Instruction Document On Multimedia Formats

Optimal Accessibility Of Audio, Video And Images

Contentlist

Preface

We increasingly express ourselves through multimedia. Internet traffic already consists for the most part of audio and video. A variety of formats are used for this purpose, often without due consideration. This document provides a background for choices that can be made for making video and audio available. In this context, open standards are (at present) less common than closed standards. Nevertheless, open standards are more useful in terms of sustainable access to multimedia content. This document provides an insight into the relevant considerations to help you make the right choice when selecting formats.

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1. Introduction

These days everybody is connected to everybody else via the internet. Not only geographically, but also in time. Ideally, files created today will still be usable in ten or twenty years' time.

Multimedia is hot. Users demand multimedia material, irrespective of time, system or location. Increasingly, government bodies deliver their message in a multimedia format. Another example is broadcasting for radio and television, which is now largely performed using digital files.

One aspect people are often unaware of is that choices made (either consciously or unconsciously) during production and distribution of a file are decisive with respect to the usability of the information for others. What is important is the chosen multimedia format. Dozens or maybe even hundreds of formats are available. Choosing a particular format may, for instance, determine whether or not your target group is reached. Making a well-considered choice is crucial.

The NOiV Programme Agency (The Netherlands in Open Connection) and the Standardisation Forum want to encourage government information being made available and remaining available in the best possible manner. For this purpose, NOiV and the Standardisation Forum develop instruction documents (such as the present document and the open document-format paper [2]). These instruction documents provide assistance in making choices that help ensure that the information you have so carefully compiled reaches the broadest possible target group, now and in the future. Open standards play an important role in this instruction document. These standards offer important advantages:

- They are not dependent on a specific supplier.
- They can be used in a variety of software packages.
- They are supported by a large community, and are therefore more future-proof.

This document discusses file formats for multimedia (such as audio, video and images). These formats determine how your information is coded to be 'read' by computers. The formats can be recognised by their extensions: .mp3, .mp4, .jpg, .ogg, etc. There are file formats that are commonly used, while others are more obscure.
With some file formats, archiving is relatively difficult, whereas others are fairly future-proof.
With this document, the NOiV Programme Agency and Standardisation Forum assist you in making a considered choice if you actively use image, audio and video files. Such files are intended for reaching a large audience in particular.

1.1 Reading guide

This document aims to define a basic level of knowledge, and provides an overview. It is not a thorough analysis of specific file formats, and it does not constitute government policy.
It is rather an exploration of standards, open or otherwise, for multimedia. The purpose of this document is to provide a tool for making a considered choice of multimedia formats, based on background information and practical examples.

This document is intended for IT managers and communication advisers who are in a position to make choices with respect to multimedia formats.
For open multimedia standards that are compulsory for the public and semi-public sectors, please refer to the 'Comply or Explain' list of the Standardisation Forum [3].
The structure of this document is as follows. Chapter 2 provides an explanation of multimedia formats. It discusses characteristics that are relevant when choosing a suitable format. In Chapter 3 we discuss how a choice can be made. In Chapter 4 we focus on two video formats (MPEG-4 and Theora). Chapter 5 discusses some practical examples that may be used for inspiration and Chapter 6 provides a summary of the most relevant file formats.

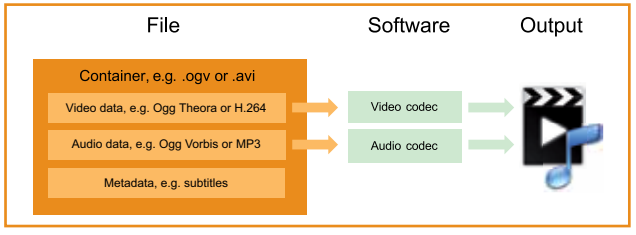
2. What are multimedia formats?

Multimedia formats are standards for files containing audio, images and video. These formats are often used in relation to other standards, for instance for text, but these will not be discussed here.

Multimedia types have a number of characteristics that may be relevant for the selection of a suitable format. These characteristics will be discussed in the subsequent sections.

2.1 Layered structure

Multimedia files often have a layered structure. It always contains one or more types of data, for instance video and audio tracks, images, metadata, subtitles or navigation data. The storage structure of the data contained in the file is determined by the container format – a kind of umbrella format. This defines the file structure, but not the format used for packing or coding the multimedia data itself (such as video, audio or image). This is done by the codec, a term that is a contraction of the words compressor and decompressor or coding and decoding. A codec is a software implementation of a compression standard. The digital structure of, for instance, an audio signal is determined by the audio codec. A container format always supports one or more codecs. The container format determines the extension of the multimedia file [1, 2, 3].



For images and audio, the container format is often directly linked to one particular codec. These are called 'single coding formats'. Examples of images include the JPEG File Interchange Format (.jpg) and the Portable Network Graphics Format (.png). An example for audio is MPEG-1 layer 3 (.mp3). The fact that a container format is not always linked to one particular codec is demonstrated by the TIFF format, which, amongst other things, can contain data coded in JPEG.

For video files in particular, many combinations of containers and codecs are possible. For instance, a multimedia file based on the container format Flash Video (.flv) may contain a video track coded with 'H.264/MPEG-4 AVC' and an audio track coded with MP3, but also a video track coded with VP6 and an audio track coded with AAC. And a multimedia file based on the container format Ogg (.ogv) may contain a video track coded with Theora and an audio track coded with FLAC, but also a video track coded with Dirac and an audio track coded with Vorbis [4, 5, 6, 7].

As a result of this layered structure of multimedia files, an application that is able to open a file built according to a particular container format may be unable to decode the data contained in the file. The cause is usually that the specific codec is missing in the application.

2.2 Intelligent storage

After recording or creation, an audio track, video track or image can be coded (packed) with the help of a codec, for storage and transmission, and decoded (unpacked) for playing or editing.

Most codecs are based on 'compression'. This means that the data is arranged and stored in an intelligent way. This intelligence may be based on recognition of patterns and of data that is (probably) redundant. As a result, the overall data size is reduced and less

storage capacity and/or bandwidth is required. There are two types of compression: lossless and lossy.

- Lossless compression is exactly reversible; there is no loss of data during file compression.
- Lossy compression is not exactly reversible; compression is, in part, achieved through reduction in quality. As a result, the compressed file will be smaller compared to lossless compression.

2.3 Other characteristics of multimedia formats

In addition to container format and codec, multimedia formats have other characteristics that may be relevant to usability in a specific case. Some of these characteristics are mentioned below, and they are referred to in the appendix 'List of multimedia file formats'.

Images:

- *Raster or vector:* With a raster image (or bitmap image, for instance JPEG), every pixel is defined. The term 'pixel' is derived from 'picture element'. A drawback of this type of image is that the pixels become visible when the image is enlarged. The counterpart of a raster image is a vector image. A vector image is based on geometrical equations (such as circles, lines, curves, etc.). A vector image (for instance, SVG) can be enlarged endlessly without loss of quality. Raster images are particularly suitable for complex images, such as photographs, while vector images are more suitable for simple images, such as logos.
- *Colour depth:* Colour depth provides information on the number of available colours. With 1 bit a computer can process one colour ('monochrome'), with 8 bits 256 colours, with 16 bits 65.536 colours, and with 24 bits or more, 16 million colours ('true colour').
- *Transparency:* This concerns transparency support of the image format. Not all image formats support transparency.
- *Animation:* Some image formats support successive display of a sequence of pictures, which creates animation.

Audio and video:

- *Bit rate:* The bit rate provides information on how much information is stored per time unit. The bit rate provides some information on quality, but it is not the only quality characteristic. Quality also depends on other factors, such as the codec.
- *Sample rate:* The sample rate is the 'speed' (frequency) at which a continuous (analogue) signal is sampled into a time-discrete 'digital' signal that consists of samples.
- *Frame rate:* The number of images per second that can be displayed in a video.
- *Resolution:* The number of usable pixels in the length x width ratio. This is relevant to video and images.
- *Streaming:* In the case of streaming, music and video can be played without downloading the full file.

