FIB

Màster en Enginyeria Informàtica (MEI)

Internet, Seguretat i Distribució de Continguts Multimèdia (ISDCM)

Colección de problemas

Transmisión de contenidos multimedia

SOLUCIONES

Curso 2024-25 Q2

Març 2025

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Preguntas Test Cierto/Falso. Indicar si las siguientes afirmaciones son ciertas o falsas.

True/False Test questions. Indicate if the following sentences are true or false.

HTML5

1. An HTML5 browser needs to be able to manage all video content formats specified in the HTML5 standard.

☐ True ☐ False

Answer: False. HTML5 specifies a limited set of video formats to use, but browsers are free to manage just a subset.

2. Apart from other features, HTML5 adds new tags with respect to HTML4 to natively manage video content.

☐ True ☐ False

Answer: True.

3. HTML5 limits the audio and video formats to be accepted.

☐ True ☐ False

Answer: True.

4. With HTML5, a web server may handle video content in any format if it is standardized.

☐ True ☐ False

Answer: False. HTML5 specifies a limited set of video formats to use.

STREAMING

1. "Continuous rendering" could be a definition of "streaming".

☐ True ☐ False

Answer: True.

2. "Multimedia that is constantly received by and presented to an end-user while being delivered" is a possible definition of "multimedia streaming".

☐ True ☐ False

Answer: True.

3. *Streaming* refers to continuous rendering of time-based content from a server to a client.

☐ True ☐ False

Answer: True.

4. There is only one protocol that allows streaming of multimedia content.

☐ True ☐ False

Answer: False. There are several protocols for both “direct” streaming or HTTP-based.

5. The RTCP protocol allows sending audio and video streams over the UDP protocol.

☐ True ☐ False

Answer: False. RTCP is only a control protocol. Streams are sent with RTP.

6. The RTCP is a control protocol that does not allow sending audio and video streams over the UDP protocol.

☐ True ☐ False

Answer: True.

7. RTP is a Client/Server protocol.

☐ True ☐ False

Answer: True.

8. RTSP is a Client/Server protocol.

☐ True ☐ False

Answer: True.

9. In order to receive a video by streaming, RTSP needs another protocol to transport the data (the video).

☐ True ☐ False

Answer: True. At least RTP or equivalent.

10. It is possible to transmit multimedia content on streaming with different qualities using the RTSP protocol.

☐ True ☐ False

Answer: False. RTSP is not a streaming protocol, but a protocol to control the streaming session.

11. RTSP is a protocol specified by the MPEG committee of ISO/IEC.

☐ True ☐ False

Answer: False. It is an Internet-based technology specified by IETF.

12. While RTSP allows managing *streaming* sessions, the RTP protocol allows sending audio and video *streams* over the UDP protocol.

☐ True ☐ False

Answer: True. We also need RTCP to control the sending process, but the sending itself is done by RTP.

13. All protocols allowing streaming of multimedia content are based on HTTP.

☐ True ☐ False

Answer: False. There are several old protocols that allow direct streaming without HTTP.

14. To provide streaming with RTP, a HTTP server is needed to deliver the content.

☐ True ☐ False

Answer: False. When RTP is used, HTTP is not doing any delivery of content.

15. RTSP is enough to receive a video through streaming.

☐ True ☐ False

Answer: False. We need at least RTP for transmission and RTCP for control.

16. An RTSP client may also interact against an HTTP server.

☐ True ☐ False

Answer: False. A Client always interacts against a Server with the same protocol. A different thing is to do streaming with HTTP.

17. RTSP se puede combinar con otros protocolos para reproducir contenido multimedia que se transmite utilizando streaming.

☐ Cierto ☐ Falso

Respuesta: Cierto. El envío del stream se puede hacer con RTP.

18. No existen protocolos para hacer streaming de contenidos multimedia basados en HTTP.

☐ Cierto ☐ Falso

Respuesta: Falso.

19. Si usamos RTSP para gestionar sesiones de streaming, necesitamos RTP para enviar streams de audio y/o vídeo sobre UDP, pero en este caso no necesitamos usar RTCP, puesto que todo el control lo hace RTSP sobre TCP.

☐ Cierto ☐ Falso

Answer: False.

20. Los protocolos de *streaming* siempre funcionan sobre UDP.

☐ Cierto ☐ Falso

Answer: False.

DASH

1. Although MPEG-DASH is better, it is possible to have adaptive multimedia *streaming* with RTSP.

☐ True ☐ False

Answer: False. Only MPEG-DASH implements adaptive streaming.

2. The DASH standard specifies, apart from other things, the file that describes the content we are going to stream over HTTP.

☐ True ☐ False

Answer: True.

3. The DASH standard specifies, apart from other things, the way clients verify the available bandwidth.

☐ True ☐ False

Answer: False. There is nothing standardized on Clients.

4. The DASH standard specifies, apart from other things, how to build URLs for the HTTP Requests.

☐ True ☐ False

Answer: True.

5. DASH only supports ISO Base Media File Format as stream.

☐ True ☐ False

Answer: False. Also MPEG-2 TS.

6. DASH only supports ISO Base Media File Format and MPEG-2 TS as stream types.

☐ True ☐ False

Answer: True.

7. DASH defines only two profiles: "On demand" and "Live".

☐ True ☐ False

Answer: False. There are 6: "On demand", "Live" and "Main" for ISO base media file format, "simple" and "main" for MPEG-2 TS, and "Full profile".

8. All DASH profiles are independent between them; i.e., they do not share any feature.

☐ True ☐ False

Answer: False. Some profiles are subsets of others.

9. The DASH standard specifies, apart from other things, how to obtain the different fragments in which the HTTP file transfer will be structured.

☐ True ☐ False

Answer: True.

10. DASH profiles are independent from the "On demand" or "Live" transmission.

☐ True ☐ False

Answer: False. It is one of the criteria to define profiles, together with the type of stream.

11. For the *streaming* over UDP we need RTP to send the audio and/or video *streams*, and RTSP to control it, but working over TCP.

☐ True ☐ False

Answer: False. We also need RTCP.

12. The DASH standard allows the DASH client to decide the structure of the *URLs* to be used by the *HTTP Requests*.

☐ True ☐ False

Answer: False. The structure is specified in the standard.

13. Some DASH profiles have not been specified by the MPEG committee.

☐ True ☐ False

Answer: True.

14. DASH sólo soporta ISO Base Media File Format como tipo de stream, pero éste puede incluir casi todos los formatos de vídeo.

☐ Cierto ☐ Falso

Respuesta: Falso. También el MPEG-2 TS es un tipo de stream soportado.

15. "On demand" o "Live" es uno de los conceptos para definir los perfiles de DASH.

☐ Cierto ☐ Falso

Respuesta: Cierto. Junto al tipo de stream.

16. DASH define exactamente cuatro perfiles: "On demand", "Main" para ISO base media file format, "Main" para MPEG-2 TS y "Full profile".

☐ Cierto ☐ Falso

Respuesta: Falso. Son 6: "On demand", "Live" y "Main" para ISO base media file format, "simple" y "main" para MPEG-2 TS y el "Full profile".

17. El estándar DASH especifica los mecanismos para construir las *URLs* que usarán los *HTTP Requests*.

☐ Cierto ☐ Falso

Respuesta: Cierto.

18. Algunos perfiles DASH son independientes entre ellos; es decir, tiene características que no comparten.

☐ Cierto ☐ Falso

Respuesta: Cierto.

19. Para el *streaming* sobre UDP sólo necesitamos RTP para enviar los *streams* de audio y/o vídeo y RTSP para hacer el control, pero funcionando sobre TCP.

