StreamName = URISAFE_IDENTIFIER_NONNUMERIC

Time = STRING_UINT64
```

2.2.4 Fragment Response

FragmentResponse and related fields encapsulate Media and metadata specific to the Requested Fragment.

FragmentResponse (variable): The Media and related metadata for a Fragment.

FragmentMetadata (variable): Metadata for the Fragment.

FragmentData (variable): Media data for the Fragment.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
FragmentResponse = FragmentMetadata FragmentData
```

```
FragmentMetadata = MoofBox

FragmentData = MdatBox
```

2.2.4.1 MoofBox

MoofBox and related fields encapsulate metadata specific to the Requested Fragment. The syntax of MoofBox is a strict subset of the syntax of the Movie Fragment Box defined in [ISOFF].

MoofBox (variable): Top-level metadata container for the Requested Fragment. The following fields are required and MUST be present in MoofBoxChildren: MfhdBox, TrafBox.

MoofBoxLength (4 bytes): The length of the MoofBox, in bytes, including MoofBoxLength. If the value of MoofBoxLength is %00.00.00.01, the MoofBoxLongLength field MUST be present.

MoofBoxLongLength (8 bytes): The length of the MoofBox, in bytes, including MoofBoxLongLength.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
MoofBox = MoofBoxLength MoofBoxType [MoofBoxLongLength]
          MoofBoxChildren

MoofBoxType = "m" "o" "o" "f"

MoofBoxLength = BoxLength

MoofBoxLongLength = BoxLongLength

MoofBoxChildren = 2 *( MfhdBox / TrafBox / VendorExtensionUUIDBox )
```

2.2.4.2 MfhdBox

MfhdBox and related fields specify the Fragment's position in the sequence for the Track. The syntax of MfhdBox is a strict subset of the syntax of the Movie Fragment Header Box defined in [ISOFF].

MfhdBox (variable): Metadata container for the sequence information for the Track.

MfhdBoxLength (4 bytes): The length of the MfhdBox, in bytes, including MfhdBoxLength. If the value of MfhdBoxLength is %00.00.00.01, the MfhdBoxLongLength field MUST be present.

MfhdBoxLongLength (8 bytes): The length of the MfhdBox, in bytes, including MfhdBoxLongLength.

SequenceNumber (4 bytes): An ordinal for the Fragment in the Track timeline. The SequenceNumber value for a Fragment later in the timeline MUST be greater than for a Fragment earlier in the timeline, but SequenceNumber values for consecutive Fragments are not required to be consecutive.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
MfhdBox = MfhdBoxLength MfhdBoxType [MfhdBoxLongLength] MfhdBoxFields
          MfhdBoxChildren
```

```
MfhdBoxType = "m" "f" "h" "d"

MfhdBoxLength = BoxLength

MfhdBoxLongLength = LongBoxLength

MfhdBoxFields = SequenceNumber

SequenceNumber = UNSIGNED_INT32

MfhdBoxChildren = *( VendorExtensionUUIDBox )
```

2.2.4.3 TrafBox

TrafBox and related fields encapsulate metadata specific to the Requested Fragment and Track. The syntax of TrafBox is a strict subset of the syntax of the Track Fragment Box defined in [ISOFF].

TrafBox (variable): Top-level metadata container for track-specific metadata for the Fragment. The following fields are required and MUST be present in TrafBoxChildren: TfhdBox, TrunBox.

TrafBoxLength (4 bytes): The length of the TrafBox, in bytes, including TrafBoxLength. If the value of TrafBoxLength is %00.00.00.01, the TrafBoxLongLength field MUST be present.

TrafBoxLongLength (8 bytes): The length of the TrafBox, in bytes, including TrafBoxLongLength.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
TrafBox = TrafBoxLength TrafBoxType [TrafBoxLongLength]
          TrafBoxChildren

TrafBoxType = "t" "r" "a" "f"

