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Optimising Media Contents for Mobile Devices

Creating Smart Media with Metadata

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The purpose of this thesis was to optimise audio visual content specifically for mobile devices. This included production of the content from the ground level with mobile use in mind and utilizing all the tools available to assess the best format for a specific mobile platform. Furthermore, this project takes into use of metadata to add intelligence into media contents.

The goal was reached by first producing a video called ‘A Day in Helsinki’, which is one minute and forty seconds long, and then exporting the video with various specifications corresponding to mobile devices. Before exporting the video, some concise and informative metadata were written in the media files. The metadata in the files were then analysed using metadata handling tools.

Subsequently, the videos that were encoded with technical and device specific metadata were valuable in efficient handling and management of the files, distinguishing them as optimal for mobile devices. The use of XMP Metadata introduced by Adobe has made it easier to include the data and manipulate them.

This thesis could be useful for someone who is producing media contents for mobile devices as the thesis covers different aspects of optimising, going from aesthetic qualities during the production process to technical details for better handling of media files. For publishing the media contents, the thesis can help developers in efficiently extracting appropriate media files for their targeted platform.

Keywords	video, mobile, optimisation, metadata, compression

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1 Introduction

Mobile devices have been an integral part of human lives for several years in modern society. In early days, mobile phones were only used for making calls but today as everyone is aware, mobile devices are not just limited to that. Mobile devices these days come in different shapes and sizes- cell phones, tablets or any electronic devices that are mobile enough. Since the introduction of smart phones and devices, there has been increase in the use of media contents and so there is rise in demand each day. Similarly, the market of audio-visual contents has increased significantly. The market is no more limited to televisions, films, CDs and DVDs. The availability of audio-visual contents for mobile devices is equally important as other platforms in todays' market sense and so the producers should be aware of the idea.

Video is a very effective way of delivering messages, concepts and advertisements for marketing and since everyone today owns one or two mobile devices, focusing on mobile platforms is a key to success. Planning and producing an audio-visual content specifically for the platform from ground level is necessary since not all videos are compatible with all mobile devices. Thus, creating aesthetically and technically compatible content for particular devices is what this thesis addresses.

This project was carried out as a Bachelors' final year thesis for Metropolia University of Applied Sciences. A video titled 'A Day in Helsinki' was produced and encoded with various settings corresponding to the mobile devices. The thesis explores how feeding data about data into a file can increase the efficiency of file handling while publishing the media files. The project thoroughly studies how such information can be created and manipulated by various means and therefore assuring that the right file gets delivered to a device. The theory also deals with how a video can be made aesthetically sound. Overall, the purpose of this thesis is to help in optimisation of an audio-visual content for mobile devices.

2 Mobile Videos

With innovative breakthroughs in technologies and wide availability of the internet, mobile devices are getting more popular than ever. They serve a very good number of purposes, like web browsing, cameras, navigation systems, movie players, games, online shopping and e-payments. Today, the possibilities of what a mobile device can do are limitless and unimaginable. A person is more likely to get breaking news, see an advertisement of a marketing campaign first on a mobile device rather than on television and in newspapers. It is the ease of access, either on-the-go, or at home or office that is making mobile devices more and more popular. Therefore, now, it can be stated as a social and economic fact that any media producer should be foolish if they do not target their contents for mobile devices as well.

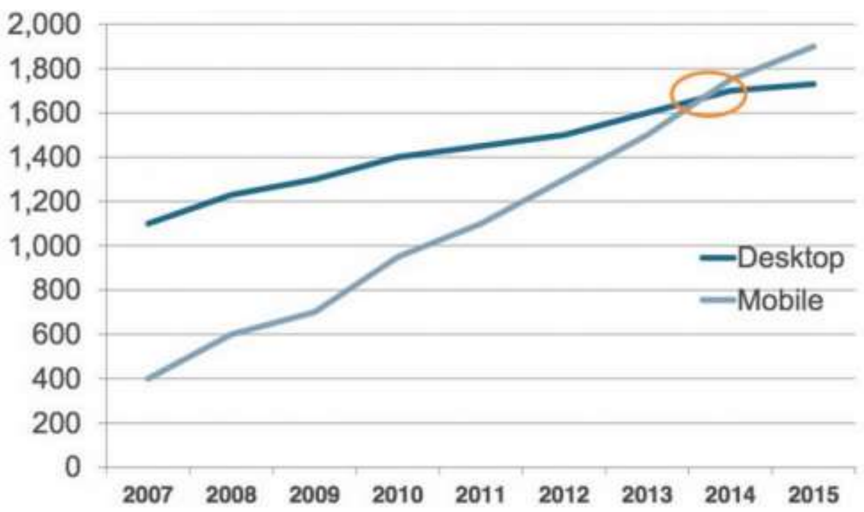

Figure 1. Number of global users (in million). Reprinted from Bosomworth (2015).

Figure 1 shows how the number of mobile users has grown over a duration of 9 years and has already overtaken the number of desktop users. The number has already passed 1.9 billion and is likely to grow more. These statistics support the above mentioned fact.

As the mobile users have increased significantly, so has the mobile marketing. It has been attracting more advertisements, investments and businesses. Today people can pay with their smart phones in a café instead of debit/credit cards, which shows how much market is shifting towards the mobile devices. Manufacturing companies are also natively integrating most of the basic services in their devices. Many kinds of electronic services are available in the form of applications or in browsers. Users can shop, pay, buy tickets, listen to music, watch movies/news and play games on their mobile device, and most of all, users seem to be spending more time on social networking sites like Facebook and Tweeter. (Perez 2014.) Today, people can virtually do anything with their mobile devices that they could have done with any other electronic devices. People are spending more time on mobile devices than on desktops, laptops and other connected devices combined.

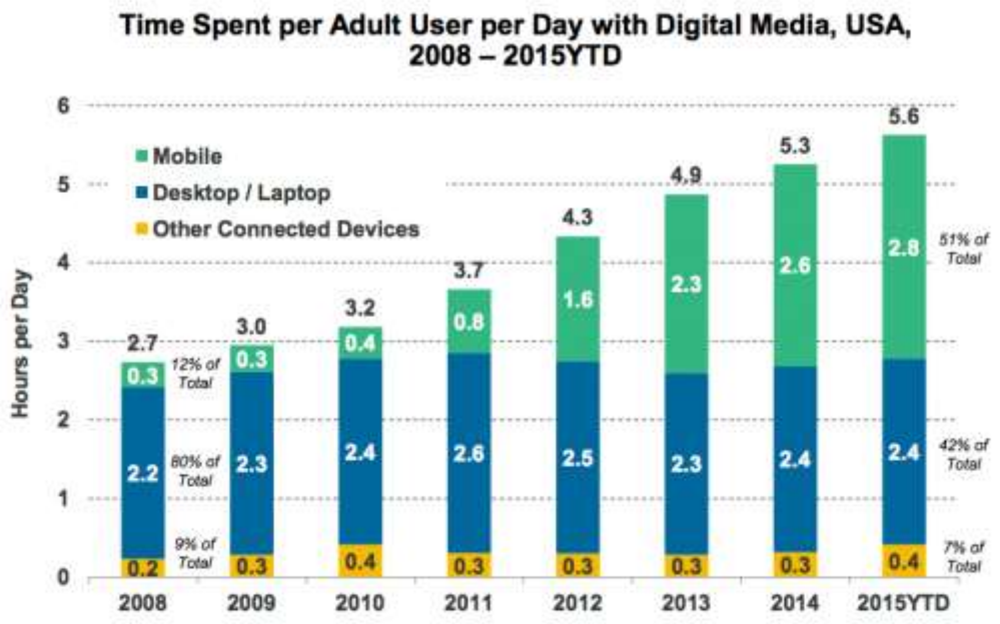

Figure 2. Time spent per adult user per day in USA. Reprinted from Bosomworth (2015).

It can be clearly seen from figure 2 that users are spending 51% of their time in a day on a mobile device which is more than on any other device (Bosomworth 2015). This number has been growing and is expected to grow further with the advancing technology. Thus, it is vital for the industries to target the mobile user groups, and creating exciting mobile experiences is what keeps them in the competition.

Business thrives on quality services. Consumers are easily attracted towards quality products and stay with them until their expectations of standards are met. There are many opportunities for marketers' to utilise this new trend of mobile media consumption (Chaffey 2015). So producing and delivering quality media content should be a fundamental duty of production teams. However, since not all audio-visual contents are the same and not all mobile devices are similar, optimisation of media files is necessary for smooth distribution across multiple mobile platforms.

In this context, a digital media service would be a quality one if the media file played or displayed properly/smoothly or as it should in the device. A typical example of such a case scenario would be a video intended for iPhone 4 that does not display properly in iPhone 6 since there is not enough pixels for the bigger screen in the video. At the same time, there is no point of creating high bitrate videos for mobile devices since they are meant for bigger screens like televisions and these devices usually have lower bandwidth receptions. A video intended for a mobile device should be of the best quality at least possible file size. Therefore, there is a necessity of appropriate codecs and formats for specific devices. By creating and manipulating metadata, the right files can be delivered to a device, which will be discussed further in this thesis. Furthermore, each model of mobile devices is designed differently to another, so a mobile video should also be optimal to its kind.