☐ Cierto ☐ Falso

Answer: False. We also need RTCP.

20. El estándar DASH deja al cliente DASH decidir la estructura de las *URLs* que usarán los *HTTP Requests*.

☐ Cierto ☐ Falso

Answer: False. The structure is specified in the standard.

21. Algunos perfiles DASH no han sido especificados por el comité de MPEG.

☐ Cierto ☐ Falso

Answer: True.

Problema 1

En el Anexo II tenemos parte del esquema del estándar MPEG DASH (Dynamic Adaptive Streaming over HTTP).

Teniendo en cuenta dicho esquema y el ejemplo de MPD (instancia XML) del Anexo I,

contestar razonada y brevemente a las siguientes preguntas:

1) ¿De qué elementos consta la estructura de un MPD? ¿Cuáles aparecen en el ejemplo?

   ProgramInformation, BaseURL, Location, Period y Metrics.

   Ejemplo: BaseURL y Period.

2) ¿Cuáles de los elementos que podría tener un elemento Period aparecen en el ejemplo?

   AdaptationSet.

3) Enumerar 8 atributos que sean números enteros del elemento AdaptationSet del esquema del MPD.

   id, group, minBandwidth, maxBandwidth, minWidth, maxWidth, minHeight y maxHeight.

4) ¿Cuántos AdaptationSet hay en el ejemplo y cuál es la función de cada uno?

   3: Uno para los audios, otro para los subtítulos y otra para los vídeos.

5) ¿Cuántos atributos tiene el AdaptationSet de la línea 13? ¿Cuántos podría llegar a tener un AdaptationSet?

   5 (mimeType, codecs, lang, subsegmentAlignment, subsegmentStartsWithSAP). Los 2 primeros no aparecen en el schema. Podríamos llegar a tener 19 (ó 21 si añadiésemos los 2 que faltan).

6) ¿Qué puede significar la línea 9 del ejemplo?

   Identifica el perfil que utilizamos. "isoff-on-demand" significa "ISO File Format" (como formato, no "MPEG-2 TS") y On Demand (como modo de funcionamiento, no "Live").

7) ¿Tienen las mismas características los BaseURL de las líneas 10, 11, 16, 19, 25 y 31?

   Sí, ya que en todos los casos son del mismo tipo "BaseURL". Sin embargo, en las líneas 10 y 11 están a nivel de MPD, mientras que en el resto están dentro de un elemento "Representation".

8) Explicar qué objetos (y en qué formato y cómo están organizados) hay referenciados en el MPD ejemplo.

   Hay un total de 6 objetos en 3 AdaptationSet distintos: 2 audios, 1 XML con los subtítulos y 3 vídeos. Cada uno de los objetos está en un elemento Representation.

9) ¿Qué contenidos parecen estar protegidos en el ejemplo?

   Los Audios y los Vídeos (sus AdaptationSets), pues tienen sendos elementos ContentProtection.

10) ¿Cómo se llama el fichero de vídeo que se reproducirá si disponemos de una red a 100 Mbps para nosotros solos?

    Se reproducirá el fichero de ancho de banda máximo (la mayor calidad), pues disponemos de una red con ancho de banda superior: fichero "562465736.mp4".

Problema 2

En el Anexo III tenemos un ejemplo de MPD (instancia XML) de MPEG DASH.

Contestar razonada y brevemente a las siguientes preguntas:

1) ¿Qué perfil sigue el ejemplo?

   ISO Base Media File Format on Demand, tal como indica el atributo profiles (`profiles="urn:mpeg:dash:profile:isoff-on-demand:2011"`).

2) ¿De qué elementos consta la estructura del MPD ejemplo?

BaseURL y Period.

3) ¿Qué elementos hay en Period y qué información proporcionan?

4 AdaptationSet: 2 audios, subtítulos y vídeos.

4) ¿Cuántas Representations de audio hay? ¿Cuáles son sus BaseURL?

4. Dos en inglés y dos en francés, de diferentes calidades.

Inglés: 64000 bps = 7657412348.mp4; 32000 bps = 3463646346.mp4

Francés: 64000 bps = 3463275477.mp4; 32000 bps = 5685763463.mp4

5) De los dos idiomas del audio, ¿cuál es la versión original y cuál la versión doblada? ¿Cómo se puede deducir?

Inglés es la v.o y francés la doblada.

El Adaptation Set en francés tiene el element:
<Role schemeIdUri="urn:mpeg:dash:role:2011" value="dub"/>

6) ¿Cómo se llama el fichero de vídeo que se reproducirá si disponemos de una red a 10 Mbps para nosotros solos?

Se reproducirá el fichero de ancho de banda máximo (la mayor calidad), pues disponemos de una red con ancho de banda superior: fichero "23536745734.mp4".

Problema 3

En el Anexo III tenemos un ejemplo de MPD (instancia XML) de MPEG DASH.

Contestar razonada y brevemente a las siguientes preguntas:

1) ¿Cuánto dura el vídeo?

3256 segundos. Lo vemos en el atributo mediaPresentationDuration.

2) ¿De qué elementos consta la estructura del MPD ejemplo?

BaseURL y Period.

3) ¿Por qué el ancho de banda para el tercer `AdaptationSet` es mucho menor que el de los otros?

Porque es para subtítulos, cuyo tamaño es mucho menor que el audio o el vídeo.

4) ¿Cuántas `Representations` de vídeo hay? ¿Qué características las hacen diferentes?

Seis con diferentes calidades: bandwith y width x height.

5) ¿En qué idioma están los subtítulos? ¿Cómo se puede saber?

Alemán. El atributo lang del AdaptationSet correspondiente vale 'de'.

6) Si transmitimos un audio con el menor ancho de banda posible, ¿cómo se llama el fichero de vídeo que se reproducirá si disponemos de una red a 1 Mbps para nosotros solos?

El audio ocupa 32000, los subtítulos 256, por lo que nos quedan para el vídeo 1000000 – 32000 – 256 = 967744 bps. La Representation más cercana, por debajo, es la de 512000 bps. Por tanto, se reproducirá el fichero "56363634.mp4".

Problema 4

En el Anexo III tenemos un ejemplo de MPD (instancia XML) de MPEG DASH.

Contestar razonada y brevemente a las siguientes preguntas:

1) ¿Qué tipo de contenedor se utiliza, de los dos posibles en el estándar?

ISO Base Media File Format, pues sigue el perfil "ISO Base Media File Format on Demand", tal como indica el atributo profiles (`profiles="urn:mpeg:dash:profile:isoff-on-demand:2011"`>).

2) ¿De qué elementos consta el elemento Period de la estructura del MPD ejemplo?

AdaptationSet. Hay 4.

3) ¿Cuántas representaciones hay del audio en francés? ¿Qué diferencia hay entre ellas?

Dos, de diferentes calidades (64000 bps y 32000 bps).

4) ¿En qué formato está representada la información de subtítulos en alemán? ¿Sabemos algo del estándar de "timed text" que se sigue?

En XML. El estándar parece ser el TTML.

5) El último Adaptation Set tiene el vídeo con varias representaciones. ¿Para qué tenemos tantas representaciones? ¿En qué se diferencian? ¿Cuándo se usará cada una?

Para tener más opciones de diferente calidad para adaptarnos mejor al ancho de banda disponible.

Exercise 5

Annex IV shows an example of a MPEG-DASH MPD (XML document).

Reasoned and briefly answer the following questions:

1) How many `Period`s does this MPD specify? How much, in seconds, is its total duration? In which elements could you find this information?