2.4 Intellectual property rights and multimedia formats

Multimedia formats can be governed by intellectual property rights, such as patents. The user must be granted permission to use the format by the holder of the patent. Permission often depends on specific conditions defined in a licensing agreement between the holder of the patent and the user. In some cases, such conditions offer the user considerable freedom, for instance, only requiring that the user states the name of the holder of the patent in any implementation. Many multimedia formats have additional restrictions. With many common multimedia formats, the user must pay a fee ('royalty') to the holder of the patent. For instance, in certain cases users of MPEG-4 must pay for the use of this format. Such fees represent a barrier to maximum interoperability and

supplier independence. Therefore these formats are not considered open standards.

In addition to patents on the format, there are often copyrights with respect to the content. Legal barriers for reuse can be reduced by choosing an open content licence, for instance a Creative Commons licence. This option was chosen by Wikipedia and Open Images (Netherlands Institute for Sound and Vision).

3. How to select a suitable multimedia format?

There are many different multimedia formats. The most common are listed in Appendix 1: 'List of multimedia file formats'. It describes the functional characteristics of the various formats. Additionally, two important non-functional characteristics of each format are evaluated: openness and market support. This chapter explains why these characteristics are important in making the right choice.

3.1 Life cycle

The life cycle of multimedia material consists of different phases:

1. Production
2. Distribution
3. Use
4. Archiving.

For each of these phases there are requirements with respect to functional characteristics. In the distribution phase, bandwidth requirements are important, whilst in the archiving phase authenticity is crucial. Therefore your purpose of use will often determine the format selection. For instance, if you intend to publish a photograph on a website, it is best to select a format with compression (to reduce download time) and high colour depth (for a realistic image).

In addition to these functional characteristics, a number of other characteristics are relevant to the choice of a file format.

3.2 Non-functional characteristics

3.2.1 Objectives

When choosing a file format it is also important to consider the objectives of your organisation:

- **Accessibility**
  You aim for optimum accessibility of your multimedia files. Therefore barriers for use must be limited as much as possible.
- **Sustainability**
  Multimedia files published today must still be usable in ten years. If you ever used a VHS (Video Home System) or Video8 camera for making film, you will have to decide at some point what to do with the video recordings on your tapes. Because there will be a moment when it is no longer possible to purchase a new system that can read this type of tape. If you make the wrong choices, access to your files in the future will be seriously impeded.
- **Freedom of choice** (supplier independence)
  For use of files you do not want to be bound to one particular product or supplier. As much freedom of choice as possible is desirable with respect to software and hardware. Many common multimedia formats can only be viewed with specific software on a particular operating system. This is like buying a car that can only be used to tow a caravan of the same brand.

3.2.2 Openness and market support

In order to realise the objectives in the previous section, two non-functional characteristics are of crucial importance.

- **Openness:** It is important to know whether the format uses an open standard. As stated in the European Interoperability Framework [1] and the action plan Nederland Open in Verbinding

(The Netherlands in Open Connection) [2], open standards have the following characteristics:

- The standard is adopted and will be maintained by a not-for-profit organisation, and its ongoing development occurs on the basis of an open decision-making procedure available to all interested parties (consensus or majority decision etc.).
- The standard has been published and the standard specification document is available either freely or at a nominal charge. It must be permissible to all to copy, distribute and use it for no fee or at a nominal fee.
- The intellectual property - i.e. patents possibly present - of (parts of) the standard is made irrevocably available on a royaltyfree basis.
- There are no constraints on the re-use of the standard.

- **Market support:** It is important to know how much hardware and software is available that supports the multimedia format.

Together, openness and market support are of major importance for realisation of the objectives of accessibility, sustainability and freedom of choice:

- Openness contributes to accessibility because your files can be used in different operating systems and browsers and in other software.
- Openness contributes to the objective of sustainability because continued availability of the specification of the format without financial or legal obstacles is guaranteed, as is continued development of the standard for future implementations for hardware and software systems. Also, continued existence of an open standard does not depend on the continued existence of a single supplier. Please note that, from the point of view of digital sustainability, some open standards are more suitable for archiving than others.
- Openness contributes to freedom of choice because any supplier is allowed to implement the standard. This increases the likelihood that there will be multiple suppliers of implementations. You can switch to another supplier at any time and continue to use multimedia files you created in the past in the same format.
- Adequate market support contributes in particular to accessibility because a wider distribution of hardware and software that supports a particular format means that a file in that format can be exchanged with a large number of potential users.
- To a limited extent, sufficient market support contributes to sustainability, because it will lead to wide use of the format. Files in this format will continue to exist, even after a long time. As a result, suppliers will be more interested in continuing to support the format for a long time.
- Adequate market support may contribute to freedom of choice because providing implementations of a format that is much used by a large number of suppliers is profitable.

In almost all cases, openness and solid market support are necessary in order to realise the objectives. A file in an open standard will not be sustainable when there is no party that creates software for it. And a format with excellent market support does not offer freedom of choice if only one supplier offers the required software. Therefore, when a file format is selected, there may be no file format that sufficiently satisfies all the conditions. In that case, in order to meet the objectives, it may be necessary to use more than one file format. The practical examples in chapter 5 also outline situations in which more than one file format was selected.

4. A close look at two video formats: MPEG-4 and Theora

In this chapter we take a close look at two video formats: MPEG-4 and Theora. After some brief background information, the formats are evaluated in terms of openness and market support.

4.1 MPEG-4

MPEG-4 is a standard for storage and transport of multimedia. The standard now consists of over 25 parts and is still under development [1]. Parts 14 and 15, for instance, specify the container structure of the MPEG-4 file. MPEG-4 describes two different lossy compression techniques: 'Visual' (part 2) and 'Advanced Video Coding' (part 10). Based on these descriptions, software developers can create a codec.

'Visual' was introduced in 1999 and was implemented, for instance, in XviD and QuickTime. There are different ways in which this part of the standards can be implemented. These methods have been documented in profiles. For MPEG-4 part 2 there are 21 profiles, of which the 'Advanced Simple Profile' is the best known. This profile is used, for instance, by XviD.

'Advanced Video Coding' (AVC) was developed by MPEG and ITU and was introduced in 2003. Within ITU the standard is known as 'H.264/AVC'. This standard is widely used, for instance for video on Blu-ray discs and YouTube. 'H.264/AVC' codecs are more efficient than 'Visual' codecs. Only about half of the bit rate is required for the same quality. For part 10 there are also multiple profiles. Blu-ray, for instance, uses the 'High Profile'.

4.1.1 Openness

The MPEG-4 standards are maintained and developed by the Moving Picture Experts Group, which is also active as a working group of ISO/IEC [2]. The standards are published by ISO as ISO/IEC 14496. Specification documents are available at a fee [3].

Approximately 25 parties, including Philips, Microsoft and Apple, have indicated that they hold patents on parts of the MPEG-4 standard. These parties have formed the MPEG LA [4], a commercial organisation acting as an intermediary via a 'patent pool'. Users of MPEG-4 can acquire a licence for use of the patented technology via MPEG LA.

For MPEG-4 there are 'patent pools' for 'Systems' (part 1), 'Visual' (part 2) and 'Advanced Video Coding' (part 10). In recent years, there have been a number of lawsuits regarding patent infringements, alleged or otherwise (such as AT&T vs. Apple and Qualcomm vs. Broadcom). MPEG LA has announced that, until 31 December 2015, they will not charge royalties for offering free ('gratis') video content via the internet. Royalties must, however, be paid for offering video content that is not free. The same is true for implementation of MPEG-4 encoders or decoders by hardware and software manufacturers. The licensing conditions of MPEG-4 are not available online, but can be requested from MPEG LA.

MPEG-4 is not an open standard. It does not meet the requirement that 'intellectual property – with respect to any patents that may exist – of the standard, or parts thereof, is irrevocably made available on a royalty-free basis'.

Because of the royalties and conditions, some parties, including Mozilla, Opera and Wikipedia, have decided not to use MPEG-4. Mozilla estimates that they would have to pay approximately 4 million euros each year in royalties, but even more to the fact that the conditions and royalties create serious obstructions for innovation and reuse [5].

Discussion concerning MPEG-4 was recently rekindled as a result of the emergence of internet video. Although MPEG-4 is widely used, the closed nature of the standard seems to be in contradiction with the fact that open standards are the basis of the success of the internet [6, 7, 8].

4.1.2 Market support

MPEG-4 is probably the most widely used video format. It is directly (without any plug-in) supported by the browsers Google Chrome and Apple Safari (total market share approximately 13%) and the next version of Internet Explorer is also expected to offer direct support for MPEG-4. Additionally, Flash offers support for H.264/AVC. Flash is installed on approximately 96% of all computers.[9] Large video websites, such as YouTube and Uitzendinggemist.nl, offer their video material based on MPEG-4.

