ANALYSIS OF FACEBOOK'S VIDEO ENCODERS

by

JACEK EMIL WOLANIN

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Jacek Emil Wolanin

Has been approved for the

Recording Arts Program

by

Catalin Grigoras, Chair

Jeff Smith

Scott Burgess

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Wolanin, Jacek Emil (M.S., Recording Arts Program)

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ABSTRACT

Ever since Facebook's launch in 2004 by Mark Zuckerberg, Dustin Moskovitz, Chris Hughes and Eduardo Saverin the social media site has only grown and expanded in popularity, features and products. In 2006, two years after its launch, Facebook announced a brand new feature for cell phones; Facebook Mobile. A year later (2007), Facebook launches another new feature; Facebook Video. This new application allowed people to upload their videos and share them with other people for the first time as well as upload them using just their cellphones [1].

When Facebook first expanded its registration to everyone in 2006, it had 12 million active users [1]. Most resent statistics show that in December 2017 there are over 1.4 billion daily active users, and around 2.13 billion active monthly users [2]. Because there are so many users and these two features have been around for over 10 years, lots of videos get uploaded to the cloud for individuals to view.

The main purpose of this study is to observe how Facebook's encoders affect different resolutions uploaded and downloaded using the Facebook mobile application and different internet browsers. Because there is a wide variety of cellphone manufactures, only two smartphone were used; Samsung Galaxy J7 and the Apple iPhone 7. The browsers that were utilized were: Chrome, Firefox and Safari.

The form and content of this abstract are approved. I recommend its publications.

Approved: Catalin Grigoras

DEDICATIONS

I would like to dedicate this to my parents; Mariusz and Urszula Wolanin, and my sister Aleksandra Kolodziej, whom without them I would not be where I am.

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LIST OF ABBREVIATIONS

AVC – Advanced Video Codec

AAC – Advanced Audio Codec

MD5 – Merkle-Damgard 5 (Hash value algorithm)

CAVLAC – Context-adaptive variable length codes

CABAC – Context-adaptive binary arithmetic coding

EXIF – Exchangeable Image File Format

FPS – Frames Per Second

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CHAPTER I

INTRODUCTION

Facebook has been around for a long time and has been available to everybody since September 26, 2006 [1]. Since then Facebook has grown in popularity as one of the major social networks for people to utilize. Because this, it has had to evolve and add many features to keep it relevant and competitive to other social network platforms that have been developed in the past couple of years. Many of the things that were added in the beginning were for users to share information about themselves to others, for example Facebook Wall. This feature gave people a place to post messages and other items for their friends to view. Then came the Facebook mobile applications and the video upload tool [1]. Because of the expanding features that have been added over time, Facebook has been a relevant social network for individuals to utilize and most likely will stay that way for a long time.

Because Facebook is one of the largest social networks in the world and has so many active users on a monthly bases it is important to study it for forensic purposes and have a base understanding of it functions and a understanding of how possible evidence can be modified comparatively to the originals [2]. As stated in the abstract, the goal of this thesis is to create a foundation of how Facebook encoders affect videos that are uploaded via both smartphone and computer and then downloaded via computer.

Previous Research

In recent years there has been a larger focus on Facebook and other social media sites on understanding how files are modified when uploaded and downloaded from their servers. Charina G. Marrion published “Digital Image Manipulation Detection on Facebook Images”. Her research focused on how Facebook’s compression algorithms affects purposely

manipulated images. In addition to this, it also covered whether the manipulations can be detected using DCT (Discrete Cosine Transformation) and ELA (Error Level Analysis). The results of her test showed that due to the heavy compression rates that Facebook uses on digital images, all results caused the manipulated areas to disappear. Thus it is difficult to detect manipulated images once uploaded to Facebook [3].

CHAPTER II

TECHNICAL OVERVIEW

The goal of this chapter is to have a better understanding of file structure and encoders in videos files. This is important as to identify specifics sections of metadata in the originals and see how they are manipulated after they are downloaded from Facebook. Because this research relies on these items so heavily, having an understanding of how they work and look is needed.

File Format

Most digital video files are structured in the same manner. They all contain a container, video data, audio data, and metadata. According to SWGDE the container is a standardized structural method to store the variety of elements necessary to represent video and audio information [4]. Containers can be very complex or very simple. Complex ones can support and large variety of different audio and video file types while simple ones can only accommodate a very specific video or audio file type.

Video codecs are algorithms that encode or decode a video stream, and are used to compress data for efficient transmission of the recording. Some video codecs compress video files while others do not. Non compressing codecs are called lossless, because they do not degrade the video quality and no information is lost in the compression process. Video encoders that do have compression with data loss are called lossy compressors. These algorithms remove redundant or irrelevant data to reduce the size of the file [4].

Metadata is information that is stored in the file. This can contain anything from the size of the file, creation time, author, and GPS information.