1 only Period. 10 minutes = 600 seconds. It is defined in:

```
<Period start="PT0S" duration="PT0H10M0.00S">
```

Or, indirectly

```
mediaPresentationDuration="PT0H10M0.00S" in MPD element.
```

2) Identify all `AdaptationSet` and indicate its nature (MIME subtype).

One for video/mp4 and another for audio/mp4.

3) How many `Representation`s does the first `AdaptationSet` include? What are the differences between them?

4.

1. id="h264bl_low", codecs="avc1.42c00d", width="320" height="180", bandwidth="50877".

2. id="h264bl_mid", codecs="avc1.42c01e", width="640" height="360", bandwidth="194870".

3. id="h264bl_hd", codecs="avc1.42c01f", width="1280" height="720", bandwidth="514828".

4. id="h264bl_full", codecs="avc1.42c028", width="1920" height="1080", bandwidth="770699".

4) Is there any difference in the language between the 2 audio `Representation`s?

There is no information about language: lang=”und”; i.e. “undefined”.

In any case, there is no difference.

5) Which profile is used? How do you know it?

ISO Base media file format main profile.

profiles="urn:mpeg:dash:profile:isoff-main:2011"

6) Which files (provide a reference to their names) would we get if we play the first 5 minutes of the video with the maximum possible bandwidth?

30 files from "mp4-main-multi-h264bl_full-1.m4s" to "mp4-main-multi-h264bl_full-30.m4s".

7) The same as before, but now we have available 6 Mbps for our streaming during 2 and a half minutes, and then our bandwidth is reduced to 300K bps for the other 2 and a half minutes.

With 6 Mbps we could use our maximum bandwidth (770699 bps):

15 files from "mp4-main-multi-h264bl_full-1.m4s" to "mp4-main-multi-h264bl_full-15.m4s".

With 300K bps we need to change to our “mid” bandwidth (194870 bps), since the next one (“hd”) is higher than 300K bps:

15 files from "mp4-main-multi-h264bl_mid-16.m4s" to "mp4-main-multi-h264bl_mid-30.m4s".

Exercise 6

Annex V shows an example of MPD of MPEG-DASH.

Reasoned and briefly answer the following questions:

1) How long is the video? Indicate which element includes this information.

9 minutes and 56.46 seconds. It is in the attribute *mediaPresentationDuration* of the MPD root element.

2) How many different content types identifies the MPD? For every content type, indicate the options offered.

There is one only content type: video/mp4.

There are 3 options, which have the same screen size, 320x240, but different bandwidth: 46986, 91932 or 270370.

3) In which language is this content represented? Indicate in which element is it defined.

No language information. There are no audio nor subtitles, only video.

4) Which is the URL to access to the first segment of the content representation with identifier 2? Indicate on which elements and attributes its definition is based. Also indicate the URLs to access the rest of segments.

It is made by concatenation of elements. In this case we will use the *BaseURL* element and the *sourceURL* attribute of the *Initialization* element. The rest of segments are in the *media* attribute of the *SegmentURL* element.

First (initialization) segment: *http://example.com/segments/main/news300/1.m4s*

Rest: *http://example.com/segments/main/news300/**[2-4]**.m4s*

5) How many bytes has the content representation with identifier 2? How is it possible to know it in this case?

95973 (byte count starts with 0 and finishes with 95972). It is visible because the URLs are organized in byte ranges.

6) Is different the size for the case of identifier 1? If so, which one is bigger? Why?

In this case, the size is 33694 bytes. It is smaller since the quality (bandwidth) is smaller.

7) Which elements do we need to add to the MPD is we want to add content of type *audio*?

We should add a new *AdaptationSet*, including several representations.

Exercise 7

Annex IV shows an example of a MPEG-DASH MPD (XML document).

Reasoned and briefly answer the following questions:

1) How much, in seconds, is the total duration of all the periods in this MPD?

1 only Period. 10 minutes = 600 seconds. It is defined in:

```
<Period start="PT0S" duration="PT0H10M0.00S">
```

Or, indirectly

```
mediaPresentationDuration="PT0H10M0.00S" in MPD element.
```

2) How many `Representation`s does the second `AdaptationSet` include? What are the differences between them?

Two.

1. id="aaclc_low", bandwidth="19079".

2. id="aaclc_high", bandwidth="66378".

3) Is there any difference in the language between the 2 audio `Representation`s?

There is no information about language: lang="und"; i.e. "undefined".

In any case, there is no difference.

4) Which files from the second `AdaptationSet` (provide a reference to their names) would we get for the whole duration of the content described in the MPD if we take the maximum possible bandwidth for audio?

All 64 files from "mp4-main-multi-aaclc_high-1.m4s" to "mp4-main-multi-aaclc_high-64.m4s".

Exercise 8

As a reference, Annex V shows an example of a MPEG-DASH MPD (XML document) that is NOT the one related to the following questions.

Reasoned and briefly answer the following questions:

1) Provide, without inner details if there is not enough information available, a MPD instance of MPEG-DASH in which there is only one `Period` element with a duration of 9 minutes with only one `Adaptation Set` with a segment template and several representations. The segment template

element includes the initialization "`bunny_$Bandwidth$bps/BigBuckBunny_1s_init.mp4`". The profile should be the ISO Base media file format Live. The content is mp4 video.

```
<MPD xmlns="urn:mpeg:dash:schema:mpd:2011"
     …
     profiles="urn:mpeg:dash:profile:isoff-live:2011"
     mediaPresentationDuration="PT0H9M0S">

  <Period>
    <AdaptationSet …>
      <SegmentTemplate …
                    initialization="bunny_$Bandwidth$bps/BigBuckBunny_1s_init.mp4" />
      <Representation … mimeType="video/mp4" … />
      …
      <Representation … mimeType="video/mp4" … />
    </AdaptationSet>

  </Period>

</MPD>
```

2) Which attributes could be used to differentiate the characteristics of the various representations? Provide an example for an `Adaptation Set` element with 6 different `Representation` elements.

The attribute `mimeType` will be the same (`video/mp4`). The identifier should be different, but its value is not relevant. Other attributes could also be different, such as *codecs*.

The more clear attributes to distinguish representations are `width` and `height`, and `bandwidth`.

An example could be:

```
    <AdaptationSet …>

      <SegmentTemplate … />

      <Representation id="1" mimeType="video/mp4" codecs="avc1.1" width="320"
height="240" … bandwidth="46980" />
      <Representation id="2" mimeType="video/mp4" codecs="avc1.1" width="320"
height="240" … bandwidth="91917" />
      <Representation id="3" mimeType="video/mp4" codecs="avc1.2" width="854"
height="480" … bandwidth="537825" />
      <Representation id="4" mimeType="video/mp4" codecs="avc1.2" width="854"
height="480" … bandwidth="620705" />
      <Representation id="5" mimeType="video/mp4" codecs="avc1.4" width="1920"
height="1080" … bandwidth="4242923" />
      <Representation id="6" mimeType="video/mp4" codecs="avc1.4" width="1920"
height="1080" … bandwidth="4726737" />

    </AdaptationSet>
```

3) If we are sure that we will have a bandwidth of at least 1 Mbps available, is the `Adaptation Set` of your answer to question 2 suitable for this case? If not, provide another one with just 3 representations.