4.2 Theora

Theora [10] is a lossy compression format for video. 'libtheora' is an open source reference implementation. Theora was derived from the VP-3 format released by the company On2, in 2001. The 'Theora I Specification' was published in 2004. Later, some small changes were made to the specification. Version 1.0 of the reference implementation was published in 2008. The container format used for Theora is usually Ogg.

Opinions regarding quality and efficiency of Theora compared to H.264/AVC vary. It turns out to be very difficult to measure the difference in quality in an objective manner. In mid-2009, Google announced that for the time being YouTube will not be switching to Theora. The American company anticipates that Theora will require much more bandwidth, but this opinion is not shared by everyone [19, 20, 21].

4.2.1 Openness

Theora is maintained by the Xiph.Org Foundation [11]. This non-profit organisation also manages other multimedia formats, including FLAC, Ogg and Vorbis. Xiph.Org seems to be an organisation that facilitates software development, similar to the Mozilla Foundation, rather than a standardisation organisation such as W3C (the World Wide Web Consortium). Participation is possible via the mailing list, IRC (Internet Relay Chat) and Wiki. The specification can be downloaded for free via the website of the Xiph.org Foundation [12].

Theora meets the criteria for an open standard. It can be implemented in open-source and closed software, without any restrictions or royalties. The patents for the standard have been made available by On2 irrevocably. While maintenance is not poorly organised, there appear to be possibilities for improvement. In the current set-up, open-source software development and maintenance of the standard are closely related. Placing the standard with a standardisation organisation, such as IETF (Internet Engineering Task Force) or W3C, might improve the possibilities for participation by third parties.

4.2.2 Market support

Recent versions of Google Chrome, Mozilla Firefox and Opera provide direct support for Theora. This covers approximately 27% of the total browser market. In other browsers (such as Internet Explorer and Safari), Theora can be used via the Java applet Cortado. In this way, Theora could be played on approximately 80% of all computers [9]. Flash does not support Theora.

In addition to browsers, VLC media player, a multimedia player available for almost any platform (such as Windows, MacOSX and Linux), offers support for Theora. A variety of software options are

also available for encoding (creating Theora files), for instance FFmpeg, Miro Video Converter and GStreamer.

Examples of websites that use Theora are Open Images (Institute for Sound and Vision), Wikipedia and Dailymotion [13, 14, 15]. In particular, combination with the new functions of HTML5 offers new possibilities without requiring a plug-in or the need to pay royalties [16, 17, 18].

4.3 New development: WebM

On 19 May 2010, Google launched the WebM video format [22]. This format is intended for video via the internet using the HTML5 video tag. WebM is in effect a specific usage of the Matroska multimedia container format, with which only the video codec VP8 and the audio codec Vorbis can be used [23]. This limitation was applied to allow software and hardware producers to implement the standard relatively easily [24].

4.3.1 Openness

Google has made the specifications of both WebM and VP8 – the video standard used – available under a Creative Commons licence; they can be downloaded from the WebM project website [23]. The patents Google has on the VP8 standard are permanently exempt from royalties [22]. Vorbis, the audio codec used, is already an open standard, and is managed by the Xiph Foundation. Open-source reference implementations are available for both Vorbis and VP8. Google realised WebM in cooperation with Mozilla, Opera, Adobe and approximately twenty other parties from the internet industry [24]. WebM has an unmistakably open character, but like Theora, its openness could be enhanced if the maintenance of the standard entrusted to a standardisation organisation.

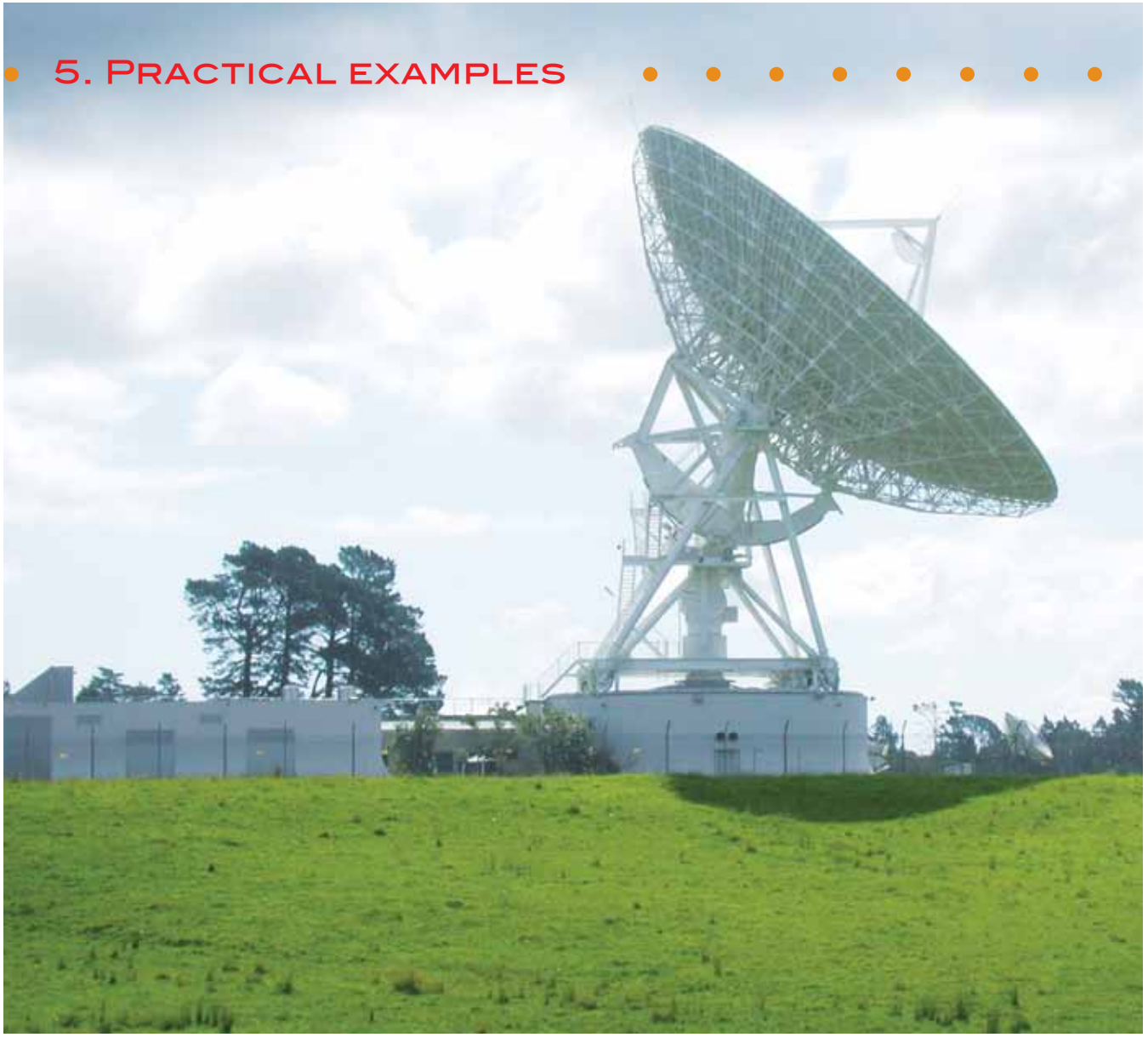
4.3.2 Market support

In the phase preceding the launch, Google succeeded in securing widespread support for WebM. Adobe will be implementing the standard in Flash Player, and the browsers of Microsoft (via plug-ins), Opera, Mozilla and, of course, Google will support WebM via the HTML5 video tag. Furthermore, the video format has proved popular among hardware producers such as AMD and NVIDIA. Google itself will be responsible for what may be the most widespread adoption of WebM by using the format for YouTube [22].

4.4 Conclusion

MPEG-4 is the most widely used video format, but it is not an open standard. This has drawbacks for accessibility, sustainability and freedom of choice. Theora is an open standard, but it is less common than MPEG-4, despite a recent strong increase in support for Theora. A new development is the format WebM, which seems set to score highly in terms of openness and market support.