TrafBoxLength = BoxLength

TrafBoxLongLength = LongBoxLength

TrafBoxChildren = 2 *( SampleEncryptionBox / TfhdBox / TrunBox
                     / VendorExtensionUUIDBox )
```

2.2.4.4 SampleEncryptionBox

SampleEncryptionBox and related fields encapsulate content protection metadata.

SampleEncryptionBox (variable): Top-level content protection metadata container for the Requested Fragment.

SampleEncryptionBoxLength (4 bytes): The length of the SampleEncryptionBox, in bytes, including SampleEncryptionBoxLength. If the value of SampleEncryptionBoxLength is %00.00.00.01, the SampleEncryptionBoxLongLength field MUST be present.

SampleEncryptionBoxLongLength (8 bytes): The length of the SampleEncryptionBox, in bytes, including SampleEncryptionBoxLongLength.

AlgorithmID (3 bytes): The algorithm used to encrypt each Sample. The following values are defined:

- %x00.00.00: Not encrypted

- %x00.00.01: Encrypted using AES 128-bit CTR mode

- %x00.00.02: Encryption using AES 128-bit CBC mode

InitializationVectorSize (1 byte): The size of the InitializationVector field, in bytes. Allowed values are %x08 and %x10.

KID (16 bytes): A UUID that identifies the key used to encrypt Samples.

SampleEncryptionBoxSampleCount (4 bytes): The number of instances of the InitializationVector field in the SampleEncryptionBox field.

InitializationVector (variable): The Initialization Vector for each Sample.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
SampleEncryptionBox = SampleEncryptionBoxLength SampleEncryptionBoxType
                      [SampleEncryptionBoxLongLength] SampleEncryptionBoxUUID
                      SampleEncryptionBoxFields SampleEncryptionBoxChildren


SampleEncryptionBoxLength = BoxLength


SampleEncryptionBoxType = "u" "u" "i" "d"


SampleEncryptionBoxLongLength = LongBoxLength


SampleEncryptionBoxUUID = %xA2 %x39 %x4F %x52 %x5A %x9B %x4F %x14
                          %xA2 %x44 %x6C %x42 %x7C %x64 %x8D %xF4


SampleEncryptionBoxFields = SampleEncryptionBoxVersion
                            SampleEncryptionBoxFlags
                           [
                             AlgorithmID
                             InitializationVectorSize
                             KID
                           ]
                            SampleEncryptionBoxSampleCount
                            *InitializationVector

                            ; The InitializationVector field MUST be repeated
                            ;     exactly SampleEncryptionBoxSampleCount times

SampleEncryptionBoxVersion = %x00


SampleEncryptionBoxFlags = 23*23 RESERVED_BIT SampleEncryptionBoxOptionalFields


SampleEncryptionBoxOptionalFields = BIT
```

```
AlgorithmID = 3*3 BYTE

InitializationVectorSize = UNSIGNED_INT8

KID = UUID

SampleEncryptionBoxSampleCount = UNSIGNED_INT32

InitializationVector = *BYTE

SampleEncryptionBoxChildren = *( VendorExtensionUUIDBox )
```

2.2.4.5   TfhdBox

TfhdBox and related fields encapsulate defaults for per Sample metadata in the Fragment. The syntax of TfhdBox is a strict subset of the syntax of the Track Fragment Header Box defined in [ISOFF].

TfhdBox (variable): Metadata container for per Sample defaults.

TfhdBoxLength (4 bytes): The length of the TfhdBox, in bytes, including TfhdBoxLength. If the value of TfhdBoxLength is %00.00.00.01, the TfhdBoxLongLength field MUST be present.

TfhdBoxLongLength (8 bytes): The length of the TfhdBox, in bytes, including TfhdBoxLongLength.

BaseDataOffset (8 bytes): The offset, in bytes, from the beginning of the MdatBox field to the **Sample** field in the MdatBox field.

SampleDescriptionIndex (4 bytes): The ordinal of the Sample description for the Track that is applicable to this **Fragment**. This field SHOULD be omitted.

DefaultSampleDuration (4 bytes): The default duration of each Sample, in increments defined by the TimeScale for the Track.

DefaultSampleSize (4 bytes): The default size of each Sample, in bytes.

DefaultSampleFlags (4 bytes): The default value of the SampleFlags field for each Sample.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
TfhdBox = TfhdBoxLength TfhdBoxType [TfhdBoxLongLength] TfhdBoxFields
          TfhdBoxChildren

TfhdBoxType = "t" "f" "h" "d"

TfhdBoxLength = BoxLength

TfhdBoxLongLength = LongBoxLength

TfhdBoxFields = TfhdBoxVersion
                TfhdBoxFlags
                [ BaseDataOffset ]
                [ SampleDescriptionIndex ]
```

```
              [ DefaultSampleDuration ]
              [ DefaultSampleSize ]
              [ DefaultSampleFlags ]


TfhdBoxVersion = %x00


TfhdBoxFlags = 18*18 RESERVED_BIT
              DefaultSampleFlagsPresent
              DefaultSampleSizePresent
              DefaultSampleDurationPresent
              RESERVED_BIT
              SampleDescriptionIndexPresent
              BaseDataOffsetPresent