Figure 3. Varying screen resolution and sizes. Reprinted from Deraco (2013).

As seen in figure 3, different products have varying screen sizes and resolution, which should be kept in mind while producing mobile videos. The formats of the media file a device supports may also differ from one another since different manufacturers follow various standards. A media file functions at its best when it is optimised to the standards and specifications of the device.

The technology behind digital media has drastically enhanced over the last decade. Analog videos were easily surpassed by digital videos. They were easier to produce, handle and store. A digital video is a collection of a number of images that represent a moving action. Each frame is built with pixels and the density of pixels defines the resolution of the video. More resolution adds more details to the picture. Most of the videos produced these days are in High Definition (HD). Though Ultra High Definition (UHD) videos are also produced for television and films, most commonly used format is still HD till this date.

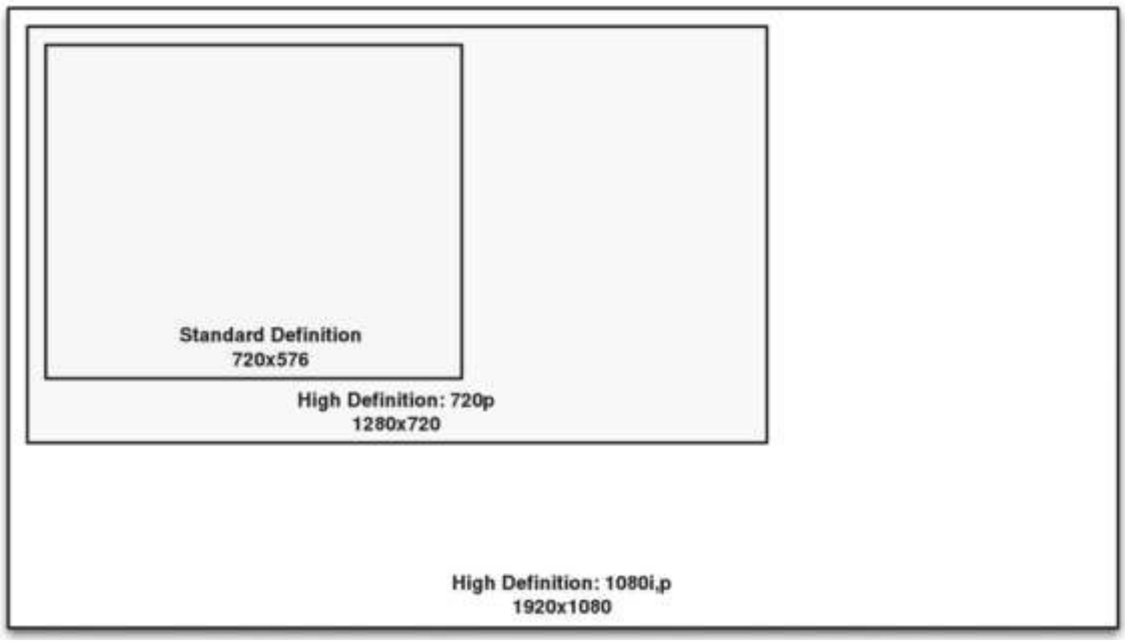

Figure 4. Display formats. Reprinted from Richardson (2010, 19).

As seen in figure 4, if a video is produced at 25 frames per second (fps), a Standard Definition (SD) video has (720x576x25) 10,368,000 pixels per second. Similarly, a 1080p HD video has (1920x1080x25) 51,840,000 pixels per second. Larger resolution of videos results in larger file sizes. Hence, the digital videos need to be compressed according to the requirements since the raw files are too large to store or transfer. (Richardson 2010, 18.)

3 Compression

Video compression also termed video encoding is the reduction in the quantity of data needed to represent a series of digital images before transmission or storage of the audio-visual content whereas video decoding is the process of recovering such compressed data before display or broadcast (Richardson 2010, 2). A video consists of sequence of frames in a time-order. Therefore, in simple terms, compression omits the repetitive data from the sequential frames with a set of codes usually termed as 'codecs'. Video encoding is important because storage space or transmission capacity is limited to some extent and the source files are practically always larger.

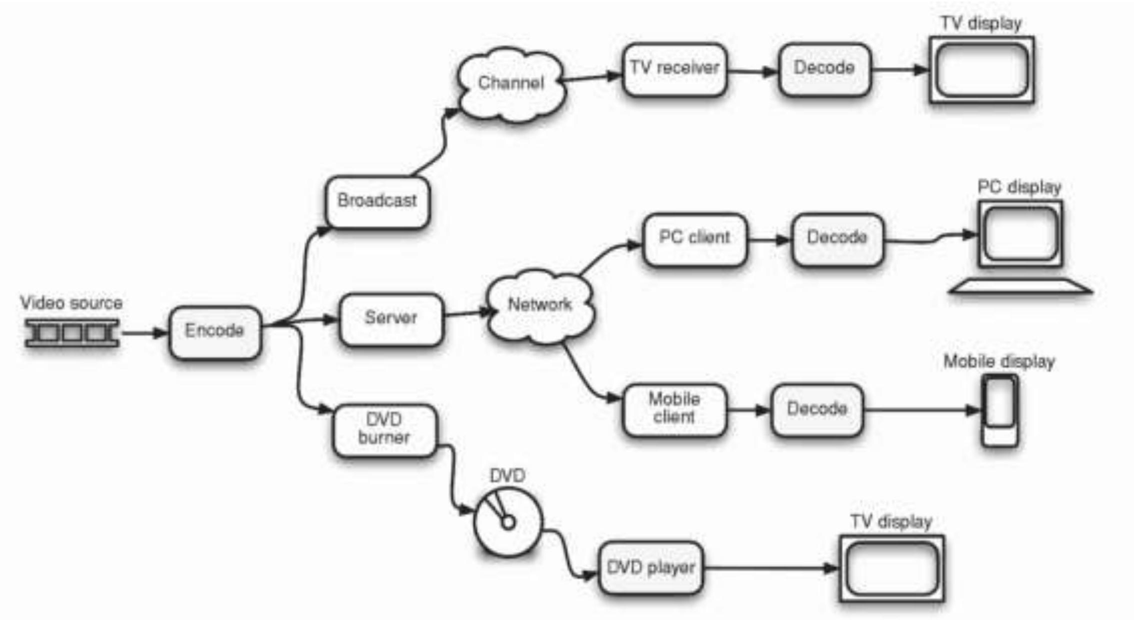

Figure 5. Typical representation of video coding. Reprinted from Richardson (2010, 3).

Figure 5 shows a case scenario for video encoding and decoding. It shows better the implementation of video coding and decoding phenomena. These are the typical examples of how encoding and decoding works in reality. During television broadcasting, video files are encoded before transmission to effectively transmit through limited bandwidth and are decoded before they reach the television. Similarly, for mobile streaming, the video is encoded before broadcasting over a mobile network. The encoding specifications however differ with the medium the video is being transmitted over. Overall, each case involves a video file being encoded before broadcasting, storing or uploading to a server and then transmitted through a medium and finally being decoded before it is viewed in the platform.

The sole purpose of compression is to reduce the number of bits required to represent an image, sound or other data (Poynton 2012, 147). This process of compacting data into a smaller number of bits is done by removing redundancy or the data that are not necessary for reversal to its nearest original composition (Richardson 2010, 25). There are several standards for video codecs like H.264, MPEG-4, VP8, etc. However, these codecs are not compatible with each other, which means, a video compressed with the H.264 codec cannot be decompressed by other codecs. There are different codecs developed by different organisations. Some of the most commonly used are the ones mentioned above.

A codec is a set of algorithms that uses different methods to analyse the data that can be reduced and eliminate them. Various techniques are used in codecs to calculate and determine the unnecessary data such as reducing color nuances, reducing color resolution, removing small invisible parts, comparing adjacent images and removing details that are unchanged. Some techniques use complex frame based mathematical calculations to analyse the data: where every single frame is analysed whereas some use psycho-visual properties that exploit the characteristics of human perception. (Axis 2008.) Therefore, file sizes are reduced in a substantial amount with negligible effect in their visual quality.

Different codecs use different methods of compression and, thus, result in different size and quality. However, there are many factors to be considered while compressing files, like the compression ratio, processing capabilities of the device, deterioration of frame quality. (Axis 2008.) There are two types of compression, which are discussed further.

3.1 Lossless Compression

Lossless compression is the type of compression where bit for bit of data is reconstituted after decompression and the decoded file is an exact copy of the original one. However, this method of compression allows only a moderate level of compression. (Richardson 2010, 25.) It means that limited techniques are available for lossless compression and the compression ratio is also limited since it has to maintain most of the details and information. This leads to a low compression ratio and relatively large file sizes.

