The 'haptics' Top-level Media Type

Abstract

This memo serves to register and document the 'haptics' top-level
media type, under which subtypes for representation formats for
haptics may be registered. This document also serves as a
registration application for a set of intended subtypes, which are
representative of some existing subtypes already in use.

Status of This Memo

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Table of Contents

1. Introduction

The term 'haptics' refers to the generation of touch-related
sensations in a device or interface. Haptics is widely used in
consumer devices in order to provide touch-based feedback to users.
The most common use of haptics is in mobile devices, where it is
used to provide feedback to users interacting with the touchscreen,
e.g., typing on a virtual keyboard. Haptic technologies are unlike
audio and visual enabling technologies in the sense that they
require some form of actuation in order to create a tactile
sensation. For mobile phones and game controllers, these actuators
are typically small vibrating motors. For large touchscreens in
vehicles, these actuators can be specialized piezoelectric
materials. Haptic capabilities are found in nearly every modern
smartphone and game and virtual reality controller, making these
devices an ideal target for enhanced media experiences.

Internet Media Types [RFC6838] are used to label content carried
over Internet protocols. This document defines a new top-level type
'haptics' according to Section 4.2.7 of [RFC6838]. This top-level
type indicates that the content specifies haptic data. Under this
top-level type, different representation formats of haptics may be
registered.

1.1. Terminology

The keywords **MUST**, **MUST NOT**, **REQUIRED**, **SHALL**, **SHALL NOT**, **SHOULD**,**SHOULD NOT**, **RECOMMENDED**, **NOT RECOMMENDED**, **MAY**, and **OPTIONAL** in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. Background and Justification

Haptic signals provide an additional layer of entertainment and sensory immersion for the user. Haptic tracks, in separate files, can be combined with audio/video files and played back in sync to provide an overall immersive media experience (audio, visual, tactile) for the user. More recently, haptic tracks embedded in standard file formats such as ISOBMFF (ISO Base Media File Format), enable playback of the haptic signals over one or more actuators, simultaneously with audio and video playback. Haptic signals are also part of media streams that use RTP, such as those for streaming games, XR, and wearables.

2.1. MPEG ISOBMFF

Historically, there has not been a registration of formats for haptics. However, haptics has been proposed as a first-order media type (at the same level as audio and video) in ISOBMFF. This proposal was made to the MPEG Systems File Format sub-group in April 2020. The proposal was accepted, has since progressed to International Standard, and was published in January 2022 [ISOBMFF-IS]. Haptics is officially part of the ISO/IEC 14496-12 (ISOBMFF) standard, 7th Edition. Given this development, a strong case can be made for haptics to be added to the list of top-level media types recognized by the IETF.

We envision the following designations for haptics in mp4 files, once the top-level type 'haptics' is registered:

1. 'haptics/mp4' - mp4 files with just haptic tracks and no audio or video in them (e.g., streaming games, haptics files for haptic vests, belts, gloves, etc.)

2. 'video/mp4' - mp4 files with video, audio, and haptics (to ensure consistency with existing mp4 files with video content)

3. 'audio/mp4' - mp4 files with audio and haptics (to ensure consistency with existing mp4 files with audio content without any video)

2.2. Haptic Sub-modalities

There are multiple sub-modalities of haptics:

   *Vibrotactile (touch, vibration)

   *Kinesthetic (force feedback)

   *Surface (surface friction)

   *Spatial, non-contact (ultrasound)

   *Thermal (temperature)

Therefore, designating 'haptics' as a top-level media type would
enable the definition of data formats pertaining to these sub-
modalities in a more streamlined manner. This would not be possible
if 'haptics' were to be placed under other top-level types like
'audio', 'video', or 'application'.

2.3. Another Human Sense

The top-level media type 'audio' pertains to the human sense of
hearing, the top-level media type 'video' pertains to the human
sense of seeing, so it only makes sense for the (equally important)
human sense of touch to be represented by another top-level media
type 'haptics'. Placing 'haptics' under 'audio' or 'video' is not
reflective of the kinds of files or use cases that would need
haptics but have nothing whatsoever to do with audio or video.

2.4. Commercial Uptake

Haptics is rapidly becoming a standard feature of consumer
electronic devices. For example:

  *iPhone (206+ million units sold in 2020): native support for
   haptic encoded data

  *Android (1.38+ billion units sold in 2020): API support of haptic
   buffers

  *W3C (HTML vibration API [W3C-Vibration]): Optionally supported in
   mobile web browsers. W3C has also defined vibration extensions
   for gamepads [W3C-Gamepad]

  *Game consoles (39+ million units sold in 2019): MS Xbox, Sony
   PlayStation, Nintendo Switch, etc.

