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MULTIMEDIA FORMAT ISSUES FOR CWS TASK FORCES

Document prepared by the International Bureau

Editorial Note: this document was prepared to inform the CWS Task Forces for discussion of the potential issues on multimedia or video formats that are recommended by standardization bodies and/or used in practice when they prepare new WIPO standards. It is shared with the Committee on WIPO Standards (CWS) for informational purposes only.

Summary

1.   There are several issues for CWS Task Forces to consider on recommendations for video or multimedia formats:

        a)   Compatibility issues – recommending video formats that are supported by commonly available platforms, to ensure that the Office and the public can access submitted videos.

        b)   Patented technology issues – some video formats are covered by patents, particularly ISO / MPEG standards.

        c)   Convenience for applicants – some formats may be more convenient for applicants to provide, despite compatibility or patent coverage issues.

        d)   Long term archival issues – ensuring that formats accepted by Offices are supported by available playback devices for the life of the IP right and possibly beyond.

These issues are described in more detail below, along with background on the situation.

Standards Bodies

2.   The Moving Picture Experts Group (MPEG) is a working group of authorities that was formed by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) to set standards for audio and video compression and transmission. MPEG specifications are recognized as ISO and IEC standards. Other groups also develop multimedia format standards, including the International Telecommunication Union (ITU) and the Xiph.Org Foundation, a non-profit organization dedicated to supporting and developing free multimedia formats and software.

Background

3.   Video (multimedia) files consist of a container and codecs.
- The container holds all the contents of the file: video, audio, subtitles, metadata, etc.

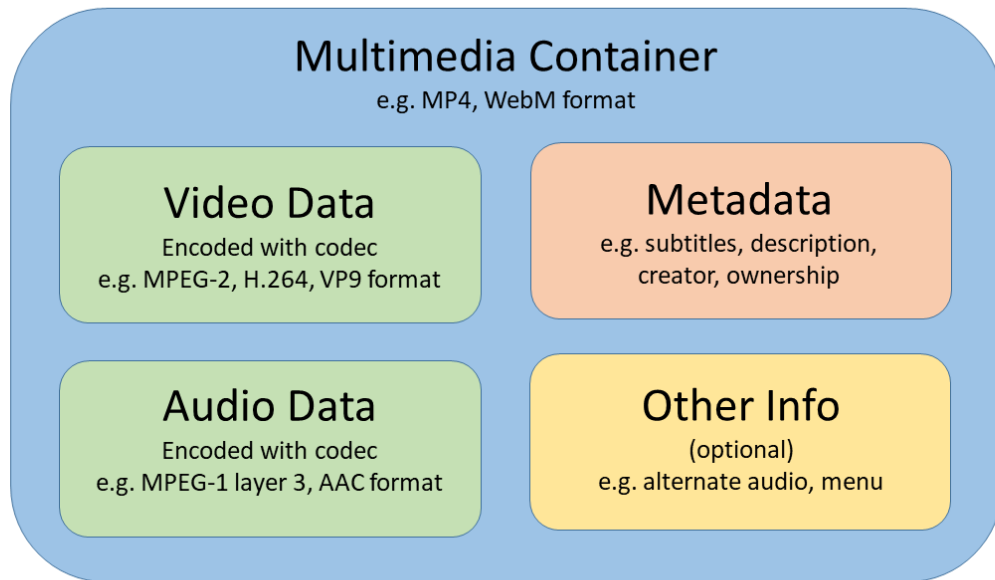- Codecs (coder/decoder) format video or audio data and decode it for playback.

Figure 1. Multimedia file structures

4.   Some container formats support a wide range of codecs. For instance, MP4 supports around 20 different video codecs. Most video players only support a limited subset of those codecs, meaning they can not play all MP4 files. See Table 2: Codec Support by Various Container Formats for more information.

5.   Common container formats include:

- **MP4 (.mp4)**: container for video and audio defined in MPEG-4 Part 12. Standardized as "ISO/IEC base media file format" (ISO/IEC 14496-12).

- **Matroska Multimedia Container (.mkv)**: royalty-free standard container format. Not defined by a formal standards body, but by the open source project on github.

- **Ogg (.ogg)**: open container format designed to be free of patent issues. Maintained by the Xiph.Org Foundation.

- **WebM (.webm)**: created by browser makers to provide a royalty-free alternative for video and audio elements on the web. Based on Matroska.

- Various other proprietary formats that are not standardized, including **Quicktime** (Apple), **AVI** (Microsoft), and **WMV** (Microsoft).

6.   Common video codecs include:

- **MPEG-1 and MPEG-2**: the first and second generation of MPEG codecs for video and audio. MPEG-2 Part 2 defines a video codec, which was adopted by ITU-T as part of H.262.