3.2 Lossy Compression

Lossy compression is the type of compression where the compression ratio is high but at the expense of loss of visual qualities. It is therefore obvious that the decompressed file is not identical to the original file. This system is based on the principle of removing subjective redundancy, which means exploiting the limitations of viewer's perception. (Richardson 2010, 25.) This method is necessary where file sizes need to be reduced drastically for transfer, broadcast or storing of files in a practically viable manner.

This compression method is used for data that is not sensitive to losses and still maintains visually acceptable qualities. Nonetheless, the degree of compression depends on the user's requirements, which can result in either high quality or low quality videos. Ideally, during compression, only the irrelevant data is supposed to be removed but there is no certainty to it. Sometimes, it can also impair data visible to human eyes. However, the ultimate goal of this method is to gain maximum compression to quality ratio. There are many codecs available in the market, both commercially and some without any royalties.

4 Content Production

This part of the thesis deals with aspects of content production that have been realised during this project. There are many things to consider while producing a mobile video. The producer should be aware of the fact that the audio-visual content is meant for relatively smaller screens of mobile devices rather than bigger screens such as televisions and desktops. S/he should know that the mobile devices have limited bandwidths comparatively and the processing power of the devices is also limited. Hence, strict attention should be given to file sizes and profiles or else the video playback may not be smooth enough. There are many codecs available in the market to choose from; choosing the right one with best settings is also one of the challenges. The factors to be considered while producing an audio-visual content optimal for mobile devices are discussed further.

4.1 Aesthetics

The first thing everyone notices when watching a video is its quality. Poor quality media content can easily distract the consumer. Engineers may later look into the technical details of a file but at the first glance, aesthetic quality is what gives the first impression to everyone. The human brain pays more attention to visual contents but the standards for videos have also been raised over time with the advancing technology. However, the purpose of a video is to keep the audience interested rather than frustrating it. Some of the factors leading to improvement in aesthetic quality of a video, especially for a mobile device, are discussed below.

4.1.1 Proper Framing

Though shooting a video is essentially similar for a given storyline irrespective of the platform it is going to be displayed, it could prove to be better to think about the shot sizes for some scenes one more time. If a video is solely intended for mobile devices, the details would be more visible if extremely long-shots were avoided and close-up shots were used more. Since, the screen sizes are relatively smaller, the story would be depicted better if the shot sizes were planned beforehand and if the contents or details are clearly visible in the shot. Also, using less movement shots, clear images can provide a great experience for the audience. (Mosko 2014.) Basically, shooting for mobile is a great way to start.

4.1.2 Text Size and Thumbnails

Similar to shooting a video for mobile, where the subject is shot to be more visible in smaller screens, a good practice would be to increase the size of the texts used in the video. Use of tiny texts should be avoided. It is better to target the smallest screen size available; in today’s market a 4-inch screen would be an ideal test platform.

Since the video’s thumbnail image has the potential to be invisible on smaller screens, it would be a good idea to design the thumbnail cover for the mobile users. A big object covering the whole frame will work as a good thumbnail image for any screen size. It will help users easily recognize the video and easily browse through many videos.

4.2 Bandwidth

It is always a good idea to keep the videos intended for mobile devices light as there is no guarantee over the kind of connectivity users will have. It could be 3G, 4G or Wi-Fi or it could sporadically change between any two. Hence, it is good to be prepared for the worst. Keeping the file sizes and codec profiles low will boost the performance of the videos in the devices. (Mosko 2014.) However, at the same time trying to maintain the quality is a great challenge. When it comes to websites, limiting the number of plugins, add-ons and any other extra features can also save a lot of bandwidth.

4.3 Ease of Access

It is always a good practice to test the usability of any application in the field of technology. It is the same with mobile videos. The feature in and around the video should be easily accessible and the videos should play smoothly. Testing what the video looks like and its usability and ensuring that the video provides a positive response is always a must.

4.3.1 Responsive Player

When embedding videos to a page for a mobile device, creating a responsive web page and player drastically improves the experience in watching videos. Making the video player responsive can retract the video player to the screen size; there is consistency with the page. (Marshall 2014.)

4.3.2 Links

Providing links to other pages or videos is a good way to connect. However, when the screen size is already small and half of it is covered with some other feature, watching video is a really annoying experience. Giving the links below the video or in some other part of a webpage rather than the video player can help prevent such bad experience.

4.3.3 User Input

Unlike desktops and laptops, users need to tap the screen on mobile devices to give any input instead of clicking with a mouse, and there is not enough space on the screen for too many buttons. Therefore, limiting the number of buttons to a few but making them larger makes them more visible and usable. (Mosko 2014.) Increasing the usability, for example by making menus and navigation buttons large enough and easy to tap for a finger, also helps improve the video experience.

4.4 Audio-Video Quality

Compressing audio-video files to smallest possible size and still maintaining enough quality is always a challenging task. There are many settings and presets available to choose from by which a file can be exported from the editing software and still there is no such thing as the right setting. Obviously, the format needs to be supported in the device but for the same format, there can be multiple parameters. However, getting the best result, as for compression to size ratio in this case, requires a lot of practice and experience.

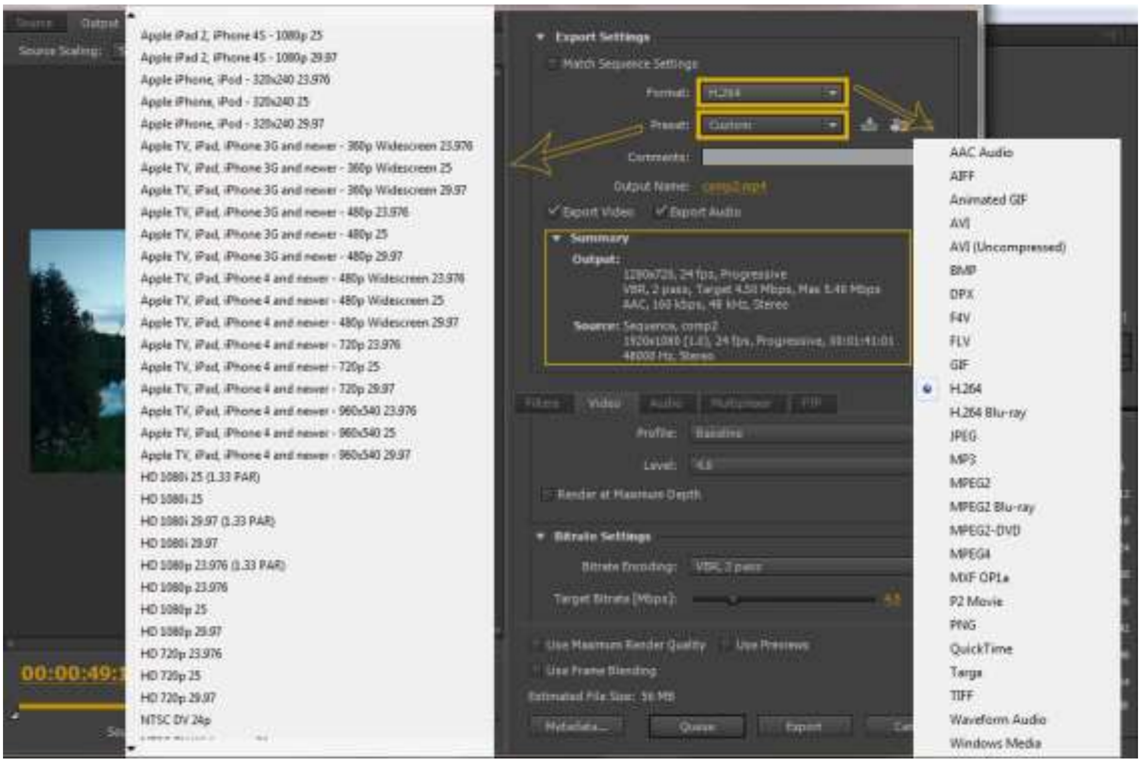

Figure 6. Screenshot of Formats and Presets. Screenshot (Adobe Premiere Pro CS6).

As seen in figure 6, there are many available codecs for compression and presets for various devices. The summary panel shows all the settings being used with the H.264 codec for this video. The resolution is 720p HD at 24 fps, the bitrate is 4.5 Mbps, and the profile is baseline at level 4, which is more than enough for mobile use. The settings for sound can also be seen in the panel. The video was exported using this setting and was played in iPad 2. The video and audio were clear and there was no visible distortion.

4.5 Codecs and Containers

Many people get confused with codecs and containers. They might sound similar but they are different units and have different functions. A codec is a standard of compression that constitutes sets of algorithms to encode and decode a file whereas containers, as name suggests, is a file that contains one or more codecs: audio, video and their metadata. Some examples of video codecs are H.263, H.264, VP8, VP9 and DivX and containers include mp4, avi, mov, webM and 3gp.

International Organization for Standardization (ISO) defines a standard as:

> A standard is a document that provides requirements, specifications, guidelines or characteristics that can be used consistently to ensure that materials, products, processes and services are fit for their purpose (ISO 2015).