5. Practical examples



In the preceding chapters we discussed the background of multimedia and looked at some concrete file formats. This chapter outlines how formats can be used in practice. These examples of practical use are described based on a template that is included in appendix 2. The examples provide guidance for selecting a multimedia format.

You may be familiar with the first example: placing a film on a website. The second example, Open Images, demonstrates how open standards can be used in combination with pragmatic choices. These examples are intended to provide inspiration.

The third example in the field of video is Wikipedia.

The first three practical examples are geared towards making video material available on the internet. For this purpose, different formats may be used, as well as a variety of playback software in the browser ('applets') as fallback to ensure broad accessibility. The different methods used for this purpose in the three practical examples are listed in the following table.

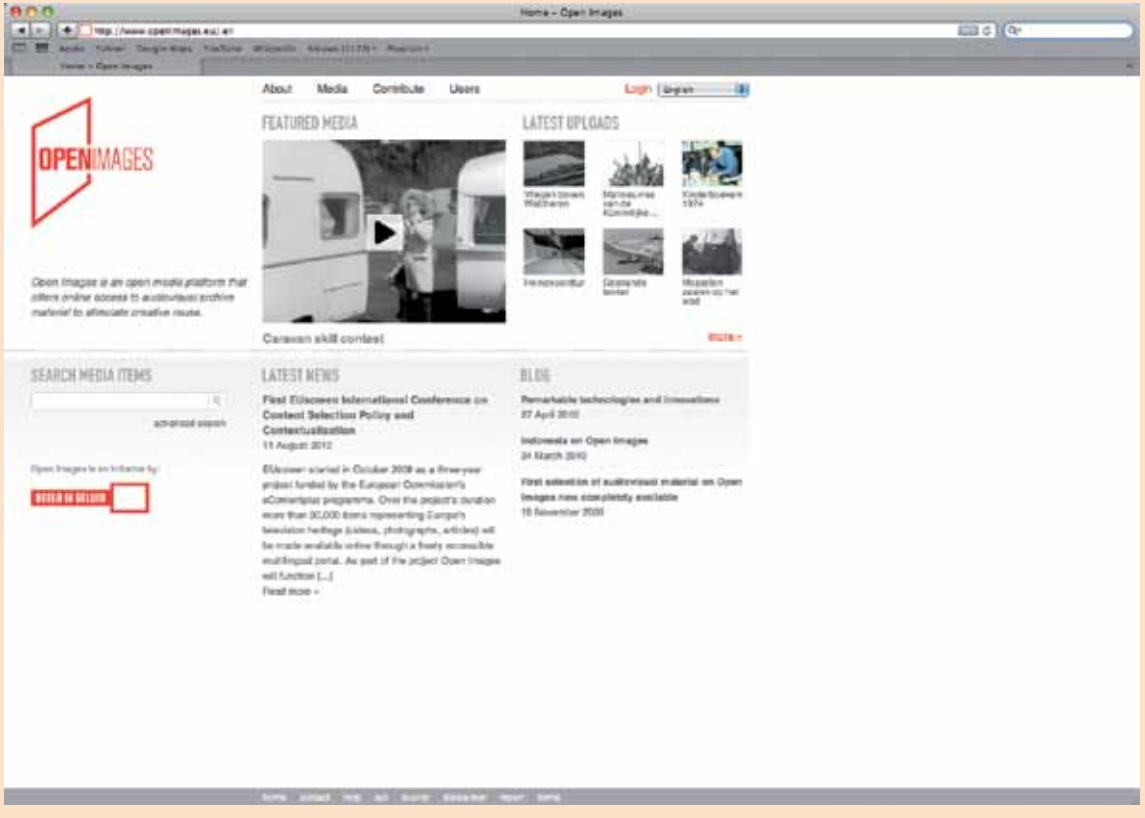
The fourth practice regards the broadcasting process of the public television channels in the Netherlands. Finally, an interesting example in the area of images is DE BASIS.

Practical example	Number of formats	Number of applets for fallback	Market support (target group scope)	Openness
Promotion film on municipality website	2 (Theora and MPEG-4)	1 (Flash)	Good	Open and closed format
Open Images - NL Institute for Sound and Vision	2 (Theora and MPEG-4)	2 (Java en Flash)	Excellent	Open and closed format
Wikipedia	1 (Theora)	1 (Java)	Fair	Open format only

5.1 Promotion film on municipality website

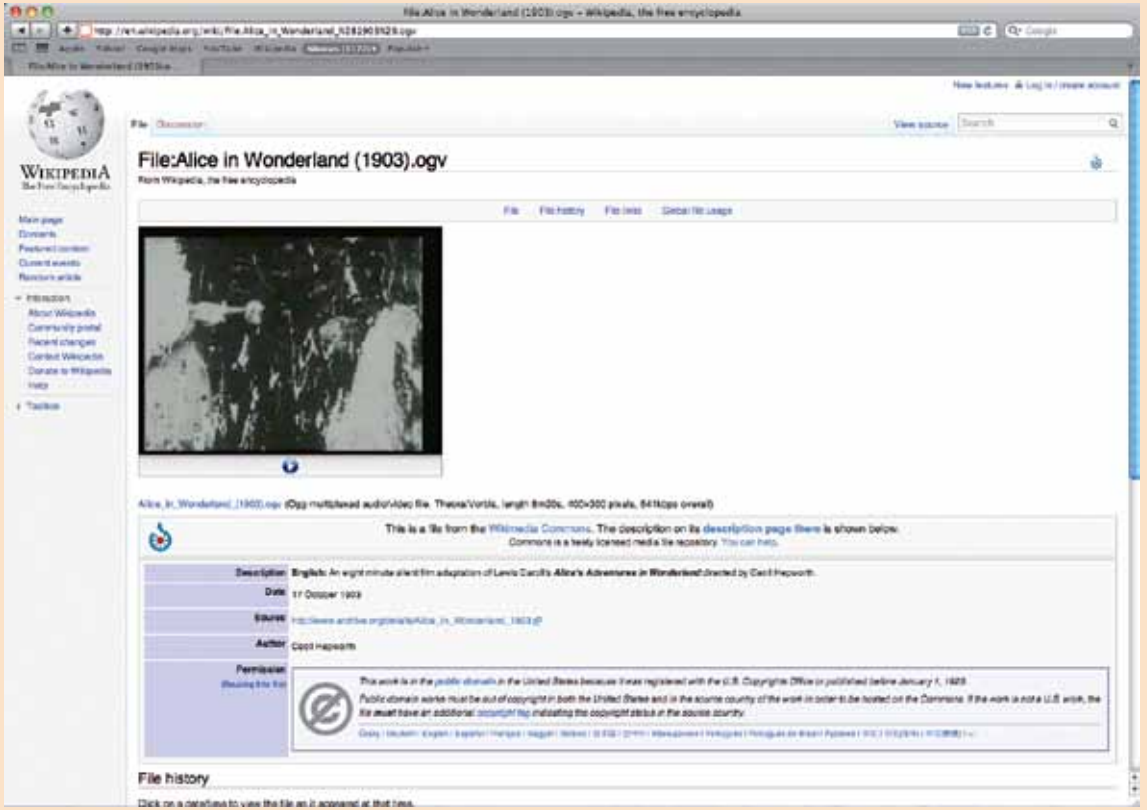
Practical application	Promotional film on municipality website.
Description	Video and audio material is being used increasingly to make municipality websites appealing. This material must be accessible to a large target group and must not exclude anyone. The provision of the information is governed by the Web Guidelines. Furthermore, it is important that changes can be made in the future, and that the material can be archived for long-term access.
Actors	The citizen as the visitor to the website, the municipality as the provider and the client commissioning the material, and the multimedia company as the creator of the content.
Assumption	The municipality determines the formats used and requests them from the multimedia company.
Steps	The life cycle of the film consists of the following standard stages:
• Production	The municipality asks the external production company to supply the film in Ogg Theora format.
• Distribution	When the film is distributed, the basic principle is that it has to be playable on as many platforms as possible, and preferably via an open standard. The following practical example follows on from this principle and elaborates on what is customary within the Dutch government. Two source formats are used, namely the open Ogg Theora format and less open MPEG-4 H.264/AVC. First of all, the Theora file is provided with the HTML5 video tag. Using this tag becomes the means of putting videos on web pages. Not all implementations of the video tag in browsers support the Theora format. If this is the case, the file is then provided in MPEG-4 format as an alternative, also by means of the video tag. This format is supported relatively widely. It may be the case that the browser used does not support the video tag fully. If this happens, a Flash player that plays the MPEG-4 video can be used, for instance JW Player. Finally, both files can be offered as downloads for, for instance, users who have a slow connection. This way, the likelihood of the user not being able to watch the video is minimal, while an open standard is also used.
• Usage	The above means of distribution are aimed at reaching the target group as effectively as possible and not excluding anyone. The open usage format is Ogg Theora, which offers guaranteed compatibility with browsers (e.g. Mozilla Firefox). In addition to Microsoft Windows, the material is accessible on other platforms. Closed formats which are offered, such as MPEG-4 and Flash, temporarily provide increased user-friendliness.
• Archiving	• Ogg Theora is used as the archiving format. • It is advisable to keep the source format in case any modifications are required. Whilst this does require a certain amount of disk space due to a lower degree of compression, storage is relatively inexpensive.
Variations	The municipality has no control over the source format. Consequently, the usage format and archiving format remain the same.
Issues	When Internet Explorer becomes HTML5-compatible, the option to choose a fallback scenario from the Flash Player will eventually cease to be available. As there is likely to be more than one format for the video tag in the HTML5 standard, it may be necessary to maintain two source formats for the time being.