It is not the best option since we have a few representations with less than 1 Mbps, which are not needed. A better example could be:

```
    <AdaptationSet …>

      <SegmentTemplate … />

      <Representation id="1" mimeType="video/mp4" codecs="avc1.3" width="1280"
height="720" … bandwidth="1071529" />
      <Representation id="2" mimeType="video/mp4" codecs="avc1.4" width="1920"
height="1080" … bandwidth="4242923" />
      <Representation id="3" mimeType="video/mp4" codecs="avc1.4" width="1920"
height="1080" … bandwidth="4726737" />

    </AdaptationSet>
```

Exercise 9

Annex VI shows an example of a MPEG-DASH MPD (XML document).

Reasoned and briefly answer the following questions:

1) Which elements does this MPD contain? What is their purpose?

A `ProgramInformation` and a `Period`. The first one provides the title and an URL where to obtain more information, while the second one provides an `Adaptation Set` with a segment template and several representations.

2) How many different ways are possible to represent the nearly 10-minute's length video identified in the MPD?

20, all described in the different `Representation` provided.

3) If we only have a bandwidth of 1 Mbps, could we receive a 1280x720 video? If so, which one?

For this size, we have 4 options:

```
      <Representation id="1280x720 808.0kbps" mimeType="video/mp4" codecs="avc1.42c01f"
width="1280" height="720" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="808057" />
      <Representation id="1280x720 1.1Mbps" mimeType="video/mp4" codecs="avc1.42c01f"
width="1280" height="720" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="1071529" />
      <Representation id="1280x720 1.3Mbps" mimeType="video/mp4" codecs="avc1.42c01f"
width="1280" height="720" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="1312787" />
      <Representation id="1280x720 1.7Mbps" mimeType="video/mp4" codecs="avc1.42c01f"
width="1280" height="720" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="1662809" />
```

The bandwidth ranges from 808.057 to 1.662.809 bits. Since we only have available 1 Mbps, the first one is the only possibility.

4) What would be the size of the screen (`width x height`) if we would only had 150 000 bits for video transmission?

For 150.000 of bandwidth, the closest `Representation` is:

```
      <Representation id="320x240 135.0kbps" mimeType="video/mp4"" codecs="avc1.42c00d"
width="320" height="240" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="135410" />
```

Therefore, the size should be: 320 x 240.

Problema 10

En el Anexo V tenemos un ejemplo de MPD (instancia XML) de MPEG DASH.

Contestar razonada y brevemente las siguientes preguntas:

1) ¿Qué perfil sigue el ejemplo? ¿Dónde está indicado? Este perfil, ¿es subconjunto de algún otro perfil existente?

ISO Base Media File Format Main, tal como indica el atributo profiles (**`profiles="urn:mpeg:dash:profile:isoff-main:2011">`**).

It is a subset of the "Full profile" profile.

2) ¿Qué elementos hay en `Period`, qué información proporcionan, y qué estándares siguen los contenidos?

1 `AdaptationSet`: vídeo. MPEG-4.

3) ¿Cuántas `Representation`s de vídeo hay y en qué se diferencian? Añadir una posible `Representation` más, que sea coherente con las que ya hay.

3 de diferentes anchos de banda.

Otra `Representation` podría ser:

```
<Representation id="3" codecs="avc1" mimeType="video/mp4"
    width="320" height="240" startWithSAP="1" bandwidth="540740">
  <SegmentBase>
    <Initialization sourceURL="main/news300/1.m4s" range="0-866"/>
  </SegmentBase>
  <SegmentList duration="1">
    <SegmentURL media="main/news300/2.m4s" mediaRange="867-50000"/>
    <SegmentURL media="main/news300/3.m4s" mediaRange="50001-140000"/>
    <SegmentURL media="main/news300/4.m4s" mediaRange="140001-180000"/>
  </SegmentList>
   </Representation>
```

4) ¿Qué URLs pedirá el cliente DASH para reproducir el periodo del vídeo si disponemos de una red a 250000 bps para nosotros solos?

La representación de mayor ancho de banda no nos cabe (270370 bps), pero la segunda (`id="1"`) sí (91932 bps).

Las URLs serán:

`http://example.com/segments/main/news200/1.m4s`
`http://example.com/segments/main/news200/2.m4s`
`http://example.com/segments/main/news200/3.m4s`
`http://example.com/segments/main/news200/4.m4s`

5) Para el caso de la pregunta anterior, ¿cuántos octetos se habrán transmitido?

33694 octetos.

Exercise 11

Reasoned and briefly answer the following questions about this fragment of a DASH MPD:

```
<Period duration="PT0H2M31.85S">
  <AdaptationSet segmentAlignment="true" maxWidth="1920" maxHeight="1080"
   maxFrameRate="60" par="16:9" lang="en">
     <SegmentTemplate timescale="60"
      media="dashevc-live-2s-$RepresentationID$n$Number$.m4s"
      startNumber="1" duration="118"
      initialization="dashevc-live-2s-$RepresentationID$n.mp4"/>
     <Representation id="v3" mimeType="video/mp4"
      codecs="hvc1.1.6.L120.90" width="1280"
      height="720" frameRate="60" bandwidth="2754425">
     </Representation>
     <Representation id="v7" mimeType="video/mp4"
      codecs="hvc1.1.6.L123.90" width="1920"
      height="1080" frameRate="60" bandwidth="5481228">
     </Representation>
  </AdaptationSet>
  <AdaptationSet segmentAlignment="true" lang="fr">
     <SegmentTemplate timescale="24000"
      media="dashevc-live-2s-$RepresentationID$n$Number$.m4s"
      startNumber="1" duration="46707"
      initialization="dashevc-live-2s-$RepresentationID$n.mp4"/>
     <Representation id="a1" mimeType="audio/mp4" codecs="mp4a.40.1"
      audioSamplingRate="24000" bandwidth="129483">
```

```
      <AudioChannelConfiguration
       schemeIdUri="urn:mpeg:dash:23003:3:
       audio_channel_configuration:2011" value="2"/>
    </Representation>
  </AdaptationSet>
</Period>
```

1) How long in time is the content of this period? Where is it specified?

2 minutes and 31.85 seconds. It is in the attribute "duration" of the element "Period".

2) Which different XML elements appear in this fragment?

Period, AdaptationSet, SegmentTemplate, Representation and AudioChannelConfiguration.

3) Even though it does not appear in this fragment, which MPEG-DASH profile may follow this MPD? Why?

It looks as a "live" profile, because of the fragments' names, which include "live".

4) How many video `Representation` are specified? Which features make them different?

Two video representations with 2 different qualities: bandwidth and width x height. The "id" is also different.

5) In which language are the MPD elements? How do you know it?

The 1st AdaptationSet (video) is in English, while the audio one is in French. The values of the attribute "Lang" of the corresponding AdaptationSet are 'en' and 'fr', respectively.

6) Define an additional `Representation` element, with `id="v5"`, specifying another element of type video. Make the needed assumptions.

```
<Representation id="v5" mimeType="video/mp4" codecs="hvc1.1.6.L120.90"
 width="1280" height="720" frameRate="60" bandwidth="3710024">
</Representation>
```

7) If we have an available bandwidth of 5.500.000 bps for video and audio transmission, which are the identifiers of the Representations we are using?

```
We have 2 options for video:
   - v3 bandwidth="3710024"
   - v7 bandwidth="5481228"
And 1 for audio:
   - a1 bandwidth="129483"

Although v7 fits in 5.500.000, we also need to send audio, so we need
5.481.228+129.483=5.610.711 bps.
Therefore, we should use v3.
```

Problema 12

1) Dado el siguiente elemento "root" de un MPD, **a)** ¿Se puede usar este contenido para un servicio de "video on-demand"? **b)** ¿Cuál es el formato de los ficheros usados? **c)** ¿Cuál es el tiempo reservado para los "buffers", si existe?

```
<MPD type="static"
   xmlns="urn:mpeg:dash:schema:mpd:2011"
   profiles="urn:mpeg:dash:profile:isoff-live:2011"
   minBufferTime= "PT0.451S" mediaPresentationDuration= "PT9M32.520S">
```

a) No, since the profile is `isoff-live`; i.e., it is intended for live content, but not for on-demand content.

b) ISO Base Media File Format.

c) At least 0.451 seconds. It is specified in the attribute `minBufferTime`.