Thus, a standard for a codec is a document that defines what a codec should do and how it should function so that it performs in a way that the outcome is acceptable throughout all grounds or all platforms. For example, H.264 is a standard for all H.264/AVC based codecs. It defines the methods to encode and decode a video so that the use of H.264 is compatible across all platforms.

There has been a huge development in how digital videos are processed over time. There are a lot of codecs that have been developed over the period. However, not all of them are similar; they have the same ultimate goal but their uses and how they function are different. Some of them are good for high quality videos, some for small sizes, and some for streaming whereas some are good for mobile use. They are efficient in their own ways and own areas. Some of the commonly used commercial and open source codecs are discussed below.

4.5.1 H.264 / MPEG-4 Part 10

H.264 is a commercially available and one of the most popular codec standards today due to its high efficiency compression and support across all platforms. For the same reason, only H.264 has been used as the codec for this final year project. It was developed by Joint Video Team (JVT) in an effort to extend MPEG-2 and during the development process; it developed towards Advanced Video Coding (AVC). The resulting standard was then promulgated jointly by the International Telecommunications Union (ITU-T) as H.264 and by ISO/IEC as MPEG-4 Part 10, despite having a very little to do with MPEG-4. (Poynton 2012, 160.) Nonetheless, it is now better known as H.264 across all stands.

H.264 is roughly similar to MPEG-2 but developments were made by more than a dozen of similar techniques. Specialists claim that its efficiency ranges from 1.5 to 3 times to that of MPEG-2. It allows encoding at more than half the bit rate of MPEG-2 for similar picture quality, which means a lot smaller file sizes. Therefore, it has been used in a wide range of applications; from surveillance videos to HDTV broadcasting and from mobile devices to internet streaming. (Poynton 2012, 537.)

H.264 is well known in many platforms people come across in their daily lives. It is also the coding standard for Blu-ray discs. It is also widely used across the internet. Some of the most known video streaming services like YouTube, Vimeo also use H.264 codecs. It is also supported in Adobe Flash Player and Microsoft Silverlight. Most importantly, for this project, it is supported in all mobile platforms.

4.5.2 H.265

H.265 is an enhanced version of H.264, which is the latest generation of video compression standard. It was developed by the Joint Collaborative Team on Video Coding (JCT-VC) and is also known as High Efficiency Video Coding (HEVC). It has been standardised by both ITU-T and ISO/IEC. (x265 2015.)

It was developed to provide twice the compression ratio of the previous H.264 standard. Although compression efficiency varies on the type of content and encoding settings, typically it is able to compress videos twice more efficiently than before. Therefore, it is capable of delivering the same visual quality at a lower bit rate and smaller file size, and it has support for Ultra-High Definition videos. (x265 2015.)

4.5.3 MPEG-4

MPEG-4 was developed by the Moving Picture Experts Group (MPEG) with the original goal of encoding videos at very low bit rates. It produced 3GP format files which were very popular in mobile devices until it was realized H.264 had a better performance with low bit rates as well. (Poynton 2012, 159.) However, MPEG-4 is still available and can be used to encode videos for mobile devices.

4.5.4 VP8

VP8 is an open source video codec, which was originally developed by On2 Technologies but acquired by Google in 2010. Since then, it started as a WebM project and Google released it as a free and open codec to be used by everyone. (Poynton 2012, 162.) It has been widely used as a video format for the internet and today almost all the latest browsers have support for it. It has generally low bandwidth requirements, making it more suitable for internet use, and its compression ratio is almost similar to that of the H.264 Baseline profile.

4.5.5 VP9

VP9 was developed by Google and is the successor to VP8. It also is an open source and royalty free video codec and has already been integrated to the Chrome and Mozilla Firefox browsers and to Youtube. (Poynton 2012, 162.) It is also supported by the HTML5 video tag.

4.6 Support for Media Format

Although this project has used only the H.264 codec, it is essential to know what other formats are supported across the mobile platforms. It is not just about other formats but also in case of H.264, it is important to have the knowledge of the general encoding settings like resolution, bit rate and profiles that are optimal for the mobile devices.

This section of the thesis deals with file formats that are recommended and supported in some of the well-known mobile Operating Systems (OS).

4.6.1 iOS

iOS supports many standard video and compression standards. Some of the standard encoding settings are listed below (Apple 2015):

- Only for iPhone 6s & 6s plus:
  H.264 codec with .m4v, .mp4 and .mov container;
  Video up to 4K, 30 fps, High Profile up to 4.2 with
  AAC-LC audio up to 160 Kbps, 48 kHz, stereo.
- H.264 codec with .m4v, .mp4 and .mov container;
  Video up to 1080p, 60 fps, High Profile up to 4.1 with
  AAC-LC audio up to 160 Kbps, 48 kHz, stereo.
- H.264 codec with .m4v, .mp4 and .mov container;
  Video up to 1.5 Mbps, 640 by 480p, 30 fps, Low-Complexity version of Baseline Profile with
  AAC-LC audio up to 160 Kbps, 48 kHz, stereo.
- H.264 codec with .m4v, .mp4 and .mov container;
  Video up to 768 Kbps, 320 by 240p, 30 fps, Baseline Profile up to 1.3 with
  AAC-LC audio up to 160 Kbps, 48 kHz, stereo.
- MPEG-4 codec with .m4v, .mp4 and .mov container;
  Video up to 2.5 Mbps, 640 by 480p, 30 fps, Simple Profile with
  AAC-LC audio up to 160 Kbps, 48 kHz, stereo.
- Motion JPEG (M-JPEG) with .avi container;
  Video up to 35 Mbps, 1280 by 720p, 30 fps with
  Audio in ulaw, PCM, stereo.

4.6.2 Android

Here are some media formats recommended for Android devices (Android 2015):

- H.264 with .mp4 container;
  Video up to 2 Mbps, 1280 by 720p, 30 fps, Baseline Profile with
  AAC-LC audio up to 192 Kbps, stereo.
- H.264 with .mp4 container;
  Video up to 500 Kbps, 480 by 360p, 30 fps, Baseline Profile with
  AAC-LC audio up to 128 Kbps, stereo.
- H.264 with .mp4 container;
  Video up to 56 Kbps, 176 by 144p, 12 fps, Baseline Profile with
  AAC-LC audio up to 24 Kbps, mono.
- VP8 with .webM, .mkv container;
  Video up to 10 Mbps, 1920 by 1080p, 30 fps.
- VP8 with .webM, .mkv container;
  Video up to 4 Mbps, 1280 by 720p, 30 fps.
- VP8 with .webM, .mkv container;
  Video up to 2 Mbps, 640 by 360p, 30 fps.
- VP8 with .webM, .mkv container;
  Video up to 800 Kbps, 320 by 180p, 30 fps.

4.7 Technical Details

Technical details such as frame rate and resolution were important to consider before starting the project since they play a significant role throughout the project regardless of the codecs used. It is easy to carry out a video project at 1080p and then encode the video at 720p, but it is impossible and impractical to start a project at 360p and export the video at 720p. Thus, planning basic project settings beforehand is important.

In this project Adobe Lightroom CC was used to edit the raw photos for the timelapse used in the video ‘A Day in Helsinki’. Adobe After Effects CS6 was used to create the timelapse sequence and to use the Warp Stabilizer effect on the sequence and also to create a black smoke effect for the outro of the video. Finally, Adobe Premiere Pro CS6 was used to put and edit all the sequences together.
The general sequence settings used for this project are:

- 1920 by 1080p
- 24 frames per second
- Progressive
- Pixel Aspect Ratio: 1
- 48 KHz audio sample rate

5 Metadata

In early days, accessing audio visual contents used to be a simple since a limited number of sources was available. Today an unimaginable amount of audio-visual information is available in digital form, in archives, on the internet and people and organisations create thousands of videos every day, and there is no end to it. The amount is increasing every day. However, the value of information depends on how easily it can be found, filtered and accessed.

The innovative and progressing technologies keeps on offering new and easy ways to produce digital media contents. Internet speed is increasing, offering more ways to sharing and broadcasting of multimedia. It is undeniable that users will be overwhelmed by the amount of data they can get access to. In contrast, obtaining relevant data is becoming exhausting due to the sheer volume of existing resources. Managing and locating data efficiently is getting more difficult these days for users and professionals as well. This is where metadata can play an important role by aiding in management of data.

Metadata is structured information that describes a digital file. It makes it easier to manage, locate and retrieve digital files. It can help users obtain data more efficiently. Metadata is also often called data about data. It has been standardized to describe the multimedia content that supports some level of interpretation between applications, computers or even humans. (Niso 2004.)