5.2 Open Images - Netherlands Institute for Sound and Vision



Practical application	Open Images
Description	Open Images is an open media platform that provides access to audiovisual data collections that are easy to reuse. It is a joint initiative of the Netherlands Institute for Sound and Vision and Stichting Nederland Kennisland which stems from the Beelden voor de toekomst (Images for the Future) programme. Open Images was started with the aim of becoming the central location in the Netherlands for open audiovisual content that can legally be reused. There are now some 650 items available on Open Images, the majority of which are Polygon Journals from the collection of the Netherlands Institute for Sound and Vision.
Actors	• The Netherlands Institute for Sound and Vision • Material providers (institutions and individual users) • Users who look for the video footage via the website, and subsequently download or play it in the browser.
Assumption	• Easily accessible in any environment • Open technology (open-source platform & components) • Open access (open standards & API) • Open material (legal conditions: Creative Commons).
Steps	
• Production	The supplier of the material determines the source format. There are no requirements in this respect. Regardless of the type of source format, that format remains the source format. Metadata can be added, for which the Dublin Core (EBU variant) open standard is used. Each source format is transcoded into the usage formats using FFmpeg and an intermediary format.
• Distribution	Open Images includes a distribution platform for the open images. The open-source Content Management System MMBase has been selected for the configuration of the platform. In addition, the open standard of the Open Archives Initiative is used to provide access to metadata and the actual material (OAI-PMH).
• Usage	In addition to the source format and the intermediary format Open Images offers two usage formats for video: the Ogg Theora format, with two types of compression. The first has the same resolution and bitrate as the source format, while the second can only play files of limited size when used as the playback format for the player. All items on Open Images can be played immediately using the video tag in HTML 5. This feature has now been implemented in various browsers (e.g. Mozilla Firefox), and makes closed media plug-ins such as Flash and Silverlight redundant for video playback on the website. This choice is based on recent developments at, amongst others, Mozilla and Wikipedia. These organisations no longer want to allow patented technology in their products and service. As an alternative or a fallback scenario, the Theora file is also offered via a Java applet. If this is not supported, the client reverts to MPEG-4 (H.264/AVC) via a Flash Player. Despite this not being an open standard, users can still benefit from this format, especially in browsers that do not yet support HTML5 sufficiently [2].
• Archiving	The original source format, the intermediary format, the two Ogg Theora formats, and the MPEG-4 format are all available on the platform and archived as a result.
Variations	
Issues	On occasion the quality argument is used to choose MPEG-4 H.264/AVC over the open Ogg Theora format. Aside from the fact that there are many discussions concerning the validity of the quality argument, it is not relevant where Open Images is concerned. For users, the quality of the files in Ogg Theora is sufficient, and certainly no reason to offer another format.

5.3 Wikipedia



Practical application	Audio and Video on Wikipedia
Description	Wikipedia is a free online encyclopedia. Consequently, multimedia additions have to meet strict quality requirements, be suitable for use by a large target group, and be free to use now and in the future.
Actors	• Wikipedia: makes the platform available and determines the applicable standards • The content producer • The content reader
Assumption	• The content is usable with legal open-source software [2]; • The content is usable with all current platforms [3] • The content is secure for the users and Wikipedia [4] • Wikipedia wants to use open standards exclusively [2]
Steps	
• Production	Wikipedia does not have any requirements with respect to the production format. However, suggestions are offered on how to achieve a high production quality. For video, Wikipedia has chosen Ogg Theora as its compulsory usage format. For audio, this is Ogg Vorbis. Content producers have to upload files in these formats.
• Distribution	Wikipedia features an open-source tool for converting video files (Miro), which can be used to convert various production formats to the usage format Theora. Files in the production format Ogg Theora do not require conversion. Because files on Wikipedia are no larger than 100 Mb, Miro can also be used if another type of compression is required for the format.
• Usage	Recent versions of the browsers Mozilla Firefox, Opera and Google Chrome offer standard support for Ogg Theora and Vorbis. Ogg Theora and Vorbis files can also be played easily in the old browser versions and the browser Internet Explorer. In this case a Java application is used for playback.
• Archiving	
Variations	
Issues	

5.4 Broadcasting process of the public television channels in the Netherlands

Practical application	The digitised broadcasting process and archiving of Standard Definition material by the public television channels of the Netherlands.
Description	The broadcasting process of the Netherlands' public television channels was fully digitised in 2006. This means that, from that moment, broadcasting companies started increasingly submitting digital files instead of video cassettes. Since then, submitted video cassettes have been digitised and also broadcast as files. The conversion system was built by Technicolor on behalf of Netherlands Public Broadcasting (NPO) and is called De Digitale Voorziening (Digital Facilities) [1]. After broadcasting, the digital files are passed on to the Netherlands Institute for Sound and Vision, and the material is put in the Digital Archive. With the iMMix search system, the Institute provides users with a tool they can use to find, order and reuse material.
Actors	• Netherlands Public Broadcasting commissioned De Digitale Voorziening (DDV). • The individual public broadcasting companies deliver the material to the broadcasting system and are reusers of the content in the archive. • The Netherlands Institute for Sound and Vision is the manager of the archive and the provider of the iMMix search system and the Digital Archive. • As the enabling partner, Technicolor is involved in the design of both DDV and the Digital Archive. It is also a service provider. • Other users of archive footage include universities, researchers, production companies, and regional and foreign broadcasting companies.
Assumption	• Uniformity in the material delivered, in terms of both interfacing and file format, despite the large number of parties by which it is submitted. • Permanent archiving, so the material can be reused at a later date. • A minimum of closed (supplier-specific) formats.
Steps	
• Production	Dozens of broadcasting companies deliver material to the central broadcasting system. Furthermore, the broadcasters cooperate with a large number of companies to ensure that a wide variety of formats are used in the production process. NPO has decided to standardise the delivery format for the broadcasting process (DDV). It wants this for a variety of reasons, such as the fact that a central system that can support multiple formats is more complex and therefore more expensive. Moreover, with a standard format consistent quality can be guaranteed more easily. All parties involved deliver their SD material (SD = Standard Definition) in the MXF-D10 50 or MXF-D10 30 format, which only differ from one another in bitrate. MXF D10 is an open container format that utilises the MPEG-2 codec for video. MPEG-2 is not an open standard, as it is protected by patents. However, the format is widely supported by the manufacturers of the hardware used in the Netherlands' television industry. MXF-D10 was selected based, among other things, on quality, market support and file size.
• Distribution	Users can view and order material using the Netherlands Institute for Sound and Vision's iMMix search system. The majority of professionals are familiar with HiRes, but it is also possible to order a derived format. The HiRes file is then converted to the desired format for broadcast via a digital theme channel, distribution on DVD, or, for instance, use on the internet. If required, the material can also be returned to a physical carrier such as a video cassette.
• Usage	MXF D10 is a large format approximately ten times the size of DVD video, making it unsuitable for viewing on a PC or distribution via the internet. Consequently, the MXF D10 file is also converted into a smaller MPEG-1 file so the material can be previewed on a PC. MPEG-1 is a somewhat older format. This format was selected in 2006 because at the time there were no sufficiently developed standards that could be used for this purpose. An advantage of MPEG-1 is the fact that it now satisfies all the requirements for an open standard. For instance, the patents it was previously protected by have now expired. Alternatives such as Windows Media and Real Video were considered, but not chosen, first of all because they are not open standards. Secondly, they are formats which are rapidly followed by newer versions. Because the MPEG-1 format can also be passed on to the Netherlands Institute of Sound and Vision for archiving, durability is important. In addition, NPO also had a system built that converts material for use on the internet. This system encodes into all 'modern' formats and is scalable and flexible to changing and new formats.
• Archiving	After broadcasting, the material is passed on to the Netherlands Institute for Sound and Vision in the form of HiRes files in the MXF D10-50/30 and MPEG-1 formats for previewing purposes. The internet formats are not archived, as this would create an archive with a proliferation of formats, which is more difficult to manage. Furthermore, this would probably be of limited use, because if a program is requested within a certain period of time, the internet format which is popular at that time will be different from the stored formats.
Variations	
Issues	In recent years we have learned that agreeing a standard is not the same as applying it meticulously. Suppliers claim that their equipment and systems meet these standards. Organisations that buy them assume that this is the case. However, it has emerged that in some cases slight deviations are made from the standard. In the short term this does not necessarily have to be a problem. For instance, for public broadcasting companies this in no way affects the broadcasting of the material. However, storing material which is not fully compliant can cause major problems in the future. As a result, the decision has been made to perform spot checks on submitted material to prevent corrupt files from entering the archive. The durability of the selected format represents a challenge for the future. Newer formats will appear and replace the old format. For instance, there is now already a different format for High-Definition material. This raises the question of what should happen with the older formats. Whilst the migration of the storage infrastructure takes place in the background, and technology will replace the older technology, a decision must eventually be made as to whether the older file format needs to be converted to a newer format.