2) Dado el siguiente fragmento de un elemento de un MPD, **a)** ¿Cuál es el "content type" del "Adaptation Set"? **b)** ¿Cómo lo podemos saber? **c)** ¿Es posible tener un segundo elemento "Representation" en el "Adaptation Set"? **d)** En caso afirmativo, proporcionar un ejemplo de segundo "Representation" realizando las suposiciones necesarias con un resultado coherente. **e)** Proporcionar un ejemplo de URL para obtener un segmento de este fichero (realizar las suposiciones necesarias). **f)** Proporcionar un ejemplo de "opening tag" de un segundo "Adaptation Set" (con las suposiciones necesarias).

```
<Period duration="PT9M32.520S" start="PT0S">
   <AdaptationSet startWithSAP="2" segmentAlignment="true" id="1"
   frameRate="25" mimeType="video/mp4" >
         <BaseURL>avc3/</BaseURL>
         <SegmentTemplate timescale="1000" duration="3840"
               media="$RepresentationID$/$Number%06d$.m4s"
               initialization="1920x1080p25/IS.mp4" />
         <Representation id="1920x1080p25" codecs="avc3.640028"
               height="1080" width="1920" bandwidth="4741120" />
```

a) mp4 video.

b) Because of the `mimeType` attribute of the AdaptationSet, and the file names extensions of the segments, such as IS.mp4 or .m4s.

c) Yes, Adaptation Sets may have (and normally have) several Representations of different qualities.

d) `<Representation id="896x504p25" codecs="avc3.64001f" height="504" width="896" bandwidth="1416688" />`

It has less quality than the other one. The identifier is based on height and width.

e) `avc3/RepID/segment0.m4s`. We assume it is segment 0 and we have invented the RepresentationID.

f) `<AdaptationSet mimeType="audio/mp4" lang="en" subsegmentAlignment="true">`

Problema 13

El Anexo VII presenta un MPD de DASH.

Contestar razonada y brevemente a las siguientes preguntas:

1) **a)** ¿Qué perfil DASH y qué tipo de contenidos maneja? **b)** ¿Cuánto dura el contenido? ¿Cuántos periodos tiene? **c)** ¿El número de tramas por segundo es el mismo en todas las representaciones?

a) The profile is `isoff-live`. The content includes MP4 video and MPEG audio.

b) 10'54". There is one only Period, since the total duration and the Period duration are the same.

c) Yes. frameRate=24.

2) ¿Para los siguientes anchos de banda disponibles ("M" se refiere a "un millón") en la red ¿cuáles serían las representaciones de vídeo que recibiríamos?: **a)** 2Mbps, **b)** 4 Mbps, **c)** 5 Mbps, **d)** 10 Mbps, **e)** 4,15 Mbps.

Disponemos de los siguientes valores de ancho de banda de video:

bandwidth="1196512" (id="1"), bandwidth="1951761" (id="2"),

bandwidth="4118235" (id="3"), bandwidth="7953041" (id="4").

Por otro lado, tenemos un único ancho de banda para audio:

bandwidth="33432" (id="5").

a) El valor de id="2" cabe en 2 Mbps, incluyendo el audio.

b) El valor de id="3" no cabe en 4 Mbps, por lo que hemos de bajar al de id="2".

c) El valor de id="3" cabe en 5 Mbps, incluyendo el audio.

d) El valor de id="4" cabe en 10 Mbps, incluyendo el audio.

e) En 4,15 Mbps no cabe id="3" más audio (4118235+33432=4151667>4150000). Por tanto, nos hemos de quedar con id="2".

3) Si recibimos un fichero con nombre "ED_1280_4M_MPEG2_video_1.mp4", ¿cúales serán sus valores de `height` y `width`?

Será un fichero de la representación id="3" (sigue su SegmentTemplate), por lo que:

width="1280" height="720"

ANEXO I. Ejemplo, en XML, de MPD de MPEG DASH

```
01    <?xml version="1.0" encoding="UTF-8"?>
02    <MPD
03      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
04      xmlns="urn:mpeg:DASH:schema:MPD:2011"
05      xsi:schemaLocation="urn:mpeg:DASH:schema:MPD:2011 DASH-MPD.xsd"
06      type="static"
07      mediaPresentationDuration="PT3256S"
08      minBufferTime="PT1.2S"
09      profiles="urn:mpeg:dash:profile:isoff-on-demand:2011">

10      <BaseURL>http://cdn1.example.com/</BaseURL>
11      <BaseURL>http://cdn2.example.com/</BaseURL>

12      <Period>
          <!-- English Audio -->
13        <AdaptationSet mimeType="audio/mp4" codecs="mp4a.0x40" lang="en"
                              subsegmentAlignment="true" subsegmentStartsWithSAP="1">
14          <ContentProtection schemeIdUri="urn:uuid:706D6953-656C-5244-4D48-
                                                                  656164657221"/>
15          <Representation id="1" bandwidth="64000">
16            <BaseURL>7657412348.mp4</BaseURL>
17          </Representation>
18          <Representation id="2" bandwidth="32000">
19            <BaseURL>3463646346.mp4</BaseURL>
20          </Representation>
21        </AdaptationSet>
          <!-- Timed text -->
22        <AdaptationSet mimeType="application/ttml+xml" lang="de">
23          <Role schemeIdUri="urn:mpeg:dash:role" value="subtitle"/>
24          <Representation id="5" bandwidth="256">
25            <BaseURL>796735657.xml</BaseURL>
26          </Representation>
27        </AdaptationSet>
          <!-- Video -->
28        <AdaptationSet mimeType="video/mp4" codecs="avc1.4d0228"
                              subsegmentAlignment="true" subsegmentStartsWithSAP="2">
29          <ContentProtection schemeIdUri="urn:uuid:706D6953-656C-5244-4D48-
                                                                  656164657221"/>
30          <Representation id="6" bandwidth="256000" width="320" height="240">
31            <BaseURL>8563456473.mp4</BaseURL>
32          </Representation>
33          <Representation id="7" bandwidth="512000" width="320" height="240">
34            <BaseURL>56363634.mp4</BaseURL>
35          </Representation>
36          <Representation id="8" bandwidth="1024000" width="640" height="480">
37            <BaseURL>562465736.mp4</BaseURL>
38          </Representation>
39        </AdaptationSet>
40      </Period>
41    </MPD>
```

ANEXO II. Parte del esquema XML (XSD) de MPEG DASH

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema targetNamespace="urn:mpeg:DASH:schema:MPD:2011"
  attributeFormDefault="unqualified"
  elementFormDefault="qualified"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:xlink="http://www.w3.org/1999/xlink"
  xmlns="urn:mpeg:DASH:schema:MPD:2011">