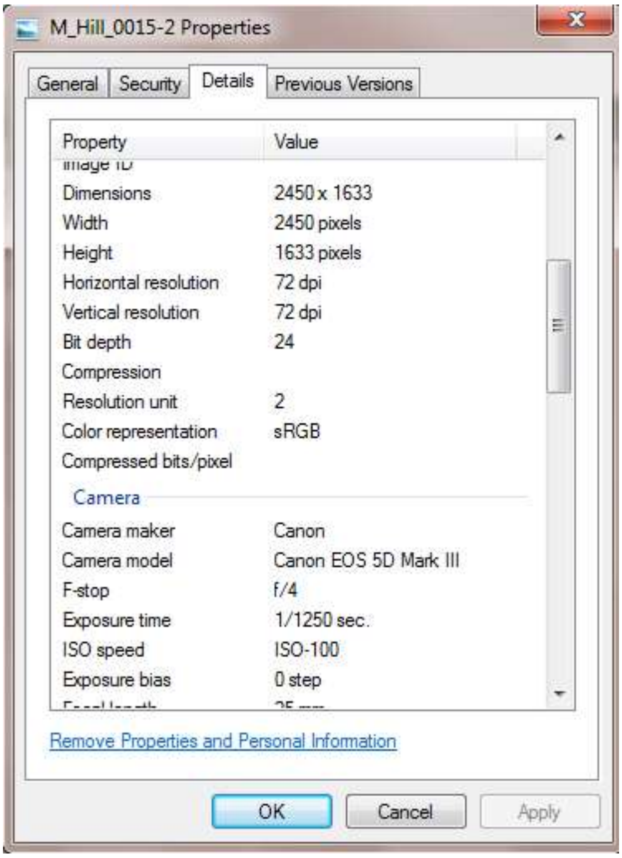

Figure 7. Properties of an image file in Windows

Figure 7 gives a very common example of a general metadata of an image file that can be found for every digital file. Everyone is used to viewing and editing basic metadata through the Properties dialog box in Windows. The dialog box shows the standard metadata stored by the camera while a specific picture was taken. Users can easily sort, manage or locate files in a directory with the help of these few available metadata.

Working with multimedia files is more efficient if the files have metadata embedded to it. Not only for users but also applications can also handle the content even if they do not understand the native format of the document. This way there is no misplacement or loss of contents and the use of metadata can critically increase efficiency of management of assets in production workflows. For example, an audio-visual file can contain metadata like title, director, producer, production date and copyright information. In production stage, there could be hundreds and thousands of such files. Thus, by accessing metadata, the project manager can easily sort out the files to be cleared for copyright permissions without actually having to open the file. (Niso 2004.)

In multimedia workflow, metadata can basically be classified into two groups (Rothmann 2015).

- The first is the data recorded by the camera during the shooting process or technical information about a file that has been altered during the production process, like the camera model, lens, aperture size, focal length, resolution or frame rate of a video. Nowadays, this information is universally embedded into the file.
- The second is customized metadata and user defined data. These descriptions are manually entered by users to serve specific purposes either during the production process or after. For example, in video production, the clips could have director, plot, scene, shot number, location or copyright information. Thus, the video clips can efficiently be accessed by scene numbers.

5.1 Standards of Metadata

Over the years, many metadata standards have been developed with a goal to establish a collective understanding and interoperability between applications and computers. To achieve this, various classes of metadata, also called tags have to be defined in a structure to ensure proper and correct use of information (Niso 2004). Hence, metadata schemas have been defined by such standards to efficiently link those elements to a particular resource for a specific purpose. Some of the useful metadata standards for these kinds of projects are listed in the next section.

5.1.1 DC (Dublin Core)

"Dublin Core is a basic 15 element set designed to represent core features across all resource formats (Riley 2010)." It is a standard that has been approved by ISO 15836-2003, ANSI / NISO Z39.85-2007 and IETF RFC 5013. It is known as the base for all metadata formats.

```
Format="image/gif"

Title="Dublin Core icon"
Identifier="http://purl.org/metadata/dublin_core/images/dc2.gif"
Type="image"
Format="image/gif 4kB"

Subject="Saturn"
Type="image"
Format="image/gif 640 x 512 pixels"
Identifier="http://www.not.iac.es/newwww/photos/images/satnot.gif"

Title="The Bronco Buster"
Creator="Frederic Remington"
Type="physical object"
Format="bronze 22 in."
```

Figure 8. A generic example of Dublin Core metadata. Reprinted from Dublin Core (2001).

Figure 8 shows how basic information about a file is stored by Dublin Core. It is indeed a baseline for many other metadata standard since its standard emphasizes the use of some basic elements.

5.1.2 MPEG-7

MPEG-7 is developed by Moving Picture Experts Group but unlike MPEG-2 or MPEG-4, it is not a media format but a standard for the description of the content of multimedia files. It provides structures for data for both humans and computers. It has description schemas for various levels of information, such as for some low-level features like lighting and colour, and for high-level features like rights, production process, history and technical information. (Riley 2010.)

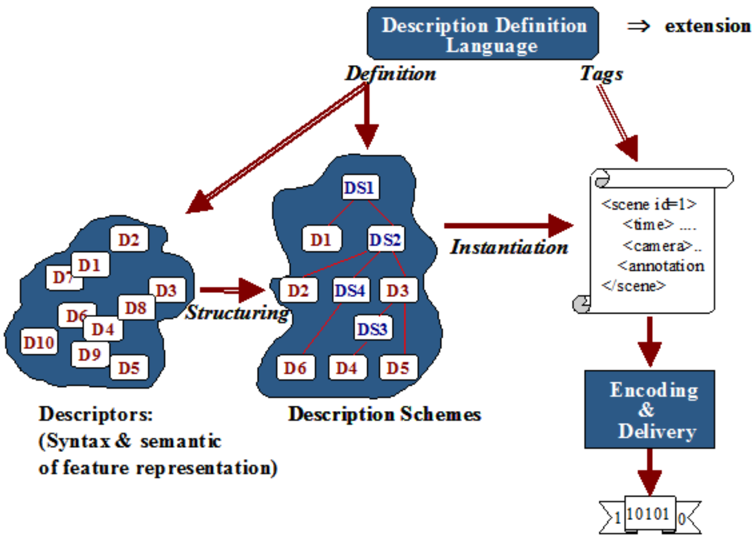

Figure 9. MPEG-7 main elements. Reprinted from MPEG (2005).

Figure 9 shows the relation between different elements defined by the standard. It uses Description Definition Language (DDL) to define the MPEG-7 description tools, Descriptors (D) and Description Schemas (DS). It uses XML (eXtensible Markup Language) schemas to represent its descriptions in text form. (MPEG 2005.)

5.1.3 PBCore

PBCore is a metadata scheme developed by Public Broadcasting in the United States with the aim of better sharing, managing and preserving media files between producers and broadcasting stations. It is a guideline for classification and description of audio visual content, which was influenced by the Dublin Core. It also includes a scheme for recording importing and exporting of files between applications. (PBCore 2015.)