5.5 Digital Heritage: Building a Successful ICT Strategy (DE BASIS)

Practical application	DE BASIS – minimum requirements for digitization of heritage.
Description	Almost all of the Netherlands' heritage institutions use ICT to achieve their strategic objectives. Digitization the collection is an important part of this process. Institutions that follow DE BASIS promote effective and sustainable use of ICT within their organisation, which is a requirement for participation in the Digitale Collectie Nederland (Netherlands Digital Collection).
Actors	Primarily the heritage institutions themselves, as well as the Ministry of Education, Culture and Science, and subsidisers and ICT suppliers.
Assumption	Institutions make a high-quality digital reproduction or 'master', which can meet usage requirements now and in the future. Exchange and reuse of digital heritage reinforces the role of heritage in society. Minimal requirements contribute to the quality of heritage digitization.
Steps	
• Production	Preferably uncompressed in TIFF format. Due to the limited storage space, JPEG 2000 lossless compression can be used if required. For large numbers of text files, JPEG (lossy compression) acceptable.
• Distribution	Primarily metadata (see 'Usage').
• Usage	DE BASIS defines minimum requirements for the metadata: Dublin Core. This metadata is made findable according to DE BASIS for findability. By means of a URI, the metadata provides access to the derivatives of the digital reproductions made available as JPEGs by the managing institution.
• Archiving	The master is archived according to DE BASIS for digital durability, and the heritage institution can outsource this process to an e-depot.
Variations	Quality control for digitization of cultural heritage is self-regulated. In other words, heritage institutions have the freedom to deviate from DE BASIS for strategic or tactical reasons DE BASIS is part of the ICT register of Digital Heritage Netherlands, which documents the standards and guidelines which are considered better or best practices.
Issues	In a period of three years, DE BASIS has selected 26 instruments as minimum practices. Evaluations are also performed to, amongst other things, establish which instruments no longer belong in DE BASIS, which – new or otherwise – are missing, and for which subject matter minimum requirements can be imposed. In addition, validations are performed to ascertain how third parties and institutions can establish whether DE BASIS is being complied with.

6. Conclusion

A large variety of file formats exists for images, audio and video. In this document we favour the use of open standards because they enhance accessibility and sustainability of files and offer the user more freedom of choice. The practical examples demonstrate that there are some open multimedia formats that are ready for use.
Below, the most important formats are listed for each media type:

- **Images:** The open formats JPEG and PNG for distribution and use of images are widely used. Use of these formats is therefore advisable. JPEG is particularly suitable for photographs, while PNG is the best choice for drawings, such as logos. For production and archiving of images, closed formats (such as TIFF and RAW) are most commonly used. Open-standard alternatives are JPEG 2000 and PNG.

- **Audio:** Vorbis is an open format for distribution and use of audio. Vorbis is less widely used than closed counterparts (MP3 in particular), but support is increasing. Use of this format contributes to accessibility and freedom of choice. Since the open format is not yet widely used, alternative playback options may be offered to ensure broad accessibility. For production and archiving of audio, closed formats are most common. Open formats such as FLAC are sometimes used.

- **Video:** Theora is an open format for distribution and use of video. Theora is less common than MPEG-4 (H.264/AVC), but support is increasing. Use of this format contributes to accessibility and freedom of choice. Since the open format is not yet widely used, alternative playback options (fallbacks) may be offered to ensure broad accessibility. For production of video (MPEG-2) use of closed formats is most common. Open-standard alternatives, such as Dirac, are rarely used.

Conclusion

This document is a snapshot in time of the rapidly developing world of multimedia formats. The wiki of NOiV (wiki.noiv.nl) offers everyone the opportunity to help keep this document up to date. Recent developments with WebM show that the situation has far from crystallised, and that further developments are definitely on the horizon. Whilst closed standards are currently still common, it seems that interest is rapidly waning. Consequently, there is a clearly growing trend towards increasing availability and support of open multimedia formats. Things are moving in the right direction!

The NOiV Programme Agency (The Netherlands Open in Connection) and the Standardisation Forum have compiled this document to offer more insight into the consequences of the choices you make (either consciously or unconsciously) with respect to accessibility and sustainability of multimedia files. With this document, we hope to increase awareness of how developments may be influenced. Hopefully, you will decide to select open multimedia formats, because these offer users more accessibility, are more sustainable and offer more freedom of choice.

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Appendix 1: List of multimedia file formats

Audio			
Standard	**Version**	**Maintenance organisation**	**Function**
Windows Media Audio (.wma)	10	Microsoft	Compressed sampled multi-channel sound with possibility of DRM and streaming.
Compact Disc Digital Audio System	IEC 60908	Philips	Uncompressed sampled stereo sound.
Waveform Audio File Format (.wav)		Microsoft	Uncompressed sampled stereo sound.
Broadcast Wave Format (.wav)	2003	European Broadcasting Union	Uncompressed sampled stereo sound and metadata.
MPEG-1 Audio Layer 3 (.mp3)	ISO/IEC 11172-3, ISO/IEC 13818-3	ISO/IEC MPEG Audio Committee	Compressed sampled stereo sound.
Ogg Vorbis (.ogg)	1.2	Xiph.Org Foundation	Compressed sampled multi-channel sound with possibility of streaming.
RealAudio	10	Real Networks	Compressed sampled multi-channel sound particularly suitable for streaming.

Openness	Market support	Links (for instance tools)	Comments
- Open alternative: Vorbis or FLAC	+/-	http://www.microsoft.com/windows/windowsmedia/forpros/codecs/audio.aspx	An open alternative is Ogg Vorbis or FLAC. A commonly used alternative is MP3.
- Open alternative: none, due to specialised hardware (CD players)	+	http://en.wikipedia.org/wiki/cdda	This is the standard for audio CDs.
+/- Open alternative: ?	+	http://en.wikipedia.org/wiki/wav	
?	+	http://en.wikipedia.org/wiki/Broadcast_Wave_Format	This is an extension of the WAV format. The files do have the same extension. This format is mainly used for radio and television production.
- (For each MP3 encoder (converting uncompressed music into MP3) a fee must be paid. Patented. Open alternative: Ogg Vorbis	+	http://www.chiariglione.org/mpeg/	MP3 occurs as an independent file format (.mp3), but can also be used within video formats for storing sound.
+	+/- (expanding rapidly) Not the same level of support in hardware players as for MP3.	http://www.vorbis.com	An open alternative for MP3.
- Open alternative: Ogg Vorbis	-	http://en.wikipedia.org/wiki/RealAudio	Container format. Can use different (non-open) codecs.