BaseDataOffset = UNSIGNED_INT64


SampleDescriptionIndex = UNSIGNED_INT32


DefaultSampleDuration = UNSIGNED_INT32


DefaultSampleSize = UNSIGNED_INT32


DefaultSampleFlags = ExtendedSampleFlags


TfhdBoxChildren = *( VendorExtensionUUIDBox )
```

2.2.4.6   TrunBox

TrunBox and related fields encapsulate per Sample metadata for the Requested Fragment. The syntax of TrunBox is a strict subset of the syntax of the Track Fragment Run Box defined in [ISOFF].

TrunBox (variable): Container for per Sample metadata.

TrunBoxLength (4 bytes): The length of the TrunBox, in bytes, including TrunBoxLength. If the value of TrunBoxLength is %00.00.00.01, the TrunBoxLongLength field MUST be present.

TrunBoxLongLength (8 bytes): The length of the TrunBox, in bytes, including TrunBoxLongLength.

SampleCount (4 bytes): The number of Samples in the Fragment.

FirstSampleFlags (4 bytes): The value of the SampleFlags field for the first Sample. This field MUST be present if and only if FirstSampleFlagsPresent takes the value %b1.

SampleSize (4 bytes): The size of each Sample, in bytes. This field MUST be present if and only if SampleSizePresent takes the value %b1. If this field is not present, its implicit value is the value of the DefaultSampleSize field.

SampleDuration (4 bytes): The duration of each Sample, in increments defined by the TimeScale for the Track. This field MUST be present if and only if SampleDurationPresent takes the value %b1. If this field is not present, its implicit value is the value of the DefaultSampleDuration field.

SampleFlags (4 bytes): The Sample flags of each Sample. This field MUST be present if and only if SampleFlagsPresent takes the value %b1. If this field is not present, its implicit value is the value of

the DefaultSampleDuration field. If the FirstSampleFlags field is present and this field is omitted, this field's implicit value for the first Sample in the Fragment MUST be the value of the FirstSampleFlags field.

SampleCompositionTimeOffset (4 bytes): The Sample Composition Time offset of each Sample, as defined in [ISOFF]. This field MUST be present if and only if SampleCompositionTimeOffsetPresent takes the value %b1.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
TrunBox = TrunBoxLength TrunBoxType [TrunBoxLongLength] TrunBoxFields
          TrunBoxChildren

TrunBoxType = "t" "r" "u" "n"

TrunBoxLength = BoxLength

TrunBoxLongLength = LongBoxLength

TrunBoxFields = TrunBoxVersion
                TrunBoxFlags
                SampleCount
                [ FirstSampleFlags ]
                *( TrunBoxPerSampleFields )

                ; TrunBoxPerSampleFields MUST be repeated exactly SampleCount times

TrunBoxFlags = 12*12 RESERVED_BIT
               SampleCompositionTimeOffsetPresent
               SampleFlagsPresent
               SampleSizePresent
               SampleDurationPresent
               RESERVED_BIT
               RESERVED_BIT
               RESERVED_BIT
               RESERVED_BIT
               RESERVED_BIT
               FirstSampleFlagsPresent
               RESERVED_BIT
               RESERVED_BIT

SampleCompositionTimeOffsetPresent = BIT

SampleFlagsPresent = BIT

SampleSizePresent = BIT

SampleDurationPresent = BIT

FirstSampleFlagsPresent = BIT
```

```
FirstSampleFlags = ExtendedSampleFlags


TrunBoxPerSampleFields = [ SampleDuration ]
                         [ SampleSize ]
                         [ TrunBoxSampleFlags ]
                         [ SampleCompositionTimeOffset ]


SampleDuration = UNSIGNED_INT32


SampleSize = UNSIGNED_INT32


TrunBoxSampleFlags = ExtendedSampleFlags


SampleCompositionTimeOffset = UNSIGNED_INT32


TrunBoxChildren = *( VendorExtensionUUIDBox )
```

2.2.4.7 MdatBox

MdatBox and related fields encapsulate Media data for the Requested Fragment. The syntax of MdatBox is a strict subset of the syntax of the Media Data Container Box defined in [ISOFF].

MdatBox (variable): Media data container.

MdatBoxLength (4 bytes): The length of the MdatBox, in bytes, including MdatBoxLength. If the value of MdatBoxLength is %00.00.00.01, the MdatBoxLongLength field MUST be present.

MdatBoxLongLength (8 bytes): The length of the MdatBox, in bytes, including MdatBoxLongLength.

SampleData (variable): A single Sample of Media. Sample boundaries in the MdatBox are defined by the values of the DefaultSampleSize and SampleSize fields in the TrunBox.

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
MdatBox = MdatBoxLength MdatBoxType [MdatBoxLongLength]
          MdatBoxFields


MoofBoxType = "m" "d" "a" "t"


MoofBoxLength = BoxLength


MoofBoxLongLength = LongBoxLength


MdatBoxFields = *( SampleData )


SampleData = *BYTE
```

2.2.4.8 Fragment Response Common Fields

This section defines fields commonly used in the Fragment Response message.

ExtendedSampleFlags (4 bytes): A comprehensive Sample flags field.

SampleFlags (1 byte): A compact Sample flags field useful to choose Samples to discard.

SampleDependsOn (2 bits): Specifies whether this Sample depends on another Sample.

SampleDependsOnUnknown (2 bits): Unknown whether this Sample depends on other **Samples**.

SampleDependsOnOthers (2 bits): This Sample depends on other Samples.

SampleDoesNotDependOnOthers (2 bits): This Sample does not depend on other Samples.

SampleIsDependedOn (2 bits): Specifies whether other Samples depend on this Sample.

SampleIsDependedOnUnknown (2 bits): Unknown whether other Samples depend on this **Sample**.

SampleIsNotDisposable (2 bits): Other Samples depend on this Sample.

SampleIsDisposable (2 bits): No other Samples depend on this Sample.

SampleHasRedundancy (2 bits): Specifies whether this Sample uses redundant coding.

RedundantCodingUnknown (2 bits): Unknown whether this Sample uses redundant coding.

RedundantCoding (2 bits): This Sample uses redundant coding.

NoRedundantCoding (2 bits): This Sample does not use redundant coding.

SampleIsDifferenceValue (1 bit): Specifies whether the Sample is a difference between two states.

SamplePaddingValue (3 bits): The Sample padding value, as specified in [ISOFF].

SampleDegradationPriority (2 bytes): The Sample degradation priority, as specified in [ISOFF].

The syntax of the fields defined in this section, specified in ABNF [RFC5234], is as follows:

```
ExtendedSampleFlags = 6*6 RESERVED_BIT
                    SampleDependsOn
                    SampleIsDependedOn
                    SampleHasRedundancy
                    SamplePaddingValue
                    SampleIsDifferenceValue
                    SampleDegradationPriority

SampleFlags = 2*2 RESERVED_BIT
            SampleDependsOn
            SampleIsDependedOn
            SampleHasRedundancy

SampleDependsOn = SampleDependsOnUnknown
                / SampleDependsOnOthers
                / SampleDoesNotDependsOnOthers

SampleDependsOnUnknown = %b0 %b0
```

```
SampleDependsOnOthers = %b0 %b1

SampleDoesNotDependOnOthers = %b1 %b0

SampleIsDependedOn = SampleIsDependedOnUnknown
                     / SampleIsNotDisposable
                     / SampleIsDisposable

SampleIsDependedOnUnknown = %b0 %b0

SampleIsNotDisposable = %b0 %b1

SampleIsDisposable = %b1 %b0

SampleHasRedundancy = RedundantCodingUnknown
                     / RedundantCoding
                     / NoRedundantCoding

RedundantCodingUnknown = %b0 %b0

RedundantCoding = %b0 %b1

NoRedundantCoding = %b1 %b0

SamplePaddingValue = 3*3 BIT

SampleIsDifferenceValue = BIT

SampleDegradationPriority = UNSIGNED_INT16

VendorExtensionUUIDBox = UUIDBoxLength UUIDBoxType [UUIDBoxLongLength] UUIDBoxUUID
                         UUIDBoxData

UUIDBoxType = "u" "u" "i" "d"