- **MPEG-4 Part 2**: the fourth generation of MPEG standards are defined in MPEG-4. Part 2 defines a video codec which is based on ITU's video standard H.263.

- **H.264 or AVC**: joint video standard created by ITU and MPEG, also known as MPEG-4 Part 10.

- **H.265 or HEVC**: ITU's successor to H.264 with greater compression. Identical to MPEG-H Part 2.

- **VP8, VP9**: open and royalty-free video codecs created by Google and supported by web browsers. A successor called AV1 is being developed by the Alliance for Open Media, a non-profit organization for open and royalty-free multimedia technology.

- **Dirac**: an open and royalty-free video format developed by the BBC. Standardized by the Society of Motion Picture and Television Engineers as SMPTE 2042-1-2009.

- **Theora**: royalty-free video format developed by Xiph.Org Foundation.

7.   Common audio codecs include:

- **MPEG-I layer 3 (.mp3)**: popular standard for music files. Also used for audio in various video container files.

- **AAC**: designed as the successor to mp3 by MPEG and adopted as an ISO/IEC standard.

- **Vorbis**: royalty-free open standard for audio from the Xiph.Org Foundation.

- **FLAC**: royalty-free lossless audio codec developed by the Xiph.Org Foundation.

See Table 1: Video Format Support by Common Platforms for more information.

Patent Covered Formats

8.   The MP4 container format was first standardized in 1998. Some patents on it may still be in force, given lag time in prosecutions and grants. Also, the standard has continued to add new parts over time. Some of the newer features may be covered by patents, and it may be difficult to separate older public domain features from newer patented features in playback software. MPEG LA is an American company formed to manage a license pool for MPEG standards. MPEG LA asserts that they offer patent portfolio licenses for[1]:
- HEVC / H.265 codec
- AVC / H.264 codec
- MPEG-4 Part 2 (MPEG-4 Visual) codec
- MPEG-2 codec

9.   Worldwide licenses are available to software and device makers implementing these codecs. MPEG LA only offers licenses if royalties are paid, and licenses do not extend to downstream customers who rebrand the product. MPEG LA lists over 30 patent holders for MPEG-4 Part 2, and claims all of the patents are essential to implement the standard[2]. Royalties for software encoders / decoders are $0.25 per unit after the first 50,000 units, capped at $1.25 million per year. Licenses are granted for 5-year terms, after which licensees must renew for another 5-year period. Thus, any video player with a license today may not have a license 5 years from now.
A full list of patent holders and license terms for each of MPEG LA's portfolios are available on their website. See Table 3: Patent Holders in MPEG LA pool for AVC / H.264 Codec for an example.

10.   In addition to the MPEG LA pool, HEVC / H.265 is covered by two other patent pools that claim to hold patents essential to implementing the standard. HEVC Advance's pool has over 500 patents from major companies and IP monetization funds, mostly in Japan and Korea. HEVC offers a royalty-free license for software-only implementations on computers and mobile

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[1] See https://www.mpegla.com/
[2] See https://www.mpegla.com/wp-content/uploads/m4vweb.pdf

devices.[3] The third pool, run by Velos Media, has patents from Ericsson, Qualcomm, and Blackberry, among others. Velos only provides information about the patents in their pool under a non-disclosure agreement.

11.   While the VP8 and VP9 video codecs were designed for royalty-free use, Google claims to hold patents that cover them. The WebM license allows royalty-free use, but the license is revoked if a user litigates their own patents against anyone for use of WebM, including as a cross-claim or counterclaim.

12.   The AV1 codec is developed by an industry alliance to ensure royalty-free video. Several MPEG patent holders are also part of the alliance developing AV1, including Microsoft, Apple, and Cisco.

13.   AAC audio codecs also require patent licenses. Via Licensing Corp runs a patent pool for AAC encoders and decoders, with patents from a dozen major companies.[4]

14.   Unified Patents, a consortium of 200 mostly tech companies, including Google, , seeks to " improve patent quality and deter unsubstantiated or invalid patent assertions"[5] in technology "Zones". One zone is dedicated to video codecs, particularly H.265/HEVC, H.266/VVC, and AV1 / VP9. The video codec zone aims to avoid "Licensors' unreasonable licensing expectations; Royalty stacking; Assertion of invalid or non-essential patents. Our SEP Zones are intended to deter such activities, enable good-faith FRAND offers, and help standards thrive."[6].