Audio			
Standard	**Version**	**Maintenance organisation**	**Function**
Standard MIDI File (.mid)	RP-032	MIDI Manufacturers Association	Polyphonic music
Audio Interchange File Format (.aiff)		Apple	Uncompressed sampled stereo sound.
Free Lossless Audio Codec (.flac)	1.2.1	Xiph.Org Foundation	Compressed sampled multi-channel sound.

Openness	Market support	Links (for instance tools)	Comments
+ (see midi.org about us)	+	http://www.midi.org http://en.wikipedia.org/wiki/Musical_Instrument_Digital_Interface	Contrary to most audio formats, Midi is not wave-form-based. It is a command language for controlling digital music devices.
?	- Well supported by Apple systems.	http://en.wikipedia.org/wiki/Aiff	In Apple OS X a different version is used than in previous editions (AIFF-C/sowt).
+	+/- Market support for playing is not optimal, for instance not supported by Windows Media Player, but supported by Winamp.	http://flac.sourceforge.net	It is a lossless compression format. Combined with the Ogg container format, FLAC can also be streamed.

Images

Standard	Version	Maintenance organisation	Function
Scalable Vector Graphics (.svg)	Tiny 1.2	W3C	Raster and/or vector image.
JPEG (.jpg of .jpeg)	ISO/IEC IS 10918- or ITU-T Recom-mendation T.81	Joint Photographic Experts Group	Raster image, particularly suitable for photos. Compression: yes, lossy Colour depth: 24 bits Transparency: no Animation: no
Exchangeable image file format (EXIF)	1.02	Not a maintained standard.	Metadata for images.
JPEG 2000	ISO/IEC 15444	Joint Photographic Experts Group	Raster image, particularly suitable for photos in which a continuous colour scheme is very important. Compression: yes, lossy Transparency: no
		(ISO/IEC 15444)	Animation: no
Graphics Interchange Format (.gif)	89a	Compuserve	Raster image Compression: yes, lossy Colour depth: 8 bits Transparency: yes Animation: yes

Openness	Market support	Links (for instance tools)	Comments
+	+/-	http://www.w3.org/graphics/svg	XML-based.
+ Several parties have claimed patents for JPEG. However, these have not been assigned and the openness of the format is currently unimpaired.	+	http://www.jpeg.org/	The format concerned here is in fact JFIF: JPEG File Interchange Format. The JPEG storage format is inextricably linked with the compression algorithm.
+/- Open alternative: ?	+	http://www.exif.org/	The EXIF format is primarily used in digital cameras (also to add metadata on the photo/camera). Only works in combination with JPEG or TIFF.
+ There may be parties that hold patents. However, these have not been assigned and the openness of the format is currently unimpaired.	- The standard has not yet been fully developed. There are still many compatibility problems.	http://www.jpeg.org/	Modern file format with improved compression. JPEG 2000 is used in the medical world for temporary storage of X-rays.
+/- Open alternative: PNG (for still images)	+ (GIF is still widely used for animated images; for still images, PNG is a better alternative).	http://en.wikipedia.org/wiki/Graphics_Interchange_Format	The GIF (Graphics Interchange Format) file format was originally set up for the web. The number of possible colours in a GIF is limited to a maximum of 256.

Images

Standard	Version	Maintenance organisation	Function
Portable Network Graphics (.png)	ISO/IEC 15948:2003 / W3C Portable Network Graphics (PNG) Specification (Second Edition)	ISO / IEC / W3C	Raster image Compression: yes, lossless Colour depth: 24 bits Transparency: yes Animation: no
BMP (.bmp)		Microsoft	Raster image Compression: possible Colour depth: 1 to 32 bits Transparency: yes (in 32-bit version) Animation: no
Tagged Image File Format (.tiff)	6.0	Adobe / ISO	Raster image, particularly suitable for storing multiple images in one file. Compression: possible, lossy Colour depth: 24 bits Transparency: no Animation: no
RAW		Not standardised	Uncompressed raster images.
Computer Graphics Metafile (.cgm)	WebCGM 2.0	W3C	Metafile for vector and/or raster images.
Windows Metafile (.wmf of .emf)		Microsoft	Metafile for vector and/or raster images.

Openness	Market support	Links (for instance tools)	Comments
+	+ (support in many browsers)	http://www.libpng.org/pub/png/	The PNG (Portable Network Graphics) format applies lossless compression, reducing the size of files without any loss of quality. PNG is seen as the open alternative to GIF. In some cases, it can also replace BMP and JPEG. BMP en JPEG dienen.
- Open alternative: PNG	+	http://en.wikipedia.org/wiki/BMP_file_format	Relatively large file size, and no suitable compression algorithms.
+/- (patents and relationship to Adobe) Open alternative: PNG	+/-	http://en.wikipedia.org/wiki/Tagged_Image_File_Format	Suitable for storing faxes, as it can contain multiple images.
- - Standardised alternative: DNG	-	http://en.wikipedia.org/wiki/Raw_image_format	Manufacturers of photo cameras use RAW formats for storing and exchanging uncompressed photos. Manufacturers use different formats.
+	- Little support on the web. Is primarily used in technical areas.	http://en.wikipedia.org/wiki/Computer_Graphics_Metafile	
- Open alternative: SVG	+/-		Format allows execution of potentially unsecure code.

Images

Standard	Version	Maintenance organisation	Function
Microsoft Visio (.vsd)	12.0 (2007)	Microsoft	Metafile for vector and/or raster images, intended for creating diagrams.
Digital Negative (.dng)	1.3.0.0	Adobe	Raster image Compression: no Colour depth: 24 bits Transparency: no Animation: no
Extensible Metadata Platform (.xmp)		Adobe	Metadata for images integrated in other file formats.
IPTC		International Press Telecommunications Council?	Metadata for images and text integrated in other file formats.
Multiple-image Network Graphics (.mng)	1.0	?	Raster image Compression: yes, lossless Colour depth: 24 bits Transparency: yes Animation: yes
Encapsulated PostScript (.eps)	3.0	Adobe	Raster and/or vector image.

Openness	Market support	Links (for instance tools)	Comments
- Open alternative: SVG (MS Visio can import and export SVG)		http://en.wikipedia.org/wiki/Microsoft_Office_Visio	
+/- free to use, no open standard. Adobe has registered the format with ISO as a modification of the TIFF/EP standard.	+/- Standard has not yet been adopted by many manufacturers.	http://en.wikipedia.org/wiki/Digital_Negative_%28file_format%29	DNG is designed as a standardised alternative for RAW.
- Patented	?	http://en.wikipedia.org/wiki/Extensible_Metadata_Platform	
?	?	http://en.wikipedia.org/wiki/IPTC_Information_Interchange_Model	
?	- (often support with plug-ins)	http://www.libmng.com/pub/mng/	
+/-	?	http://partners.adobe.com/public/developer/en/ps/5002.EPSF_Spec.pdf http://en.wikipedia.org/wiki/Encapsulated_PostScript	

Video

Standard	Version	Maintenance organisation	Function
MPEG-1	ISO/IEC 11172	ISO/IEC	Compressed video. MPEG-1 is the format used for creating VCD (videoCD). It was the first widely used format for digital video.
MPEG-2	ISO/IEC 13818	ISO/IEC	MPEG-2 is a continuation of MPEG-1 for storing high-quality video. MPEG-2 has a higher compression and is applied in DVDs and digital (satellite) television. Is also used as broadcasting and archiving format by the national channels/ the Netherlands Institute for Sound and Vision.
MPEG-4	ISO/IEC 14496	ISO/IEC MPEG	MPEG-4 is designed to make high-quality video suitable for the internet. It contains a variety of advanced techniques that reduce the size of files even further. In addition to video, the MPEG-4 standard offers space for images, text, animation and interactive elements. MPEG-4 provides space for bibliographical data, including author, title, copyright, etc. Furthermore, the standard offers capabilities to protect intellectual property.
H.264 / MPEG-4 AVC	ISO/IEC 14496-10 and ITU-T H.264	ISO/IEC and ITU-T	AVC is Part 10 of the MPEG-4 standard (see MPEG-4). Within the standard, different profiles may be selected.