  <xs:import namespace="http://www.w3.org/1999/xlink" schemaLocation="xlink.xsd"/>

  <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>

  <!-- MPD: main element -->
  <xs:element name="MPD" type="MPDtype"/>

  <!-- MPD Type -->
  <xs:complexType name="MPDtype">
    <xs:sequence>
      <xs:element name="ProgramInformation" type="ProgramInformationType"
                                                minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="BaseURL" type="BaseURLType"
                                                minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="Location" type="xs:anyURI"
                                                minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="Period" type="PeriodType" maxOccurs="unbounded"/>
      <xs:element name="Metrics" type="MetricsType"
                                                minOccurs="0" maxOccurs="unbounded"/>
      <xs:any namespace="##other" processContents="lax"
                                                minOccurs="0" maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="id" type="xs:string"/>
    <xs:attribute name="profiles" type="xs:string" 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="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>

…
  <!-- Period -->
  <xs:complexType name="PeriodType">
    <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="AdaptationSet" type="AdaptationSetType"
                                                minOccurs="0" maxOccurs="unbounded"/>
      <xs:element name="Subset" type="SubsetType" 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 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>

  <!-- Adaptation Set -->
  <xs:complexType name="AdaptationSetType">
    <xs:complexContent>
      <xs:extension base="RepresentationBaseType">
        <xs:sequence>
          <xs:element name="Accessibility" type="DescriptorType"
                                                minOccurs="0" maxOccurs="unbounded"/>
          <xs:element name="Role" type="DescriptorType"
                                                minOccurs="0" maxOccurs="unbounded"/>
          <xs:element name="Rating" type="DescriptorType"
                                                minOccurs="0" maxOccurs="unbounded"/>
          <xs:element name="Viewpoint" type="DescriptorType"
                                                minOccurs="0" maxOccurs="unbounded"/>
          <xs:element name="ContentComponent" type="ContentComponentType"
                                                minOccurs="0" maxOccurs="unbounded"/>
          <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="Representation" type="RepresentationType"
                                                minOccurs="0" maxOccurs="unbounded"/>
        </xs:sequence>
        <xs:attribute ref="xlink:href"/>
        <xs:attribute ref="xlink:actuate" default="onRequest"/>
        <xs:attribute name="id" type="xs:unsignedInt"/>
        <xs:attribute name="group" type="xs:unsignedInt"/>
        <xs:attribute name="lang" type="xs:language"/>
        <xs:attribute name="contentType" type="xs:string"/>
        <xs:attribute name="par" type="RatioType"/>
        <xs:attribute name="minBandwidth" type="xs:unsignedInt"/>
        <xs:attribute name="maxBandwidth" type="xs:unsignedInt"/>
        <xs:attribute name="minWidth" type="xs:unsignedInt"/>
        <xs:attribute name="maxWidth" type="xs:unsignedInt"/>
        <xs:attribute name="minHeight" type="xs:unsignedInt"/>
        <xs:attribute name="maxHeight" type="xs:unsignedInt"/>
        <xs:attribute name="minFrameRate" type="FrameRateType"/>
        <xs:attribute name="maxFrameRate" type="FrameRateType"/>
        <xs:attribute name="segmentAlignment" type="ConditionalUintType"
                                                              default="false"/>
        <xs:attribute name="subsegmentAlignment" type="ConditionalUintType"
                                                              default="false"/>
        <xs:attribute name="subsegmentStartsWithSAP" type="SAPType" default="0"/>
        <xs:attribute name="bitstreamSwitching" type="xs:boolean"/>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>

…

  <!-- Representation -->
  <xs:complexType name="RepresentationType">
    <xs:complexContent>
      <xs:extension base="RepresentationBaseType">
        <xs:sequence>
          <xs:element name="BaseURL" type="BaseURLType"
                                                minOccurs="0" maxOccurs="unbounded"/>
```

```
          <xs:element name="SubRepresentation" type="SubRepresentationType"
                                                  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:sequence>
        <xs:attribute name="id" type="StringNoWhitespaceType" use="required"/>
        <xs:attribute name="bandwidth" type="xs:unsignedInt" use="required"/>
        <xs:attribute name="qualityRanking" type="xs:unsignedInt"/>
        <xs:attribute name="dependencyId" type="StringVectorType"/>
        <xs:attribute name="mediaStreamStructureId" type="StringVectorType"/>
      </xs:extension>
    </xs:complexContent>
  </xs:complexType>

…

</xs:schema>
```

ANEXO III. Ejemplo de MPD MPEG-DASH

```
<?xml version="1.0" encoding="UTF-8"?>
<MPD
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns="urn:mpeg:dash:schema:mpd:2011"
  xsi:schemaLocation="urn:mpeg:dash:schema:mpd:2011 DASH-MPD.xsd"
  type="static"
  mediaPresentationDuration="PT3256S"
  minBufferTime="PT1.2S"
  profiles="urn:mpeg:dash:profile:isoff-on-demand:2011">

  <BaseURL>http://cdn1.example.com/</BaseURL>
  <BaseURL>http://cdn2.example.com/</BaseURL>

  <Period>
    <!-- English Audio -->
    <AdaptationSet mimeType="audio/mp4" codecs="mp4a.40" lang="en"
subsegmentAlignment="true" subsegmentStartsWithSAP="1">
      <ContentProtection schemeIdUri="urn:uuid:706D6953-656C-5244-4D48-656164657221"/>
      <Representation id="1" bandwidth="64000">
        <BaseURL>7657412348.mp4</BaseURL>
      </Representation>
      <Representation id="2" bandwidth="32000">
        <BaseURL>3463646346.mp4</BaseURL>
      </Representation>
    </AdaptationSet>
    <!-- French Audio -->
    <AdaptationSet mimeType="audio/mp4" codecs="mp4a.40.2" lang="fr"
subsegmentAlignment="true" subsegmentStartsWithSAP="1">
      <ContentProtection schemeIdUri="urn:uuid:706D6953-656C-5244-4D48-656164657221"/>
      <Role schemeIdUri="urn:mpeg:dash:role:2011" value="dub"/>
      <Representation id="3" bandwidth="64000">
        <BaseURL>3463275477.mp4</BaseURL>
      </Representation>
      <Representation id="4" bandwidth="32000">
        <BaseURL>5685763463.mp4</BaseURL>
      </Representation>
    </AdaptationSet>
```

```
    <!-- Timed text -->
    <AdaptationSet mimeType="application/ttml+xml" lang="de">
      <Role schemeIdUri="urn:mpeg:dash:role" value="subtitle"/>
      <Representation id="5" bandwidth="256">
        <BaseURL>796735657.xml</BaseURL>
      </Representation>
    </AdaptationSet>
    <!-- Video -->
    <AdaptationSet mimeType="video/mp4" codecs="avc1.4d0228" subsegmentAlignment="true"
subsegmentStartsWithSAP="2">
      <ContentProtection schemeIdUri="urn:uuid:706D6953-656C-5244-4D48-656164657221"/>
      <Representation id="6" bandwidth="256000" width="320" height="240">
        <BaseURL>8563456473.mp4</BaseURL>
      </Representation>
      <Representation id="7" bandwidth="512000" width="320" height="240">
        <BaseURL>56363634.mp4</BaseURL>
      </Representation>
      <Representation id="8" bandwidth="1024000" width="640" height="480">
        <BaseURL>562465736.mp4</BaseURL>
      </Representation>
      <Representation id="9" bandwidth="1384000" width="640" height="480">
        <BaseURL>41325645.mp4</BaseURL>
      </Representation>
      <Representation id="A" bandwidth="1536000" width="1280" height="720">
        <BaseURL>89045625.mp4</BaseURL>
      </Representation>
      <Representation id="B" bandwidth="2048000" width="1280" height="720">
        <BaseURL>23536745734.mp4</BaseURL>
      </Representation>
    </AdaptationSet>
  </Period>
</MPD>
```

ANNEX IV. MPEG-DASH MPD example

(http://www.digitalprimates.net/dash/streams/gpac/mp4-main-multi-mpd-AV-NBS.mpd)