UUIDBoxLength = BoxLength

UUIDBoxLongLegnth = LongBoxLength

UUIDBoxUUID = UUID

UUIDBoxData = *BYTE

BoxLength = UNSIGNED_INT32

LongBoxLength = UNSIGNED_INT64

RESERVED_UNSIGNED_INT64 = %x00 %x00 %x00 %x00 %x00 %x00 %x00 %x00

UNSIGNED_INT64 = 8*8 BYTE
```

```
RESERVED_UNSIGNED_INT32 = %x00 %x00 %x00 %x00

UNSIGNED_INT32 = 4*4 BYTE

RESERVED_UNSIGNED_INT16 = %x00 %x00

UNSIGNED_INT16 = 2*2 BYTE

RESERVED_BYTE = %x00

BYTE = 8*8 BIT

RESERVED_BIT = %b0

BIT = %b0 / %b1
```
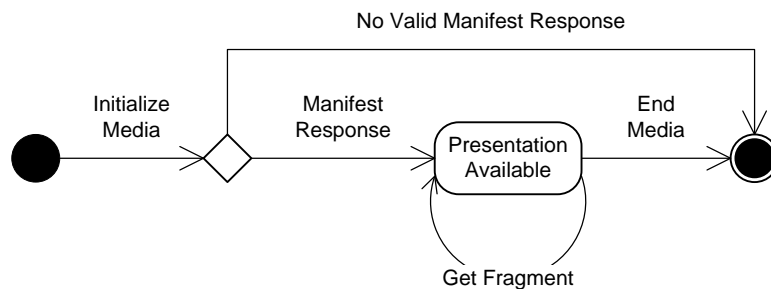
3 Protocol Details

3.1 Client Details

The **Client** acts in accordance with the following model:

3.1.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

The main data Elements that are required by any implementation are:

- Presentation Description: A hierarchical data Element that encapsulates metadata from the Presentation, as specified in section 3.1.1.1   .

- Fragment Description: Metadata and Samples for a single Fragment, as specified in section 0.

- Active Presentation: An instance of the Presentation Description data Element. This data Element is maintained as state by the Client.

- Presentation Available: A flag that indicates whether the Active Presentation has been successfully initialized. This data Element is maintained as state by the Client.

3.1.1.1 Presentation Description

The Presentation Description data Element encapsulates all metadata for the Presentation.

Presentation Metadata: A set of metadata that is common to all Streams in the Presentation. Presentation Metadata comprises the following fields, specified in section 2.2.2.1   :

- MajorVersion

- MinorVersion

- TimeScale

- Duration

Stream Collection: A collection of Stream Description data Elements, as specified in section 3.1.1.1.2 .

Protection Description: A collection of Protection System Metadata Description data Elements.

3.1.1.1.1 Protection System Metadata Description

The Protection System Metadata Description data Element encapsulates metadata specific to a single Content Protection System.

Protection Header Description: Content protection metadata that pertains to a single Content Protection System. Protection Header Description comprises the following fields, specified in section 2.2.2.2 :

- SystemID

- ProtectionHeaderContent

3.1.1.1.2 Stream Description

The Stream Description data Element encapsulates all metadata specific to a single Stream.

Stream Metadata: A set of metadata that is common to all Tracks for the Stream. Stream Metadata comprises the following fields, specified in section 2.2.2.3 :

- StreamTimeScale

- Type

- Name

- NumberOfFragments

- NumberOfTracks

- Subtype

- Url

- StreamMaxWidth

- StreamMaxHeight

- DisplayWidth

- DisplayHeight

Track Collection: A collection of Track Description data Elements, as specified in section 3.1.1.1.2.1 .

Fragment Reference Collection: An ordered collection of Fragment Reference Description data Elements, as specified in section 3.1.1.1.3 .

3.1.1.1.2.1 Track Description

The Track Description data Element encapsulates all metadata specific to a single Track.

Track Metadata: A set of metadata that is common to all Fragments for the Track. Track Metadata comprises the following fields, specified in section 2.2.2.5 :

- Index

- Bitrate

- MaxWidth

- MaxHeight

- SamplingRate

- AudioTag

- BitsPerSample

- PacketSize

- CodecPrivateData

- NALUnitLengthField

Custom Attributes Collection: A collection of Custom Attribute Description data Elements, as specified in section 3.1.1.1.2.1.1 .

3.1.1.1.2.1.1 Custom Attribute Description

The Custom Attribute Description data Element encapsulates a key/value pair that disambiguates Tracks.

Key Value Pair: A single key/value pair. Key Value Pair comprises the following fields, specified in section 2.2.2.5.1 :

- CustomAttributeName

- CustomAttributeValue

3.1.1.1.3 Fragment Reference Description

The Fragment Reference Description data Element encapsulates metadata needed to identify a Fragment in the Stream, and create a corresponding Fragment Request message.

Fragment Reference Metadata: A set of metadata that describes a set of related Fragments in all Tracks for the Stream. Fragment Reference Metadata comprises a collection of Track-Specific Fragment Reference Description data Elements, specified in section 3.1.1.1.3.1 , and the following fields, specified in section 2.2.2.6 :

- FragmentNumber

- FragmentDuration

- FragmentTime

Track-Specific Fragment Reference Collection: A collection of Track-Specific Fragment Reference Description data Elements, as specified in section 3.1.1.1.3.1 .

3.1.1.1.3.1 Track-Specific Fragment Reference Description

The Fragment Reference Description data Element encapsulates metadata needed to identify a Fragment in the Stream, and create a corresponding Fragment Request message.

Track-Specific Fragment Reference Metadata: A set of metadata that describes a set of related Fragments in all Tracks for the Stream. Fragment Reference Metadata comprises the following fields, specified in section 2.2.2.6 :

- TrackFragmentIndexAttribute

- VendorExtensionTrackFragmentAttribute

3.1.1.2 Fragment Description

The Fragment Description data element encapsulates metadata and Sample data for a single Fragment.

Fragment Metadata: A set of metadata that is common to all Samples in the Fragment. Fragment Metadata comprises the following fields:

- SequenceNumber, specified in section 2.2.4.2

- DefaultSampleDuration, specified in section 2.2.4.5

- DefaultSampleSize, specified in section 2.2.4.5

- DefaultSampleFlags, specified in section 2.2.4.5

- FirstSampleFlags, specified in section 2.2.4.6

- AlgorithmID, specified in section 2.2.4.4

- KID, specified in section 2.2.4.4

Sample Collection: A collection of Sample Description data Elements, as specified in section 3.1.1.2.1 .

3.1.1.2.1 Sample Description

The Sample Description data Element encapsulates the metadata and data for a single Sample.

Sample Metadata: A set of Attributes that pertain to the Sample. Sample Metadata comprises the following fields:

- SampleDuration, specified in section 2.2.4.6

- SampleFlags, specified in section 2.2.4.6

- SampleTime, specified in section 2.2.4.6

- SampleSize, specified in section 2.2.4.6

- SampleCompositionTimeOffset, specified in section 2.2.4.6

- InitializationVector, specified in section 2.2.4.4

- AlgorithmID, specified in section 2.2.4.4

- KID, specified in section 2.2.4.4

- Sample, specified in section 2.2.4.7

3.1.2 Timers

There are no Timers for the Client.

3.1.3 Initialization

Initialization of the Client is triggered by Open Presentation event, specified in section 3.1.4.1 . At Initialization, the Presentation Available flag is set to false.

3.1.4 Higher-Layer Triggered Events

The **Client** is driven by a higher-layer implementation that Decodes Samples for playback to the end user and uses the state of playback and end user interaction to drive Fragment Requests by the Client. The following events trigger specific behavior on the Client:

- Open Presentation, specified in section 3.1.4.1

- Get Fragment, specified in section 3.1.4.2

- Close Presentation, specified in section 0

3.1.4.1 Open Presentation

The Open Presentation event is used at the start of a viewing session. This event has no effect if the value of the Presentation Available flag is true.

The higher-layer implementation provides the following data Element:

- Presentation URI: A string whose syntax matches the syntax of the PresentationURI field, specified in section 2.2.1 .

When the Open Presentation event is triggered, the Client sends a Manifest Request message to the Server. Creation of the Manifest Request message is subject to the following rules:

- The value of the PresentationURI field in the Fragment Request is set to the value of the Presentation URI data Element.