Openness	Market support	Links (for instance tools)	Comments
+/- (the video section is open; the audio section is still subject to patents that impair the openness)	+/-	http:// mpeg.chiariglione.org	Current browse format of the Netherlands Institute for Sound and Vision is MPEG-1. Is widely used internationally. The MP3 standard is incorporated in MPEG-1.
+/- (there are patents that limit the openness)	+ Broad hardware support. The disadvantage is that it is a family of different profiles. That means that there are many different possibilities. Choosing the right parameter set is important. For television archiving and broadcasting purposes, the D10 standard is used. That is a 50 Mbps I frame-only version of MPEG-2. only versie van MPEG-2	http://mpeg.chiariglione.org	Part 2 of MPEG-2 is designed for video. It is the format used by DVD players. It is also supported by Blu-ray players.
+/- (there are patents that limit the openness)	+/- The standard consists of 27 Parts. Implementations of the standard may support some, but not all Parts. Within the Parts, different profiles can be distinguished. Profiles do not always implement a complete Part.	http://mpeg.chiariglione.org	Some common Parts of MPEG-4 are listed in this table.
+/- (there are patents that limit the openness)	+ Circa two thirds of the videos online use this format, partially due to the fact that it is used by YouTube.		The format is supported by Blu-ray.

Video

Standard	Version	Maintenance organisation	Function
AAC (MPEG4) (.mp4, .m4a, .m4p)	ISO/IEC 13818-7 and ISO/IEC 14496-3	ISO/IEC	AAC is short for Advanced Audio Codec. The most recent AAC specification is included in the MPEG4 standard. AAC should offer higher quality and better compression than MP3. Although .mp4 is the standard extension for MPEG4 files, MPEG4 audio is often stored using the .m4a extension. The standard can be combined with Digital Rights Management (DRM) as applied for Apple iTunes. These files have the .m4p extension.
XviD			XviD is an implementation of the MPEG-4 standard, specifically MPEG-4 Part 2 Advanced Simple Profile.
DivX (.divx)			DivX is an implementation of the MPEG-4 standard, specifically MPEG-4 Part 2 Advanced Simple Profile.
Quicktime (.mov)	X (10.0)	Apple	Container format for video, etc.

Openness	Market support	Links (for instance tools)	Comments
+/- (there are patents that limit the openness)	- (little support?)	http://mpeg.chiariglione.org	
+/- The implementation has a GPL licence. There are, however, patents that limit the openness.	? (see, for instance, http://www.xvid.org/Interoperability.17.0.html)	http://www.xvid.org	Based on MPEG-4
- Alternative: XviD	+ Market support: hardware support via certification programme.		Based on MPEG-4
-			

Video

Standard	Version	Maintenance organisation	Function
Ogg Theora	1.1.1	Xiph.Org Foundation	Compressed video.
Real Video	10.0	Real Networks	Compressed video, suitable for streaming.
MPEG7	ISO/IEC 15938	ISO/IEC	MPEG7 is designed for assigning data (metadata) that describes audio en video. The metadata structure is based on XML and can contain information on, amongst other things, the structure and elements of the content (colours, shapes, objects, people, movement).
MPEG21	ISO/IEC 21000	ISO/IEC	MPEG21 focuses on smooth playback on devices with varying technical possibilities. A description of all media elements is included. In addition, MPEG21 offers extensive possibilities to verify the use and distribution of digital material. This Digital Rights Management enables complete control of the usage and can be set for each individual media element.
MP4	ISO/IEC 14496-14	ISO/IEC	MP4 is a standard container format for MPEG4 multimedia. It is described in the MPEG-4 standard itself (part 14). It has originated from the QuickTime format.

Openness	Market support	Links (for instance tools)	Comments
+ There is an open-source reference implementation.	+/- (growing market support from Wikipedia, Google etc.)	http://www.theora.org	
-	-	http://en.wikipedia.org/wiki/Real_Video	
+/-	?	http://mpeg.chiariglione.org	
+/-	?	http://mpeg.chiariglione.org	Controversial
+/-	+	http://mpeg.chiariglione.org	The MP4 container format can contain a variety of data, including MPEG-4 AVC, MPEG-2.

Video

Standard	Version	Maintenance organisation	Function
Advanced Streaming Format (.asf)	1.20.3	Microsoft	Advanced Streaming Format is the container format for Microsoft's WMA en WMV codecs for streaming. Other codecs may be used in it as well. It also offers possibilities for DRM.
Audio Video Interleave (.avi)		Microsoft	Audio Video Interleave (AVI) is a container format for PCs. In reality, many AVI files are encoded with MPEG codecs. This means the MPEG is packaged in the AVI form, where audio and video are interwoven. AVI cannot be streamed, meaning it must first be downloaded before it can be played.
Matroska (.mkv)		matroska.org	Matroska is an open and universal container format. It can contain a variety of data.
Ogg Media File (.ogm)			Ogg Media File was the standard format for the Ogg codecs, but is no longer supported by Ogg. Matroska is the alternative.
RealMedia		Real Networks	RealMedia is the standard container for RealVideo and RealAudio.
Material Exchange Format (.mxf)	SMTPE	Material Exchange Format. This container format is designed to enable the exchange between different (video) systems.	Material Exchange Format. Doel is met behulp van dit containerformaat de uitwisseling tussen verschillende (video) systemen mogelijk te maken. SMPTE 377M: The MXF File Format Specification

Openness	Market support	Links (for instance tools)	Comments
-	?	http://en.wikipedia.org/wiki/Advanced_Systems_Format	
-	+ (most commonly used)	http://msdn.microsoft.com/en-us/library/ms779636(VS.85).aspx	
+	?	http://www.matroska.org	

Video

Standard	Version	Maintenance organisation	Function
Synchronized Multimedia Integration Language (.smil)	3.0	W3C	SMIL (pronounced 'smile') enables animations with a programmed progression and interaction possibilities. (Synchronized Multimedia Integration Language)
Windows Media Video (.wmv)	9	Microsoft (standardised by SMPTE)	Windows Media Video: Compressed video
Flash Video (.flv of .swf)	10	Adobe	Compressed video for streaming. Is widely used for embedded videos on web pages.
Dirac	1.02	BBC	Dirac is a codec for compressed videos and must be used in a container format (for instance, Matroska).
VP8		ON2	Video codec
Digital Video Encoding (.dv of .dif)	IEC 61834-2	IEC	Compressed video. Is primarily used on tapes, but can occur as a file as well. Can also be integrated in a container as AVI, QuickTime or MXF.
WebM		Google	Compressed video on internet. Combination of Matroska, VP8 and Vorbis.

Openness	Market support	Links (for instance tools)	Comments
+	+ (is supported by most browsers)	http://www.w3.org/AudioVideo/	Offers many of the capabilities provided by Flash.
-	+/-	http://en.wikipedia.org/wiki/Wmv	
-	+ Market support: good, many players installed.	http://www.adobe.com/devnet/video/	Is used by YouTube.
+	-	http://diracvideo.org	Schrodinger is an open-source implementation of Dirac.
+	+/-	http://www.on2.com/index.php?599	On2 is taken over by Google.
+ The DV format is an open standard. Many non-open derivations have been created, including DVCPRO and DVCAM.	+/- Legacy compression method. Relatively broad support from hardware and software.	http://en.wikipedia.org/wiki/Dv http://www.digitalpreservation.gov/formats/fdd/fdd000183.shtml	
+	- , will probably increase rapidly to +	www.webmproject.org	New development. seems to be gaining considerable market support.

Appendix 2: Template for practical examples

The descriptions of practical applications are based on the below template.

Practical application	Name of practical application
Description	Description of the situation and the objectives.
Actors	Description of the involvement of the different actors.
Assumptions	List of the assumptions relevant to this use case.
Steps	Description of the use of standards, based on a number of common steps.
• Production	The production format: Development of material based on standards.
• Distribution	The distribution format: Distribution of materials based on standards.
• Usage	The usage format: Usage and playback of the materials based on standards.
• Archiving	The archiving format: Archiving materials for future use based on standards.
Variations	Description of variations or exceptions, if any.
Issues	Description of particulars, if known, such as plans for the future.

COLOPHON

A group consisting of specialists from various fields evaluated the subject and the file formats during a number of sessions. The current document was drawn up based on their findings. Subsequently, the document was reviewed and amended with practical examples.

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