HTML 5

15.   The HTML 5 specification does not recommend any particular video codecs or formats for use in HTML, due to lack of agreement among participants. Some participants favored ISO standard formats covered by patents, while others preferred free and open formats. As a result, the decision of which formats and codecs to support is left to each browser maker to decide. HTML 5 originally recommended Ogg containers with Theora codecs, but replaced that recommendation in 2009, with the following statement: " However, there are no known codecs that satisfy all the current players: we need a codec that is known to not require per-unit or per-distributor licensing, that is compatible with the open source development model, that is of sufficient quality as to be usable, and that is not an additional submarine patent risk for large companies."[7]

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[3] See https://www.prnewswire.com/news-releases/hevc-advance-announces-royalty-free-hevc-software-300367212.html
[4] See https://www.via-corp.com/licensing/aac/
[5] See https://www.unifiedpatents.com/faq
[6] See https://www.unifiedpatents.com/sep
[7] See https://en.wikipedia.org/wiki/HTML5_video#Supported_video_and_audio_formats

Issues

CWS Task Forces should consider the following issues when dealing with multimedia formats:

I.   Compatibility issues

16. Container formats such as MP4 support many different types of codecs. Most video playing software only supports a subset of those codecs. Thus, a given video player may play some but not all MP4 files.

For example, if an Office accepts any MP4 file in an applicant submission, the Office may not have the tools to play the video. Similarly, if the Office publishes an MP4 file, members of the public may not be able to play that particular video.
The Task Force should consider:

- Whether Offices should limit applicant-submitted video files to using certain codecs for which playback software is widely (or freely) available.

- Whether Offices can or should detect which codec a submission uses, and how to handle videos submitted with non-preferred codecs (reject, transform, etc).

- Whether to convert submitted videos to a more widely available format, including the computing resources and video / audio quality issues with performing such a conversion.

II.   Patented technology issues

17. Some multimedia formats may be covered by patents. This can apply to both containers and codecs. Particularly MPEG standards are known to incorporate patented technology from industry members.
The Task Force should consider:

- Whether to allow applicant submissions using formats that are or could be covered by patents. Do the patents apply to video creation or playback? Has the patent owner made guarantees that royalty-free playback is available?

- Whether to convert applicant submissions in patent-covered formats to non-patent-covered or royalty-free formats. Also consider the computing resources and video / audio quality issues with performing such conversions.

- If patent-covered formats are accepted, what are the impacts for the Office? Will this impact examination or other Office procedures?

- If patent-covered formats are accepted, what are the impacts on applicants? Will they need licensed tools to prepare multimedia submissions?

- If patent-covered formats are accepted, what are the impacts on the public? Will they be limited or restricted in any way from viewing applications or IP rights published by the Office?

III.   Convenience for applicants

18. Notwithstanding the issues above, some formats are very popular among applicants and supported by a wide variety of software tools. Applicants may prefer to use these formats even if they have compatibility or patent issues.
The Task Force should consider:

- Whether the accepted formats are convenient for applicants to use. Are they supported by the most common applicant tools for creating multimedia files? If not, are tools to convert multimedia files to the accepted formats readily available and easy to use?

- If Offices accept containers with a subset of possible codecs, such as MP4 with only H.264 codecs: how difficult will it be for applicants to tell which codec their video uses? How difficult will it be for applicants to change their video to another codec which is accepted by the Office?

IV.   Long term archival issues

19. Multimedia files accepted by Offices may be need to be accessible for 20 years or more. As older digital formats fall out of use, support for those formats may disappear from software video players. How can Offices ensure that multimedia submissions are accessible, both within the Office and by the public, for the entire life of the IP right and beyond?

The Task Force should consider:

- How widely used is the format by current tools? Is the format supported on many systems / platforms?

- Are reference implementations or open source implementations available?

Options for consideration

Based on the situation, the International Bureau proposes the following several options for the relevant CWS Task Forces to consider:

I.   **Option 1: Highest patent issue risk with broadest compatibility**

MP4 container with H.264 / AVC video encoding and MP3 or AAC audio encoding

20.   This format has the widest support across a variety of platforms. If Task Forces want to maximize compatibility across Offices and across devices, this would be the best choice. This format would also be the easiest for applicants to create videos in and for the public to access published videos.

21.   There are patent licensing issues to consider with this format. However, it appears that providers of the most common devices (Windows, Mac, iPhone, Android) have licenses for this format. It is not clear whether Linux systems have licensed players. MPEG has indicated in the past that free / open source software still requires a license to play H.264 video.[8]

II.   **Option 2: Decreased patent issue risk with moderate compatibility**

Webm container with VP8 / VP9 / AV1 video encoding and MP3 audio encoding

22.   Among formats designed to avoid patent issues, it is not clear that any work seamlessly across all platforms. None are natively supported by Windows, Mac, or iPhone, though all can install additional software to play Ogg, MKV, or WebM files.

23.   WebM has the greatest support among web browsers since it was designed specifically for web video and has high industry support. However, the VP8 and VP9 codecs have defensive licensing issues, and the AV1 codec is still in beta with limited use.