  *XR devices (9+ million units sold in 2019): OpenXR haptic API

Haptic media is expected to be commonly exchanged between these
devices. Since they represent the majority of CE devices, a strong
case can be made for 'haptics' as a top-level media type.

2.5. Haptic Data Formats in Use

There are multiple instances of existing haptic data formats that
would live as sub-types under the proposed 'haptics' top-level media
type. While these subtypes have *not* been registered with IANA or
standardized (yet), the prevalence of these haptic data formats in a
large number of devices around the world, pre-dating the
standardization of haptic tracks in ISOBMFF, provides a compelling
argument for 'haptics' to be designated as a top-level media type:

  *'ahap': The AHAP haptic data format [AHAP] is currently the
   standard encoding on all iOS devices + iOS connected game
   peripherals. The format has seen usage and adoption beyond Apple
   devices as well, with decoders available for Android and other XR
   systems.

  *'ogg': Google has introduced a proprietary extension to the OGG
   format in the latest version of Android 11. This encoding enables
   haptic media to be stored in OGG files.

  *'ivs': The IVS haptic data format is currently a vendor-specific
   format that is in use:

     -In mobile phones from LG Electronics (specifically, the models
      V30, V40, and the newest V50) that are sold worldwide

     -In gaming phones from ASUS (specifically, models ROG, ROG
       Phone II, ROG Phone 3) that are sold worldwide

  *'hapt': The HAPT haptic data format is currently a vendor-
   specific format that is in use:

     -In mobile haptic advertising (for W3C devices)

     -The following Japanese game developers use the HAPT format as
       part of Immersion's TouchSense SDK:

         oKLAB: https://www.klab.com/en/

         oCraft&Meister: http://www.crafts-meister.co.jp/pc/
          company_en.html

     -Tencent is using the TouchSense SDK for their popular social
       media application QQ and live streaming application NOW:
       Immersion-Announces-Tencent-Licenses-TouchSense-Technology-
       Deliver

Given the widespread use of these subtypes, it makes sense for 'haptics' to be a top-level media type.

2.6. Haptic Subtypes (envisioned standards)

The MPEG ISOBMFF proposal included an informative annex of known haptic coding formats with proposed FourCC codes for them. These codes are not registered yet, but the plan is indeed to standardize these haptic coding formats in the near future. Once standardized, they will also live as subtypes under the proposed 'haptics' top-level media type:

  *'hmpg': the MPEG-I haptics binary coding format described in the Committee Draft of ISO/IEC 23090-31: Haptics Coding [MPEG-Haptics-Coding]

  *'hjif': the MPEG-I haptics JSON-based interchange format described in the Committee Draft of ISO/IEC 23090-31: Haptics Coding [MPEG-Haptics-Coding]

  *'mihs': the MPEG-I haptics streaming format described in the Committee Draft of ISO/IEC 23090-31: Haptics Coding [MPEG-Haptics-Coding]

  *'hiee': IEEE P1918.1.1 vibrotactile coding standard [IEEE-P191811] being developed under the IEEE Tactile Internet initiative as part of the 5G URLL profile

  *'henm': enumerated effects haptic coding format (based on MIDI)

  *'havc': audio-to-vibe haptic coding format (automatic audio to vibration conversion algorithms)

2.7. 'application' top-level type not suitable

From the above arguments, it is clear that haptics does not really belong under any other media type. To reiterate, there are three main reasons why the 'haptics' media type does not fit under the 'application' top-level type:

  *haptics connects to a sensory system, touch/motion, directly, and is more specific than the abstract 'application' type, and

  *'application' has historically been used for applications, i.e., code, which means it is viewed and treated with great care for security. 'haptics' is not code, just as 'audio' and 'video' are not code either.

  *haptics is a property of a media stream, it is not an application under any normal definition. As such, it should be its own type.

3. Security Considerations

Haptics are interpreted data structures that represent collections
of different media rendering instructions intended to be decoded and
rendered on target device hardware. Haptic data can be represented
as collections of signal data and/or descriptive text in XML/JSON or
similar format. Signal data is typically not executed by endpoint
processors and represents minimal security risk. Descriptive text is
typically parsed and represented in memory using standard XML data
structures. This data is utilized to construct one or more signals
that are sent to the endpoint device hardware.