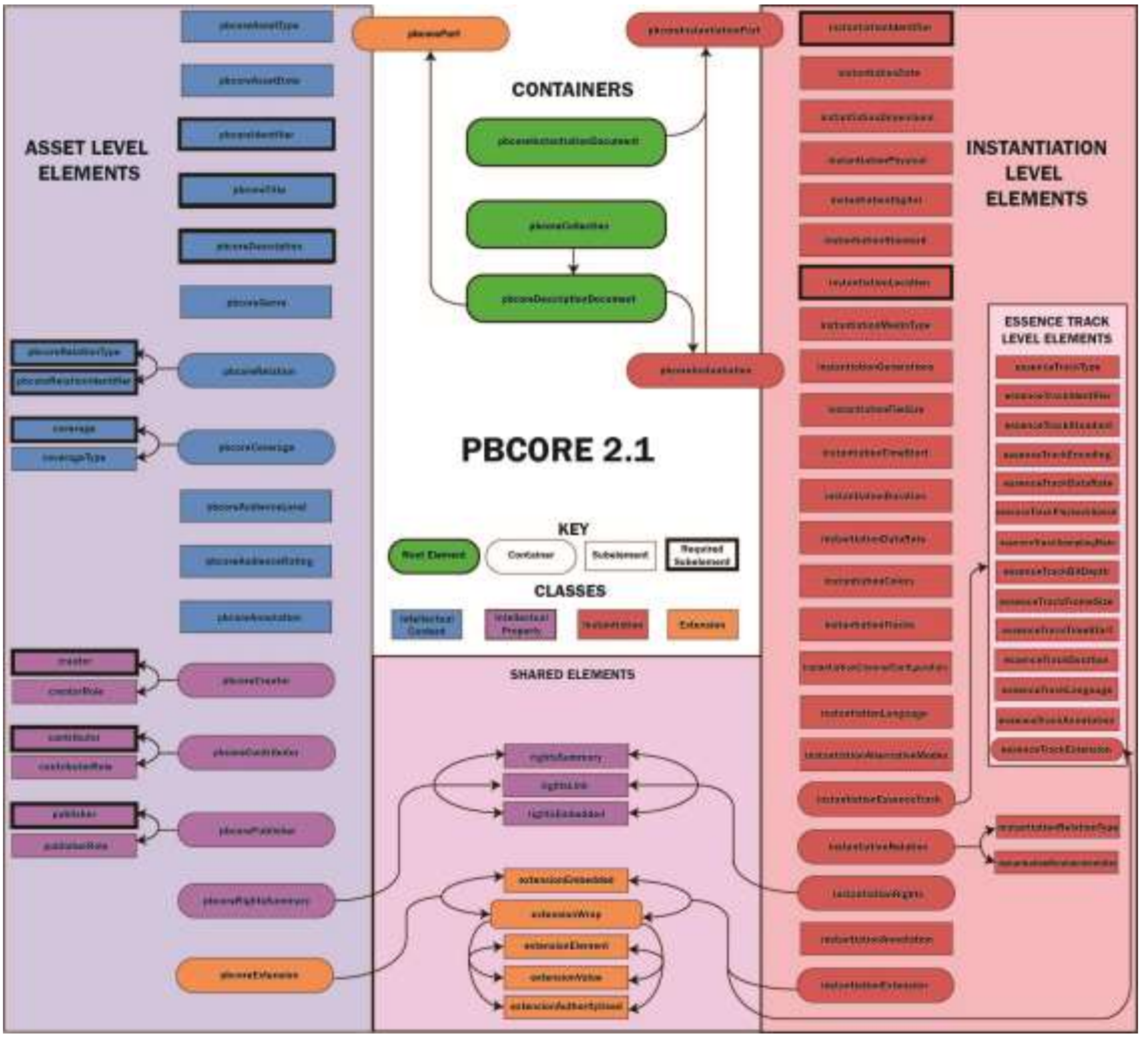

Figure 10. Visualization of PBCore schema. Reprinted from PBCore (2015).

As seen in figure 10, PBCore 2.1 consists of 4 classes, 15 containers and 82 elements. Attributes are further used to describe the elements and their values. PBCore also uses the XML language for textual representation of elements. There is an example of one of the containers below.

```xml
<pbcoreCreator>
<!-- No data here directly; it's within sub-elements instead -->
        <creator>WGBH Educational Foundation</creator>
        <creatorRole source="PBCore creatorRole" ref="http://metadataregistry.org/conceptprop/list/concept_id/1425.html">Producer</creatorRole>
</pbcoreCreator>
<pbcoreCreator>
        <creator>Lone Wolf Documentary Group</creator>
        <creatorRole source="PBCore creatorRole" ref="http://metadataregistry.org/conceptprop/list/concept_id/1425.html">Producer</creatorRole>
</pbcoreCreator>
<pbcoreCreator>
        <creator>Paula Apsell</creator>
        <creatorRole>Senior Executive Producer</creatorRole>
</pbcoreCreator>
<pbcoreCreator>
        <creator>Jed Rauscher</creator>
        <creatorRole>Editor</creatorRole>
</pbcoreCreator>
<pbcoreCreator>
        <creator>Matthew Collins</creator>
        <creatorRole source="PBCore creatorRole" ref="http://metadataregistry.org/conceptprop/list/concept_id/1425.html">Producer</creatorRole>
</pbcoreCreator>
<pbcoreCreator>
        <creator>Matthew Collins</creator>
        <creatorRole>Writer</creatorRole>
</pbcoreCreator>
<pbcoreCreator>
        <creator>Kirk Wolfinger</creator>
        <creatorRole>Producer</creatorRole>
</pbcoreCreator>
<pbcoreCreator>
        <creator>Lisa Quijano Wolfinger</creator>
        <creatorRole source="PBCore creatorRole" ref="http://metadataregistry.org/conceptprop/list/concept_id/1425.html">Producer</creatorRole>
</pbcoreCreator>
```

Figure 11. An example of PBCore container. Reprinted from PBCore (2015).

Figure 11 shows an example of one of the containers in PBCore 2.1. *pbcoreCreator* contains two sub-elements: *creator* and *creatorRole.* The *creator* element identifies the primary person who created the asset and is a mandatory element whereas *creator-Role* is optional and identifies the role played by the person. This element is valuable when the same person can play multiple roles.

5.2 Utilization of Standards

The ultimate goal of utilizing metadata standards is to efficiently manage data and ensure that they are accessible relevantly, now and in future. It helps people discover resources, enables also the automatic discovery of resources by computer codes making it easier to browse and sort the data. Giving media a digital identity assists people and applications to recognize the type or class of data. Thus, embedding media files with metadata adds intelligence to the files. In this project, Extensible Metadata Platform (XMP) was used to add information to the video files and make them stand out for use in mobile devices; therefore getting the optimal ones for the devices.

6 Extensible Metadata Platform (XMP)

Extensible Metadata Platform (XMP) is a metadata packaging technology created by Adobe that lets users to embed metadata into files themselves while creating them. XMP is a standard that defines, creates and processes metadata. It has formed a common standard that multiple applications can understand and effectively work with the metadata of the file. It has been approved as a standard for metadata by ISO since early 2012. (Adobe 2015.)

With XMP, users can get useful information about a file like creator, format, publisher, rights information, sources or search any keywords it has been tagged with. It is easily understood by humans, applications and hardware devices. It also allows editing and creating metadata. It uses the XML data structure for storing information and its data model is based on the Resource Definition Framework (RDF) framework, which makes it capable of rendering metadata from multiple schemas (Pdfa 2011).

A metadata schema is a set of properties assigned to a specific workflow or criteria. Dynamic Media schema includes properties like Tape Name, Shot Name, Scene and Shot Date whereas generic properties like Title, Publisher and Creator are categorized under Dublin Core schema (Adobe 2015).

Property	Value Type	Description
BitRate	Integer	Bits per second
Dimensions	Dimensions	Size of playback view rectangle
Interleaved	Boolean	If true, NTSC fields, otherwise frames
NaturalRate	Real number	Fields/Frames per second

Figure 12. An example of a XMP schema. Reprinted from Pdfa (2011).

The example in figure 12 shows a value type and a description set for each property. Additionally, XMP allows users to extend the standard schemas or create a new one.

For this project, a short video clip was produced titled ‘A Day in Helsinki’. The video clip had to be exported with various encoding settings. The goal was to optimise it for mobile devices by the use of metadata. The idea is that the content created will describe itself without any other user having to sort the media files and deliver the optimal format of the video to its ideal mobile device. Hence, this way, the consumer has a good experience of watching the video on a mobile device.

When the video clip was ready in Adobe Premiere Pro, it was time to experiment with the capability of XMP metadata.

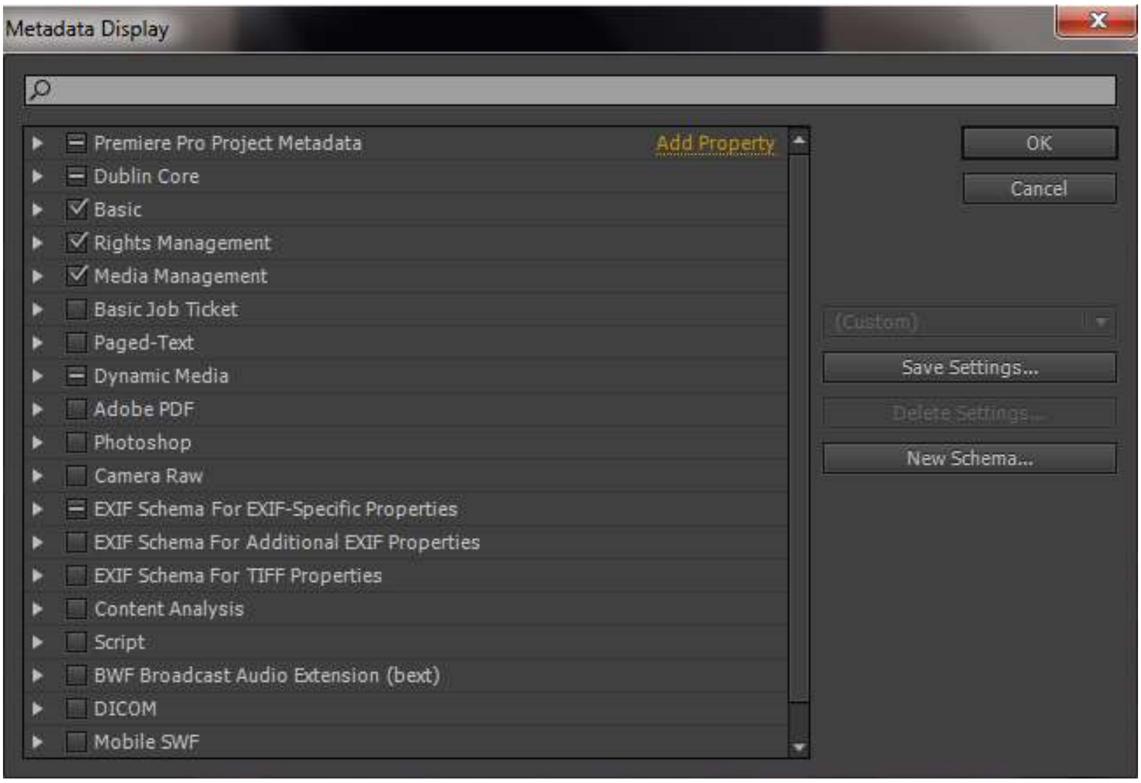

Figure 13. Screenshot of Metadata Display panel. Screenshot (Adobe Premiere Pro CS6).