If the processing of the Manifest Request, as specified in section 3.1.5.1 , yields a Presentation Description data Element, the Client MUST perform the following operations:

- Set the Presentation Available flag to true.

- Return the Presentation Description data Element to the higher-layer implementation.

3.1.4.2 Get Fragment

The Get Fragment event is used during the course of the viewing session. This event has no effect if when the value of the Presentation Available flag is false.

The higher-layer implementation provides the following data Elements:

- Presentation URI: A string whose syntax matches the syntax of the PresentationURI field, specified in section 2.2.1 .

- Request Stream: A Stream Description data Element for the Fragment to Request.

- Request Track: A Track Description data Element for the Fragment to Request.

- Request Fragment: A Fragment Reference Description data Element for the Fragment to Request.

When the Get Fragment event is triggered, the Client sends a Fragment Request message to the Server. Creation of the Fragment Request message is subject to the following rules:

- The value of the PresentationURI field in the Fragment Request is set to the value of the Presentation URI data Element.

- The value of the BitratePredicate field in the Fragment Request is set to the value of the Bitrate field in the Request Track data Element.

- One instance of the CustomAttributesPredicate field is created per instance of the Custom Attribute Description data Element in the Request Track data element.

- The value of the CustomAttributeKey field of each CustomAttributesPredicate field is set to the value of the CustomAttributeName field in the corresponding Custom Attributes Description data Element.

- The value of the CustomAttributeValue field of each CustomAttributesPredicate field is set to the value of the CustomAttributeValue field in the corresponding Custom Attributes Description data Element.

- The value of the StreamName field in the Fragment Request is set to the value of the Name field in the Stream Description data Element.

- The value of the Time field in the Fragment Request is set to the value of the FragmentTime field in the Request Fragment data Element.

If the processing of the Fragment Request, as specified in section 3.1.5.2 , yields a Fragment Description data Element, the Client MUST return the data Element to the higher-layer implementation.

No state change is effected when the Get Fragment event is triggered.

3.1.4.3 Close Presentation

The Close Presentation event is used at the end of a viewing session. This event has no effect if the value of the Presentation Available flag is false.

When the Close Presentation event is triggered, the Client sets the Presentation Available flag to false and enters the Final state.

3.1.5   Processing Events and Sequencing Rules

The following event processing and sequencing Rules apply:

- Manifest Request and Manifest Response, as specified in section 3.1.5.1

- Fragment Request and Fragment Response, as specified in section 3.1.5.2

- The expected Response from the Server to a Fragment Request message is a Fragment Response message. If the response received to a Fragment Request message contains a message-body [RFC2616] but is not a valid Fragment Response, the Client SHOULD return the error to the higher layer.

- The expected Response from the Server to a Manifest Request Message is a Manifest Response message. If the Response received is not a valid Manifest Response message, the Client MUST enter the Final state.

3.1.5.1   Manifest Request and Manifest Response

When a Manifest Request is sent to the server, the Client MUST wait for a Manifest Response message to arrive. If the underlying transport returns an error, the Client MUST enter the Final state.

If the underlying transport returns a Response that adheres to the syntax of the Fragment Response message, the message is processed to yield a Presentation Description, subject to the following processing rules:

- The Presentation Metadata data element is populated using data in the SmoothStreamingMedia field, as specified in section 2.2.2.1   , subject to the field mapping rules specified in section 3.1.1.1   .

- The Protection Description data element is populated using data in the ProtectionElement field, as specified in section 2.2.2.2   , subject to the field mapping rules specified in section 3.1.1.1.1   .

- The Stream Collection data element is populated by creating one Stream Description data element per instance of the StreamElement field, specified in section 2.2.2.3   .

- Each Stream Description data element is populated using data in the corresponding StreamElement field, subject to the field mapping rules specified in section 3.1.1.1.2   .

- The Track Collection data element of each Stream Description data element is populated by creating one Track Description data element per instance of the TrackElement field, specified in section 2.2.2.5   , in the corresponding StreamElement field.

- Each Track Description data element is populated using data in the corresponding TrackElement field, subject to the field mapping rules specified in section 3.1.1.1.2.1   .

- The Custom Attributes Collection data element of each Track Description data element is populated by creating one Custom Attribute Description data element per instance of the CustomAttributesElement field, specified in section 2.2.2.5.1   , in the corresponding TrackElement field.

- Each Custom Attribute Description data element is populated using data in the corresponding CustomAttributesElement field, subject to the field mapping rules specified in section 2.2.2.5.1   .

- The Fragment Reference Collection data element of each Stream Description data element is populated by creating one Fragment Reference Description data element per instance of the StreamFragmentElement field, specified in section 2.2.2.6, in the corresponding StreamElement field.

- Each Fragment Reference Description data element is populated using data in the corresponding StreamFragmentElement field, subject to the field mapping rules specified in section 3.1.1.1.3.

- The Fragment Reference Collection data element of each Stream Description data element is populated by creating one Fragment Reference Description data element per instance of the StreamFragmentElement field, specified in section 2.2.2.6, in the corresponding StreamElement field.

- Each Fragment Reference Description data element is populated using data in the corresponding StreamFragmentElement field, subject to the field mapping rules specified in section 3.1.1.1.3.

- The Track-Specific Fragment Reference Collection data element of each Fragment Reference Description data element is populated by creating one Track-Specific Fragment Reference Description data element per instance of the TrackFragmentElement field, specified in section 2.2.2.6.1, in the corresponding StreamFragmentElement field.

- Each Track-Specific Fragment Reference Description data element is populated using data in the corresponding StreamFragmentElement field, subject to the field mapping rules specified in section 3.1.1.1.3.

After the population of the Presentation Description, the following rules MUST be applied:

- If the StreamTimeScale field for any given Stream Description data element is not set, the StreamTimeScale field for that Stream Description data element is set to the value of the Duration field of the Presentation Description data element.

- If the Duration field of the Presentation Metadata data element is equal to 0, the Duration field is set to the result of the following computation:

  - For each Stream Description data element, compute a Stream Duration value by summing the Fragment Duration fields of each Fragment Reference Description data element, and dividing by the value of the StreamTimeScale field for that Stream Description data element

  - Set the Duration field by multiplying the maximum of the set of computed Stream Duration values by the value of the TimeScale field in the Presentation Metadata data element

- If the Name field of the Stream Description data element is not set, the Name element is set to the value of the Type field. If, after this operation, the Name fields of all Stream Description data elements are not unique with respect to each other, the data is considered invalid, and the Client SHOULD enter the Final state without yielding a Presentation Description data element.

- If, for any given Stream Description data element, the StreamMaxWidth field is not set, and the Type field is "video", the StreamMaxWidth field is set to the maximum of all MaxWidth fields in all TrackDescription data elements contained in the Stream Description data element.

- If, for any given Stream Description data element, the StreamMaxHeight field is not set, and the Type field is "video", the StreamMaxHeight field is set to the maximum of all MaxHeight fields in all TrackDescription data elements contained in the Stream Description data element.

- In each Stream Description data element, the Client MUST iterate through the Fragment Reference Collection in order and apply the following rules for each Fragment Reference Description data element:

- If the current Fragment Reference Description data element is the last in the collection and the value of the FragmentDuration field is not set, the data is considered invalid, and the Client MUST enter the Final state without yielding a Presentation Description data element.

- If neither of the values of the FragmentTime and FragmentDuration fields for a single Fragment Reference Description is set, the data is considered invalid, and the Client MUST enter the Final state without yielding a Presentation Description data element.

- If the current Fragment Reference Description data element is the first in the collection and the value of the FragmentTime field in the collection is not set, the value of the FragmentTime field is set to 0.

- If the value of the FragmentTime field in the current Fragment Reference Description data element is not set, the value of the FragmentTime field is set to the sum of the values of the FragmentTime and FragmentDuration fields of the preceding Fragment Reference Description data element.

- If the value of the FragmentDuration field in the current Fragment Reference Description data element is not set, the value of the FragmentDuration field is set to the value obtained by subtracting the value of the FragmentTime field from the value of the FragmentTime field in the following Fragment Reference Description data element in the collection.

- If the value of the FragmentTime field is greater than the value of the FragmentTime field in the following Fragment Reference Description data element in the collection, and the Client MUST enter the Final state without yielding a Presentation Description data element.

If the underlying transport returns a Response that does not adhere to the syntax of the Manifest Response message, the Client MUST enter the Final state without yielding a Presentation Description data element.

3.1.5.2   Fragment Request and Fragment Response

When a Fragment Request is sent to the server, the Client MUST wait for a Fragment Response message to arrive. If the underlying transport returns an error, the Client MUST enter the Final state. Processing makes use of the following variable:

Current Sample Start: The offset of the beginning of the current sample, in bytes. This value of Current Sample Start is initialized to 0.

If the underlying transport returns a Response that adheres to the syntax of the Fragment Response message, the message is processed to yield a Presentation Description, subject to the following processing rules:

- The Fragment Description data element using data in the FragmentMetadata field, as specified in section 2.2.4   , subject to the field mapping rules specified in section 3.1.1.2   .

- The Sample Collection data element is populated by creating Sample Description data element per instance of the TrunBoxPerSampleFields field, specified in section 2.2.4.6   .

- Each Sample Description data element is populated using data in the corresponding TrunBox and SampleEncryptionBox fields, specified in sections 2.2.4.6   and 2.2.4.4   respectively, subject to the field mapping rules specified in section 3.1.1.1.2   .

After the population of the Presentation Description, the following rules MUST be applied:

- If the FirstSampleFlags field of the Fragment Description is not set, the value of this field is set to the value of the DefaultSampleFlags field.

- In each Fragment Description data element, the Client MUST iterate through the Fragment Collection in order and apply the following rules for each Fragment Description data element:

  - If the current Sample Description data element is the first in the collection and the value of the SampleFlags field is not set, the value of the SampleFlags is set to the value of the FirstSampleFlags field in the Fragment Description data element.

  - If the value of the SampleDuration field of the current Sample Description data element is not set, the value is set to the value of the DefaultSampleDuration field in the Fragment Description data element.

  - If the value of the SampleSize field of the current Sample Description data element is not set, the value is set to the value of the DefaultSampleSize field in the Fragment Description data element.

If the underlying transport returns a Response that does not adhere to the syntax of the Fragment Response message, the Client MUST enter the Final state without yielding a Presentation Description data element.

3.1.6 Timer Events

There are no Timers for the Client.

3.1.7 Other Local Events

There are no additional local events for the Client.

3.2 Server Details

The Server does not maintain state and treats all arriving messages independently.

3.2.1 Abstract Data Model

This section describes a conceptual model of possible data organization that an implementation maintains to participate in this protocol. The described organization is provided to facilitate the explanation of how the protocol behaves. This document does not mandate that implementations adhere to this model as long as their external behavior is consistent with that described in this document.

The Server uses the same conceptual model as the Client, specified in section 3.1.1 .

3.2.2 Timers

There are no Timers for the Server.

3.2.3 Initialization

There is no initialization required for the IIS Smooth Streaming Transport Protocol layer. Successful initialization of the underlying transport (HTTP) is a prerequisite for successful operation of the Server.

3.2.4 Higher-Layer Triggered Events

There are no higher-layer events specific to the IIS Smooth Streaming Transport Protocol on the Server.

3.2.5 Processing Events and Sequencing Rules

The following event processing and sequencing Rules apply:

- When a valid Manifest Request message arrives, the Server MUST respond with a Manifest Response message.

- When a valid Fragment Request message arrives, the Server MUST respond with a Fragment Response message.

3.2.6 Timer Events

There are no Timers for the Server.

3.2.7 Other Local Events

There are no additional events specific to the IIS Smooth Streaming Transport Protocol on the Server.

4   Protocol Examples

The following is an example of a Manifest Response message, as specified in section 2.2.2   :