Because of the media/rendering nature of the data path for haptic
coded data the security profile of haptic data is expected to be
largely consistent with the security profile of visual and audio
media data.

As with any synthesized media data (audio, video, and haptics),
there is a security risk associated with execution of commands based
on the descriptive encoding either through its inherent
extensibility or through the insertion of arbitrary executable data
in the descriptive format itself. Indeed, media rendering systems
are normally implemented with a mix of user and kernel space
execution since these media must ultimately make their way to a
hardware system. In theory, malicious instructions present in
descriptive haptic media have the potential to execute arbitrary
code in kernel space, effectively bypassing system permissions
structures and/or execution sandboxes.

Haptics, audio, and video media have widespread use and careful
attention should be paid by operating system and device driver
implementors to ensure that synthesis and rendering signal paths do
not provide attack surfaces for malicious payloads. Ultimately, any
coded representation of haptic media is insufficient to implicitly
provide sufficient security and this protection should be enforced
by the operating system implementor.

These security considerations apply to the subtype registrations
described in this document as well as all future haptics
registrations.

4. IANA Considerations

This specification registers a new top-level type, 'haptics', in the
standards tree, adds it as an alternative value of "Type Name" in
the media types registration form [Media-Type-Registration], and
registers several subtypes for it.

4.1. Definition and Encoding

'haptics' as the primary media content type indicates that the
content identified by it requires a certain haptics subsystem such
as low-level haptics APIs, which in turn will require hardware
capabilities such as one or more actuators to render the haptics
media. The 'haptics' media type does not provide any specific
information about the underlying data format and how the haptics
information should be interpreted -- the subtypes defined within a
'haptics' tree name the specific haptic formats. Unrecognized
subtypes of 'haptics' should be treated as 'application/octet-
stream'. Implementations may still pass unrecognized subtypes to the
haptics subsystem and associated rendering hardware.

4.2. Registration Procedure

New haptics formats should be registered using the online form
[Media-Type-Registration]. [RFC6838] should be consulted on
registration procedures. In particular, the haptics specification
should preferably be freely available.

Note that new parameter sub-values may be defined in the future. If
an implementation does not recognize a sub-value in the comma-
separated list, it should ignore the sub-value and continue
processing the other sub-values in the list.

4.3. Subtype Registrations

In this section, the initial entries under the top-level 'haptics'
media type are specified. They also serve as examples for future
registrations.

4.3.1. IVS Haptics Type

Type name: haptics

Subtype name: ivs

Required parameters: N/A

Optional parameters: N/A

Encoding considerations: binary

Interoperability considerations: The IVS format is a device-
independent haptic effect coding. It is designed to enable
interoperability between distinct physical endpoints. Not all
devices may be able to render all effects present in an IVS file.

Security considerations: See Section 3.

Published specification: ISO/IEC JTC 1/SC 29/WG 2 N 72 "Encoder
Input Format for MPEG Haptics" being developed by ISO/IEC JTC1/SC29
WG 2 [MPEG-Haptics-Encoder].

Applications that use this media type: All applications that are
able to create, edit, or display haptic media content.

Additional information:

   *File extension(s): Haptic file extensions used for IVS files:
    .ivs (xml) and .ivt (binary)

   *Macintosh file type code(s): (no code specified)

   *Macintosh Universal Type Identifier code: N/A

   *Fragment Identifier: N/A

   *Deprecated Alias: N/A

Person & email address to contact for further information: Yeshwant
Muthusamy(yeshwant@yeshvik.com)

Change controller: Immersion Corporation

4.3.2. HAPT Haptics Type

Type name: haptics

Subtype name: hapt

Required parameters: N/A

Optional parameters: N/A

Encoding considerations: binary

Interoperability considerations: The HAPT format is a device-
dependent haptic effect coding based on the RIFF coding standard. It
is designed to enable efficient coding of a device-specific haptic
effect.

Security considerations: See Section 3.

Published specification: HAPT is a logical extension of the RIFF
standard [RIFF].

Applications that use this media type: All applications that are
able to create, edit, or display haptic media content.

Additional information:

   *File extension(s): Haptic file extensions used for HAPT files:
    .hapt

   *Macintosh file type code(s): (no code specified)

   *Macintosh Universal Type Identifier code: N/A

   *Fragment Identifier: N/A

   *Deprecated Alias: N/A

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