Figure 13 shows the list of XMP schemas that were available. These are the standard schemas that are available in Adobe Premiere Pro. The ones that were useful for this project are listed below with their parameters, value type and description.

Table 1. Dublin Core schema. Reprinted from Adobe (2010,32).

Property	Value Type	Category	Description
dc:contributor	bag ProperName	External	Contributors to the resource (other than the authors).
dc:coverage	Text	External	The extent or scope of the resource.
dc:creator	seq ProperName	External	The authors of the resource (listed in order of precedence, if significant).
dc:date	seq Date	External	Date(s) that something interesting happened to the resource.
dc:description	Lang Alt	External	A textual description of the content of the resource. Multiple values may be present for different languages.
dc:format	MIMEType	Internal	The file format used when saving the resource. Tools and applications should set this property to the save format of the data. It may include appropriate qualifiers.
dc:identifier	Text	External	Unique identifier of the resource.
dc:language	bag Locale	Internal	An unordered array specifying the languages used in the resource.
dc:publisher	bag ProperName	External	Publishers.
dc:relation	bag Text		Relationships to other documents.
dc:rights	Lang Alt	External	Informal rights statement, selected by language.
dc:source	Text	External	Unique identifier of the work from which this resource was derived.
dc:subject	bag Text	External	An unordered array of descriptive phrases or keywords that specify the topic of the content of the resource.
dc:title	Lang Alt	External	The title of the document, or the name given to the resource. Typically, it will be a name by which the resource is formally known.
dc:type	bag open Choice	External	A document type; for example, novel, poem, or working paper.

Table 1 shows a set of parameters available in the Dublin Core schema. These are some of the most commonly used properties. The namespace prefix used for Dublin Core is dc. The parameters useful for the video in this project were Contributor, Creator, Description, Format and Title. They help recognise this content better.

Table 2. XMP Basic schema. Reprinted from Adobe (2010, 34).

Property	Value Type	Category	Description
xmp:Advisory	bag XPath	External	An unordered array specifying properties that were edited outside the authoring application. Each item should contain a single namespace and XPath separated by one ASCII space (U+0020).
xmp:BaseURL	URL	Internal	The base URL for relative URLs in the document content. If this document contains Internet links, and those links are relative, they are relative to this base URL. This property provides a standard way for embedded relative URLs to be interpreted by tools. Web authoring tools should set the value based on their notion of where URLs will be interpreted.
xmp:CreateDate	Date	External	The date and time the resource was originally created.
xmp:CreatorTool	AgentName	Internal	The name of the first known tool used to create the resource. If history is present in the metadata, this value should be equivalent to that of xmpMM:History's softwareAgent property.
xmp:Identifier	bag Text	External	An unordered array of text strings that unambiguously identify the resource within a given context. An array item may be qualified with xmpidq:Scheme to denote the formal identification system to which that identifier conforms. NOTE: The dc:identifier property is not used because it lacks a defined scheme qualifier and has been defined in the XMP Specification as a simple (single-valued) property.
xmp:MetadataDate	Date	Internal	The date and time that any metadata for this resource was last changed. It should be the same as or more recent than xmp:ModifyDate.
xmp:ModifyDate	Date	Internal	The date and time the resource was last modified. NOTE: The value of this property is not necessarily the same as the file's system modification date because it is set before the file is saved.
xmp:Nickname	Text	External	A short informal name for the resource.
xmp:Thumbnails	alt Thumbnail	Internal	An alternative array of thumbnail images for a file, which can differ in characteristics such as size or image encoding.

The XMP Basic schema contains the parameters that offer some basic descriptive information about the file. Some of the useful parameters are Date Created, Creator Tool, Metadata Date and Date Modified. However, those parameters are filled up automatically during the content creation stage. These data could be used for sorting or filtering purposes.

Table 3. Rights Management schema. Reprinted from Adobe (2010, 35).

Property	Value Type	Category	Description
xmpRights:Certificate	URL	External	Online rights management certificate.
xmpRights:Marked	Boolean	External	Indicates that this is a rights-managed resource.
xmpRights:Owner	bag ProperName	External	An unordered array specifying the legal owner(s) of a resource.
xmpRights:UsageTerms	Lang Alt	External	Text instructions on how a resource can be legally used.
xmpRights:WebStatement	URL	External	The location of a web page describing the owner and/or rights statement for this resource.

Table 3 shows the Right Management schema that contains the parameters regarding copyright restrictions of the media file. Owner and Usage Terms are relevant in this case as they can help to prevent any misuse of contents.

There was no use for any of the Media Management schemas since this project was not carried out on an organizational level and the amount of files could be handled easily. Therefore, this schema was omitted from study. Furthermore, after going through all of the standard schemas and their parameters, it was conclusive that there was not any parameter relevant enough to define a video for mobile use.

There was a need for new schema and the next step was to build one with parameters that would specifically define a mobile video. There had to be enough parameters to differentiate varying generation and models of mobile devices. Thus, a new schema named Mobile Support was designed.

Table 4. XMP Mobile Support schema.

Property	Value Type	Description
xmp:FrameSize	Text	Resolution of the content
xmp:FrameRate	Real	Frames per second
xmp:VideoBitRate	Real	Bit rate of the video it is being exported in
xmp:AudioBitRate	Real	Bit rate of the audio it is being exported in
xmp:OperatingSystem	Text	Operating system of the mobile device the video is intended for
xmp:Generation	Text	Generation or model of the mobile device

Creating a new schema was effortless. After opening the *Metadata Display* panel, the option to create a new schema is clearly visible. After a schema had been created, any number of properties could be added or deleted. A little attention had to be given to the value types. However, it seems once created, the schema cannot be deleted within the application.

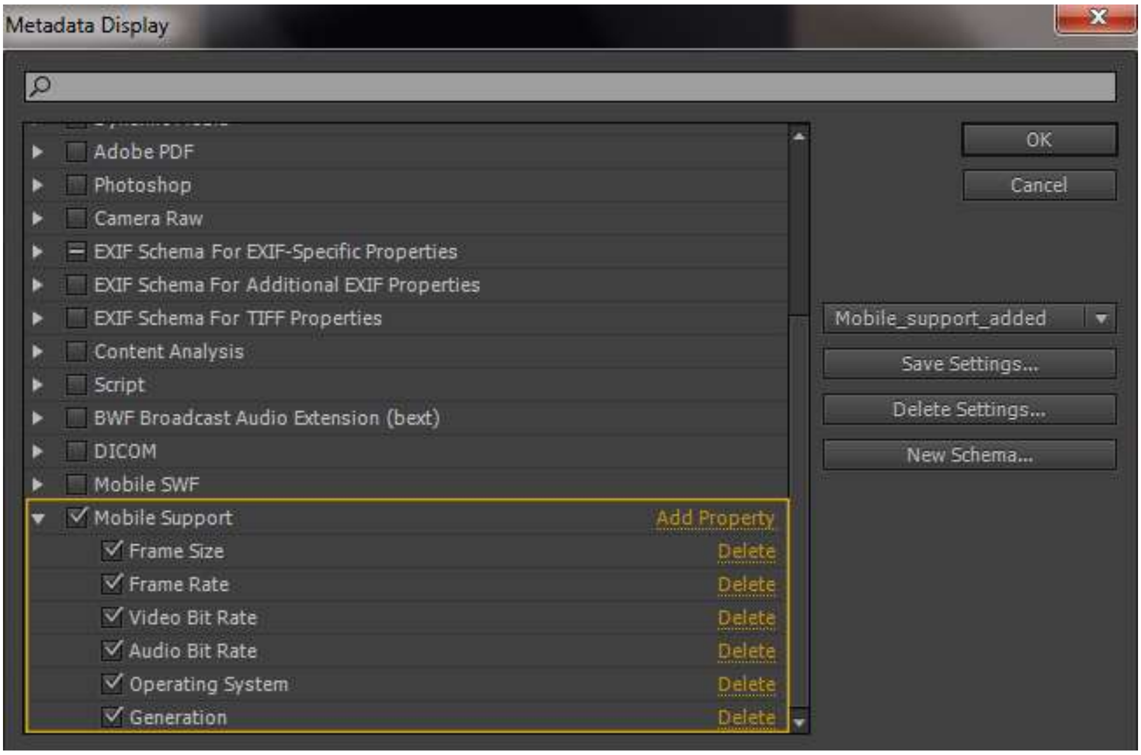

Figure 14. Screenshot of Mobile Support schema. Screenshot (Adobe Premiere Pro CS6).

Figure 14 shows the schema and its properties in Adobe Premiere Pro CS6 after it was created. However, the usability of the dialog box seems to be a little under-developed. Once the schema is created, it cannot be deleted. The properties cannot be realigned; they stay in the same order they were created.