```
<?xml version="1.0"?>
<MPD type="static" xmlns="urn:mpeg:DASH:schema:MPD:2011" minBufferTime="PT1.5S"
mediaPresentationDuration="PT0H10M0.00S" profiles="urn:mpeg:dash:profile:isoff-
main:2011">
 <ProgramInformation moreInformationURL="http://gpac.sourceforge.net">
  <Title>mp4-main-multi-mpd-AV-NBS.mpd generated by GPAC</Title>
  <Copyright>TelecomParisTech(c)2012</Copyright>
 </ProgramInformation>
 <Period start="PT0S" duration="PT0H10M0.00S">
  <AdaptationSet segmentAlignment="true" maxWidth="1920" maxHeight="1080"
maxFrameRate="25" par="16:9">
   <ContentComponent id="1" contentType="video"/>

   <Representation id="h264bl_low" mimeType="video/mp4" codecs="avc1.42c00d"
width="320" height="180" frameRate="25" sar="1:1" startWithSAP="1" bandwidth="50877">
    <SegmentList timescale="1000" duration="10000">
     <Initialization sourceURL="mp4-main-multi-h264bl_low-.mp4"/>
    <SegmentURL media="mp4-main-multi-h264bl_low-1.m4s"/>
    … SIMILAR ELEMENTS WITH TERMINATIONS OF FILE NAMES "2" TO "59" …
    <SegmentURL media="mp4-main-multi-h264bl_low-60.m4s"/>
    </SegmentList>
   </Representation>
```

```
   <Representation id="h264bl_mid" mimeType="video/mp4" codecs="avc1.42c01e"
width="640" height="360" frameRate="25" sar="1:1" startWithSAP="1" bandwidth="194870">
    <SegmentList timescale="1000" duration="10000">
     <Initialization sourceURL="mp4-main-multi-h264bl_mid-.mp4"/>
    <SegmentURL media="mp4-main-multi-h264bl_mid-1.m4s"/>
    … SIMILAR ELEMENTS WITH TERMINATIONS OF FILE NAMES "2" TO "59" …
    <SegmentURL media="mp4-main-multi-h264bl_mid-60.m4s"/>
    </SegmentList>
   </Representation>

   <Representation id="h264bl_hd" mimeType="video/mp4" codecs="avc1.42c01f"
width="1280" height="720" frameRate="25" sar="1:1" startWithSAP="1" bandwidth="514828">
    <SegmentList timescale="1000" duration="10000">
     <Initialization sourceURL="mp4-main-multi-h264bl_hd-.mp4"/>
    <SegmentURL media="mp4-main-multi-h264bl_hd-1.m4s"/>
    … SIMILAR ELEMENTS WITH TERMINATIONS OF FILE NAMES "2" TO "59" …
    <SegmentURL media="mp4-main-multi-h264bl_hd-60.m4s"/>
    </SegmentList>
   </Representation>

   <Representation id="h264bl_full" mimeType="video/mp4" codecs="avc1.42c028"
width="1920" height="1080" frameRate="25" sar="1:1" startWithSAP="1"
bandwidth="770699">
    <SegmentList timescale="1000" duration="10000">
     <Initialization sourceURL="mp4-main-multi-h264bl_full-.mp4"/>
    <SegmentURL media="mp4-main-multi-h264bl_full-1.m4s"/>
    … SIMILAR ELEMENTS WITH TERMINATIONS OF FILE NAMES "2" TO "59" …
    <SegmentURL media="mp4-main-multi-h264bl_full-60.m4s"/>
    </SegmentList>
   </Representation>

  </AdaptationSet>

<AdaptationSet segmentAlignment="true" lang="und">
   <ContentComponent id="1" contentType="audio" lang="und"/>

   <Representation id="aaclc_low" mimeType="audio/mp4" codecs="mp4a.40.2"
audioSamplingRate="44100" lang="und" startWithSAP="1" bandwidth="19079">
    <AudioChannelConfiguration
schemeIdUri="urn:mpeg:dash:23003:3:audio_channel_configuration:2011" value="1"/>
    <SegmentList timescale="1000" duration="9520">
     <Initialization sourceURL="mp4-main-multi-aaclc_low-.mp4"/>
    <SegmentURL media="mp4-main-multi-aaclc_low-1.m4s"/>
    … SIMILAR ELEMENTS WITH TERMINATIONS OF FILE NAMES "2" TO "63" …
    <SegmentURL media="mp4-main-multi-aaclc_low-64.m4s"/>
    </SegmentList>
   </Representation>

   <Representation id="aaclc_high" mimeType="audio/mp4" codecs="mp4a.40.2"
audioSamplingRate="44100" lang="und" startWithSAP="1" bandwidth="66378">
    <AudioChannelConfiguration
schemeIdUri="urn:mpeg:dash:23003:3:audio_channel_configuration:2011" value="1"/>
    <SegmentList timescale="1000" duration="9520">
     <Initialization sourceURL="mp4-main-multi-aaclc_high-.mp4"/>
    <SegmentURL media="mp4-main-multi-aaclc_high-1.m4s"/>
    … SIMILAR ELEMENTS WITH TERMINATIONS OF FILE NAMES "2" TO "63" …
    <SegmentURL media="mp4-main-multi-aaclc_high-64.m4s"/>
    </SegmentList>
   </Representation>

  </AdaptationSet>
 </Period>
</MPD>
```

ANNEX V. Example of a MPD (MPEG-DASH)

(https://developer.mozilla.org/en-US/Apps/Fundamentals/Audio_and_video_delivery/Setting_up_adaptive_streaming_media_sources)

```
<MPD xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
     xmlns="urn:mpeg:DASH:schema:MPD:2011"
     xsi:schemaLocation="urn:mpeg:DASH:schema:MPD:2011"
     profiles="urn:mpeg:dash:profile:isoff-main:2011"
     type="static" mediaPresentationDuration="PT0H9M56.46S">

    <BaseURL>
      http://example.com/segments
    </BaseURL>

    <Period start="PT0S">
      <AdaptationSet bitstreamSwitching="true">

        <Representation id="0" codecs="avc1" mimeType="video/mp4"
            width="320" height="240" startWithSAP="1" bandwidth="46986">
          <SegmentBase>
            <Initialization sourceURL="main/news100/1.m4s" range="0-862"/>
          </SegmentBase>
          <SegmentList duration="1">
            <SegmentURL media="main/news100/2.m4s" mediaRange="863-7113"/>
            <SegmentURL media="main/news100/3.m4s" mediaRange="7114-14104"/>
            <SegmentURL media="main/news100/4.m4s" mediaRange="14105-17990"/>
          </SegmentList>
        </Representation>

        <Representation id="1" codecs="avc1" mimeType="video/mp4"
            width="320" height="240" startWithSAP="1" bandwidth="91932">
          <SegmentBase>
            <Initialization sourceURL="main/news200/1.m4s" range="0-864"/>
          </SegmentBase>
          <SegmentList duration="1">
            <SegmentURL media="main/news200/2.m4s" mediaRange="865-11523"/>
            <SegmentURL media="main/news200/3.m4s" mediaRange="11524-25621"/>
            <SegmentURL media="main/news200/4.m4s" mediaRange="25622-33693"/>
          </SegmentList>
        </Representation>