24.   WebM would be a good compromise format if Task Forces want to avoid patent-covered formats that require royalties, while maintaining some commercial support across different platforms. Applicants may face more work finding tools to produce video in WebM format. However, the public should be able to play these videos in a web browser with little issue.

III.   **Option 3: Minimized patent issue risk with lowest compatibility**

Ogg container with Theora or Dirac video encoding and Vorbis audio encoding

25.   The Theora and Dirac codecs, while having no known patent issues and having been in use for over a decade, also have the lowest support and usage among formats considered in this paper. Task Forces should consider these formats if they want to avoid all patent issues as much as possible. However, device compatibility and convenience for users will be significantly impacted.

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[8] See https://blog.christophersmart.com/2010/02/01/mpeg-la-confirms-h-264-license-needed-for-free-software-and-end-users/

Table 1: Video Format Support by Common Platforms

The following table shows native support for video formats by several common platforms. Other formats can be played by installing additional software or codecs in certain situations.

p = partial support

Note: the table shows technical capabilities, not whether a particular use is licensed.

	Windows	Apple Mac	Linux	iPhone	Android	Chrome	Firefox	VLC Player
Containers								
MP4	Y	Y	Y	Y	Y	Y	p	Y
MKV			Y		Y			Y
Ogg			Y				Y	Y
WebM			Y		Y	Y	Y	Y
Codecs								
MPEG-1/2	Y	Y	Y					Y
MPEG-4	Y	Y	Y	Y	Y		p	Y
H.264 / AVC	Y	Y	Y	Y	Y	Y	p	Y
H.265 / HEVC	Y	Y	Y	Y	Y			Y
Theora			Y			Y		Y
VP8			Y		Y	Y	Y	Y
VP9			Y		Y	Y	Y	Y
AV1			Y					Y
Dirac			Y					Y

Table 2: Codec Support by Various Container Formats

Video Codec	Type	MKV	MP4	Ogg	WebM
MPEG-1 Video	Lossy	Yes	Yes	No	No
MPEG-2 Video	Lossy	Yes	Yes	Needs VLC	No
MPEG-4 Visual	Lossy	Yes	Yes	Needs VLC	No
WMV	Lossy	Yes	Yes	No	No
H.263	Lossy	No	Yes	No	No
Theora	Lossy	Yes	Yes	Yes	No
H.264 AVC	Lossy or lossless	Yes	Yes	No	No
H.265 HEVC	Lossy or lossless	Beta	Yes	No	No
Dirac	Lossy or lossless	VCM	Yes	Yes	No
VP8	Lossy or lossless	Yes	Yes	Needs Firefox	Yes
VP9	Lossy or lossless	Yes	Yes	Needs Firefox	Yes
AV1	Lossy or lossless	Beta	Yes	No	Beta

Table 3: Patent Holders in MPEG LA pool for AVC / H.264 Codec[9]

Organization	Active patents	Expired patents	Total patents
Panasonic Corporation	1,137	60	1,197
Godo Kaisha IP Bridge	1,111	19	1,130
LG Electronics	949	41	990
Dolby Laboratories	759	16	775
Toshiba	358	33	391
Microsoft	208	7	215
Nippon Telegraph and Telephone (including NTT Docomo)	187	2	189
Sony	116	31	147
Fraunhofer Society	125	16	141
Google	136	3	139
GE Video Compression	136	0	136
Fujitsu	102	4	106
Mitsubishi Electric	54	50	104
Tagivan II LLC	77	0	77
Samsung Electronics	23	40	63
Maxell	51	2	53
Philips	5	39	44
Vidyo	41	2	43
Ericsson	34	0	34
Electronics and Telecommunications Research Institute (ETRI) of Korea	32	0	32
Siemens	20	12	32
The Trustees of Columbia University in New York City	0	25	25
Polycom	19	1	20
Robert Bosch GmbH	14	5	19
Apple	9	0	9
JVC Kenwood	3	5	8
Orange S.A.	0	7	7
Sharp Corporation	5	0	5
Korea Advanced Institute of Science and Technology (KAIST)	1	4	5
Cisco Systems	4	0	4

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9 From https://en.wikipedia.org/wiki/MPEG_LA

Table 3: Patent Holders in MPEG LA pool for AVC / H.264 Codec[9]

Organization	Active patents	Expired patents	Total patents
ZTE Corporation	0	2	2
Cisco Technology	1	0	1
Cable Television Laboratories, Inc.	0	1	1
Hewlett-Packard Company	0	1	1
LSI Corporation	0	1	1
Newracom, Inc.	0	1	1
Zhigu Holdings Limited	0	1	1

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