After the creation of the schema, the video sequence was imported into Adobe Media Encoder CS6 and values for the following properties were written after the encoding settings were selected and before exporting the video content.

- Dublin Core: Contributor
  Creator
  Description
  Title

- Rights Management: Owner
  Usage Terms

- Adobe PDF: Keywords

- Mobile Support: Frame Size
  Frame Rate
  Video Bit Rate
  Audio Bit Rate
  Operating System
  Generation

After exporting the video, following XMP file was produced. It generated the metadata in XML structure.


```
    <dc:title>
        <rdf:Alt>
            <rdf:li xml:lang="x-default">A Day in Helsinki</rdf:li>
        </rdf:Alt>
    </dc:title>
    <dc:creator>
        <rdf:Seq>
            <rdf:li>Sudhir Shrestha</rdf:li>
        </rdf:Seq>
    </dc:creator>
</rdf:Description>
<rdf:Description rdf:about=""
        xmlns:xmpRights="http://ns.adobe.com/xap/1.0/rights/">
    <xmpRights:Owner>
        <rdf:Bag>
            <rdf:li>Sudhir Shrestha</rdf:li>
        </rdf:Bag>
    </xmpRights:Owner>
    <xmpRights:UsageTerms>
        <rdf:Alt>
            <rdf:li xml:lang="x-default">This movie clip can only be used for educational purposes.
            No commercial rights.</rdf:li>
        </rdf:Alt>
    </xmpRights:UsageTerms>
</rdf:Description>
<rdf:Description rdf:about=""
        xmlns:Mobile_Support="_6d0cc33-930f-466d-93fd-9280138a3c5c">
    <Mobile_Support:Frame_Size>1280x720</Mobile_Support:Frame_Size>
    <Mobile_Support:Frame_Rate>24.000000</Mobile_Support:Frame_Rate>
    <Mobile_Support:Video_Bit_Rate>3.000000</Mobile_Support:Video_Bit_Rate>
    <Mobile_Support:Audio_Bit_Rate>160.000000</Mobile_Support:Audio_Bit_Rate>
    <Mobile_Support:Operating_System>iOS</Mobile_Support:Operating_System>
    <Mobile_Support:Generation>iPhone5; iPhone5s; iPad mini 2; iPad mini 4</Mobile_Support:Generation>
</rdf:Description>
```


Figure 15. Screenshot of extract from XMP metadata. Screenshot (Notepad ++).

Figure 15 shows the metadata that were entered during the encoding process. The setting was set to embed the metadata into the media file as well as an external XMP metadata. The extract of the XMP file can be seen in the figure. It shows the Dublin Core property title set to ‘A Day in Helsinki’ and creator to ‘Sudhir Shrestha’ and the Rights Management schema, in which the properties Owner and Usage Terms can be seen in XML format. Most importantly, for this project, the Mobile Support schema that describes the video has been generated. It has all the values like Frame Size, Video Bit Rate and Operating System that were entered during the encoding.

It had been certain that all of the metadata had been embedded and generated in an external XMP file. There had to be certainty that the metadata was embedded in the media file as well. The overall purpose was to create standard metadata that every application could read and understand besides the Adobe applications. Therefore, the media content was opened using a second application called Daminion.

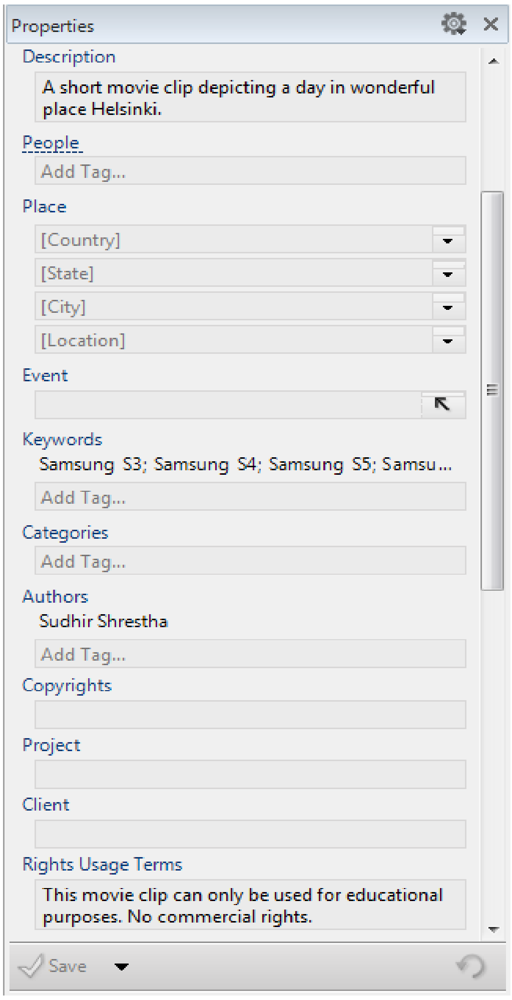

Figure 16. Screenshot of Daminion Properties panel. Screenshot (Daminion).

Figure 16 shows the Properties panel of Daminion. It was clear that the metadata were embedded into the media file as well. This project included only a small number of metadata that was suitable for mobile devices but with some more of them, the media content will stand out when operating on programs or metadata enabled devices. Now that metadata is embedded in the file; a simple set of computer code can efficiently manipulate and extract the relevant format of the file and deliver it to the mobile device. Tagging the videos also helps search engines find it better. Thus, the media content has been optimised to function better on mobile devices.

Nonetheless, the other application could not display the schema and the properties that were created in the Adobe Premiere Pro CS6 program. The only properties it displayed were from the standard and the default schemas that already existed in the Adobe application. Despite the setback, the standard schemas were used to pass some of the keywords that define the media content. However, it has been observed that the metadata were in fact embedded to the video and all of it can be seen with the Adobe applications but the other application could read only the standard metadata.

7 Discussion and Future of Metadata

This project explored the areas of how media content can be optimised for a mobile device. There is no doubt that using metadata is an efficient way of managing digital files. The use of metadata does not only apply to audio-visual contents but it applies to any digital content such as pictures or word documents. In fact, it applies not just to digital contents but has been used in traditional libraries for a long time. The ID, index number, shelf number, title written in the header; everything is metadata for the books. However, now, since the amount of digital files is countless, more meaningful information is saved along with the files. This way, the files could be managed better, they can be located easily, and getting the right or relevant information is one of the goals.

I learnt a lot in the course of this project. Metadata was just a property panel for me earlier, maybe because I never handled so many files before. However, exploring the ideas and possibilities of metadata gave me new insight. Metadata can make user experience with digital files more pleasant and exciting. It can be used to introduce files, convey messages in a concise and influential way. This project has shown how rich metadata makes the file explain itself. Somehow, there needs to be more use of metadata.

One of the issues was the interoperability of the metadata between applications. There has to be more flexibility between applications but a common standard has to be implemented by software companies. The metadata tools have to be integrated and be easily accessible in applications so that people practice feeding enough metadata more often. I have found many Digital Asset Management companies but they are doing the asset management for a price. It should be more commonly available. There is need for more tools for production and management of metadata.

The future of metadata looks bright if used in a right way. Many services and technologies are using metadata to optimise their services for specific purpose. The use of metadata could also play a vital role in the development of artificial intelligence. For example, if a user is a football fanatic and does not want to miss a single match of team X, then whenever the team’s game is going on television, the TV-box of the user could automatically record the game. However, that would only be possible if the broadcasters fed the telecast with relevant metadata. So, there are many possibilities of metadata to make things much more efficient.

8 Conclusion

The purpose of this project was to optimise an audio-visual content for a mobile device. This included producing a suitable media package during the production stage and making it stand out by adding relevant metadata to the produced file. The need for smart media is prominent in today's context, where the sources of digital media are growing immensely. Information is crucial to humans and keeping it accessible in a relevant manner is where these kinds of projects will be useful.

Technology and innovative ideas always bring changes in people, society and lifestyle. Mobile devices are one of the things that have become an integral part of people's life. The mobile market is getting bigger with more consumers and there is a lot of opportunity for businesses and service providers. The contents that are produced need to reach the people. People should be able to get to what they need; they must find the data that is relevant to them. That is how the market keeps on going. Thus, there is need for a proper and efficient way of delivering contents for mobile devices.

Perhaps every film making enthusiast is aware of the challenges of producing a quality movie clip. This thesis explored the aesthetic as well as technical challenges of video production. There are numerous settings and criteria that need to be considered and getting the best quality and size is always a challenge. In conclusion, it always comes to practice and experience which bring quality. Furthermore, by using the metadata standard, XMP metadata, this project has shown how a user can make his/her media file more visible by adding information to it.

This project was successful in terms of exploring the aspects of optimal media for mobile devices. The results show that a media file can be made smarter by embedding data to it. This document serves as a guide for beginners who want to learn about metadata and embed into files. This project would succeed well if carried out again since the volume of data is only going to increase and there might be newer technologies and tools to further enhance the efficiency of metadata handling and optimise digital contents.

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