        <Representation id="2" codecs="avc1" mimeType="video/mp4"
            width="320" height="240" startWithSAP="1" bandwidth="270370">
          <SegmentBase>
            <Initialization sourceURL="main/news300/1.m4s" range="0-865"/>
          </SegmentBase>
          <SegmentList duration="1">
            <SegmentURL media="main/news300/2.m4s" mediaRange="866-26970"/>
            <SegmentURL media="main/news300/3.m4s" mediaRange="26971-72543"/>
            <SegmentURL media="main/news300/4.m4s" mediaRange="72544-95972"/>
          </SegmentList>
        </Representation>
      </AdaptationSet>
    </Period>
</MPD>
```

ANNEX VI. Example of MPEG-DASH MPD

(http://www-itec.uni-klu.ac.at/ftp/datasets/DASHDataset2014/BigBuckBunny/1sec/BigBuckBunny_1s_simple_2014_05_09.mpd)

```
<?xml version="1.0" encoding="UTF-8"?>

<MPD xmlns="urn:mpeg:dash:schema:mpd:2011" minBufferTime="PT1.500000S" type="static"
mediaPresentationDuration="PT0H9M55.46S" profiles="urn:mpeg:dash:profile:isoff-
live:2011">

  <ProgramInformation moreInformationURL="http://gpac.sourceforge.net">
    <Title>dashed/BigBuckBunny_1s_simple_2014_05_09.mpd generated by GPAC</Title>
  </ProgramInformation>

  <Period duration="PT0H9M55.46S">
    <AdaptationSet segmentAlignment="true" group="1" maxWidth="480" maxHeight="360"
       maxFrameRate="24" par="4:3">

      <SegmentTemplate timescale="96"
        media="bunny_$Bandwidth$bps/BigBuckBunny_1s$Number$.m4s" startNumber="1"
        duration="96" initialization="bunny_$Bandwidth$bps/BigBuckBunny_1s_init.mp4" />

      <Representation id="320x240 47.0kbps" mimeType="video/mp4" codecs="avc1.42c00d"
width="320" height="240" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="46980" />
      <Representation id="320x240 92.0kbps" mimeType="video/mp4" codecs="avc1.42c00d"
width="320" height="240" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="91917" />
      <Representation id="320x240 135.0kbps" mimeType="video/mp4"" codecs="avc1.42c00d"
width="320" height="240" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="135410" />
      <Representation id="480x360 182.0kbps" mimeType="video/mp4"" codecs="avc1.42c015"
width="480" height="360" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="182366" />
      <Representation id="480x360 226.0kbps" mimeType="video/mp4"" codecs="avc1.42c015"
width="480" height="360" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="226106" />
      <Representation id="480x360 270.0kbps" mimeType="video/mp4"" codecs="avc1.42c015"
width="480" height="360" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="270316" />
      <Representation id="480x360 353.0kbps" mimeType="video/mp4" codecs="avc1.42c015"
width="480" height="360" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="352546" />
      <Representation id="480x360 425.0kbps" mimeType="video/mp4" codecs="avc1.42c015"
width="480" height="360" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="424520" />
      <Representation id="854x480 538.0kbps" mimeType="video/mp4" codecs="avc1.42c01e"
width="854" height="480" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="537825" />
      <Representation id="854x480 621.0kbps" mimeType="video/mp4" codecs="avc1.42c01e"
width="854" height="480" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="620705" />
      <Representation id="1280x720 808.0kbps" mimeType="video/mp4" codecs="avc1.42c01f"
width="1280" height="720" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="808057" />
      <Representation id="1280x720 1.1Mbps" mimeType="video/mp4" codecs="avc1.42c01f"
width="1280" height="720" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="1071529" />
      <Representation id="1280x720 1.3Mbps" mimeType="video/mp4" codecs="avc1.42c01f"
width="1280" height="720" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="1312787" />
      <Representation id="1280x720 1.7Mbps" mimeType="video/mp4" codecs="avc1.42c01f"
width="1280" height="720" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="1662809" />
      <Representation id="1920x1080 2.2Mbps" mimeType="video/mp4" codecs="avc1.42c032"
width="1920" height="1080" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="2234145" />
      <Representation id="1920x1080 2.6Mbps" mimeType="video/mp4" codecs="avc1.42c032"
width="1920" height="1080" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="2617284" />
      <Representation id="1920x1080 3.3Mbps" mimeType="video/mp4" codecs="avc1.42c032"
width="1920" height="1080" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="3305118" />
      <Representation id="1920x1080 3.8Mbps" mimeType="video/mp4" codecs="avc1.42c032"
width="1920" height="1080" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="3841983" />
      <Representation id="1920x1080 4.2Mbps" mimeType="video/mp4" codecs="avc1.42c032"
width="1920" height="1080" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="4242923" />
      <Representation id="1920x1080 4.7Mbps" mimeType="video/mp4" codecs="avc1.42c032"
width="1920" height="1080" frameRate="24" sar="1:1" startWithSAP="1" bandwidth="4726737" />

    </AdaptationSet>

  </Period>

</MPD>
```

ANEXO VII. Ejemplo de MPD de MPEG-DASH

(https://dash.akamaized.net/dash264/TestCasesHD/2b/qualcomm/1/MultiResMPEG2.mpd)

```
<?xml version="1.0" encoding="utf-8"?>
<MPD xmlns="urn:mpeg:dash:schema:mpd:2011" minBufferTime="PT1.500000S"
     mediaPresentationDuration="PT0H10M54.00S"
     profiles="urn:mpeg:dash:profile:isoff-live:2011">

 <Period id="" duration="PT0H10M54.00S">

   <AdaptationSet segmentAlignment="true" maxWidth="1920" maxHeight="1080"
                  maxFrameRate="24" par="16:9">

     <Representation id="1" mimeType="video/mp4" width="512" height="288"
                     frameRate="24" bandwidth="1196512">
       <SegmentTemplate media="ED_512_640K_MPEG2_video_$Number$.mp4" startNumber="1"
                        initialization="ED_512_640K_MPEG2_video_init.mp4" />
     </Representation>

     <Representation id="2" mimeType="video/mp4" width="768" height="432"
                     frameRate="24" bandwidth="1951761">
       <SegmentTemplate media="ED_768_1440K_MPEG2_video_$Number$.mp4" startNumber="1"
                        initialization="ED_768_1440K_MPEG2_video_init.mp4" />
     </Representation>

     <Representation id="3" mimeType="video/mp4" width="1280" height="720"
                     frameRate="24" bandwidth="4118235">
       <SegmentTemplate media="ED_1280_4M_MPEG2_video_$Number$.mp4" startNumber="1"
                        initialization="ED_1280_4M_MPEG2_video_init.mp4" />
     </Representation>

     <Representation id="4" mimeType="video/mp4" width="1920" height="1080"
                     frameRate="24" bandwidth="7953041">
       <SegmentTemplate media="ED_1920_8M_MPEG2_video_$Number$.mp4" startNumber="1"
                        initialization="ED_1920_8M_MPEG2_video_init.mp4" />
     </Representation>

   </AdaptationSet>

   <AdaptationSet segmentAlignment="true">

     <Representation id="5" mimeType="audio/mp4" audioSamplingRate="48000"
                     bandwidth="33432">
       <AudioChannelConfiguration
             schemeIdUri="urn:mpeg:dash:23003:3:audio_channel_configuration:2011"
             value="2" />
       <SegmentTemplate media="ED_MPEG2_32k_$Number$.mp4" startNumber="1"
                        initialization="ED_MPEG2_32k_init.mp4" />
     </Representation>

   </AdaptationSet>

 </Period>

</MPD>
```