```xml
<?xml version="1.0" encoding="UTF-8"?>
<SmoothStreamingMedia MajorVersion="2" MinorVersion="0"
      Duration="2300000000" TimeScale="10000000">
   <Protection>
     <ProtectionHeader SystemID="{9A04F079-9840-4286-AB92E65BE0885F95}">
        <!-- Base 64 Encoded data omitted for clarity -->
     </ProtectionHeader>
   </Protection>


   <StreamIndex
      Type = "video"
      Chunks = "115"
      QualityLevels = "2"
      MaxWidth = "720"
      MaxHeight = "480"
      TimeScale="10000000"
      Url =
       "QualityLevels({bitrate},{CustomAttributes})/Fragments(video={start_time})"
      Name = "video"
   >
      <QualityLevel Index="0" Bitrate="1536000" FourCC="WVC1"
         MaxWidth="720" MaxHeight="480"
         CodecPrivateData =
"270000010FCBEE1670EF8A16783BF180C9089CC4AFA11C0000010E1207F840"
         >
         <CustomAttributes>
            <Attribute Name = "Compatibility" Value = "Desktop" />
         </CustomAttributes>
      </QualityLevel>


      <QualityLevel Index="5" Bitrate="307200" FourCC="WVC1"
         MaxWidth="720" MaxHeight="480"
         CodecPrivateData =
"270000010FCBEE1670EF8A16783BF180C9089CC4AFA11C0000010E1207F840">
         <CustomAttributes>
            <Attribute Name = "Compatibility" Value = "Handheld" />
         </CustomAttributes>
      </QualityLevel>


      <c t = "0" d = "19680000" />
      <c n = "1" t = "19680000" d="8980000" />

   </StreamIndex>
</SmoothStreamingMedia>
```

The following is an example of a Fragment Request message, as specified in section 2.2.3 , that could follows the above Manifest Request message in compliance with the sequencing rules specified in section 3.1.5 :

```
/PubPoint.ism/QualityLevels(307200,Compatibility=Handheld)/Fragments(video=1968000)
```

5   Security

5.1   Security Considerations for Implementers

If the content transported using this protocol has high commercial value, a Content Protection System SHOULD be used to prevent unauthorized use of the content. The ProtectionElement and SampleEncryptionBox fields can be used to carry metadata related to the use of a Content Protection System.

5.2   Index of Security Parameters

Security parameter	Section
ProtectionElement	2.2.2.2
SampleEncryptionBox	2.2.4.4

6   Appendix A: Product Behavior

The information in this specification is applicable to the following product versions:

Windows Server 2008

Windows Server 2008 R2

7 Change Tracking

Section	Tracking number (if applicable) and description	Major change (Y or N)	Revision Type