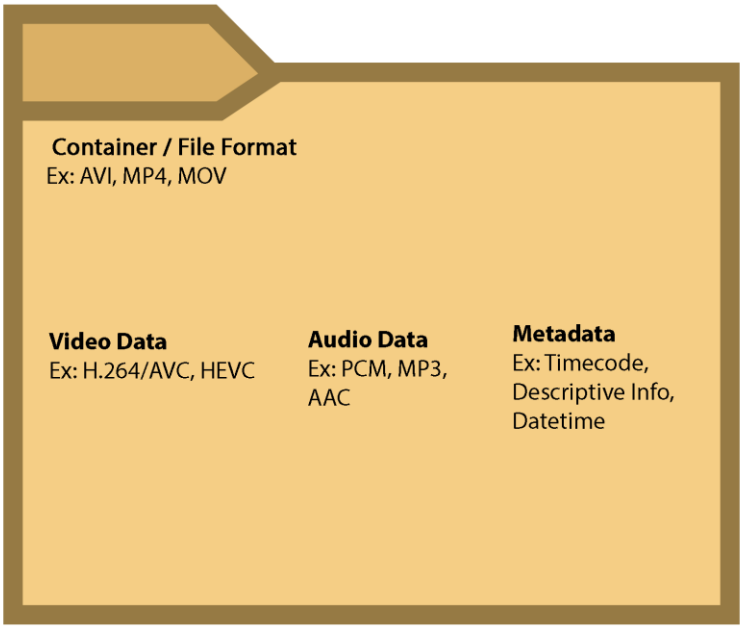

Figure 1. Simplified File Format

H.264/AVC

H.264/AVC was developed by the Joint Video Team (JVT). This group consisted of members from the Video Coding Experts Group (VCEG) and Moving Picture Experts Group (MPEG). The first iteration of the H.264/AVC was approved on May 30th, 2003 and had a provisional name of H.26L. Since then there have been 12 amendments to the encoder. One of the largest and most noticed is the Fidelity Range Extensions (FRExt) which contains the High Video Profiles [5].

H.264/AVC is a very versatile encoder that can support various applications like video broadcasting, video streaming, and video conferencing over fixed or wireless networks and over different transport protocols [5].

H.264/AVC contains eight different Video Profiles: Baseline, Main, Extended, High, High 10, High 4:2:2 and High 4:4:4. Video Profiles are designed for specific applications of video streaming. The Baseline Profile is designed for real-time conversational services like video conferencing and videophone. Main Profile is designed for digital storage and television broadcasting. Extended Profile is designed for multimedia streaming over IP. The High Profiles were created for content-distribution, content-contribution, studio editing and post-processing. The Baseline Profile and Extended Profile use CALVC while the Main Profile and High Profiles use CABAC. CALVC and CABAC are entropy encoders and are used after the H.264/AVC algorithm reduces the size of the video file [6].

HEVC

HEVC's formal development was started in January 2010 by ITU-T Video Coding Experts Group (VCEG and the ISO/IEC Moving Picture Expert Group (MPEG)). Another name for HEVC is H.265. Prior to this both groups were already working on investigatory work in compression capabilities and different algorithmic techniques. The reasoning for developing HEVC was not just to improve compression as much as possible but also help enable the deployment of new services such as ultra-high definition television (UHDTV) and video with higher-dynamic range [7]. Since its release HEVC has gotten five amendments added. The most resent being in February of 2018 [8].

Browsers

Web browsers are applications that are used on a daily bases, so defining them is important. A web browser can be summed up as a software application that is designed to retrieve, present or transfer information on a network. As of 2015 Chrome is the most popular web browser with 64.9% usage, 21.5% usage going to Firefox, 3.8% usage to Safari

and 9.8% usage to all other web browsers. This is particularly interesting since Safari was the first of the three to be introduced which was in 2003. Firefox came out in 2004, and Chrome was the last to be introduced, which was in 2008 [9].

CHAPTER III

Materials and Methods

The programs that were used to extract the information from the originals and downloaded files were FFMPEG, Exiftool, Mediainfo and Atomic Parsley. “FFMPEG is an open source, cross platform framework that uses command line to play, convert, and stream audio and video.” [10]. FFMPEG also has the capabilities of extracting some metadata as well as video and audio information about the file [11]. Exiftool is command line application for reading, writing and editing metadata information [12]. Mediainfo is a user interface or command line application that can view container information, metadata, video formats, audio formats and other analytics [13]. Atomic Parsley is also a command line tool that extracts atom location and division [14]. The rest of this chapter will discuss how the original files were created and technical information about them. It will also cover the details about how the videos were uploaded and downloaded.

Originals

The original videos were created using two different smartphones; a Samsung Galaxy J7 Prime and an Apple iPhone 7. Each phone created two sets of videos with four different resolutions.

The Samsung was capable of creating four different resolutions: 640x480, 1072x1072, 1280x720 and 1920x1080. All the videos had the same container (mp42) and where encoded AVC (Advanced Video Codec). The 640x480 and 1920x1080 videos had a variable frame rate of 29.970fps while the 1072x1072 and 1280x720 had a variable frame rate of 30fps. All the original videos had slightly different video profiles. 640x480 had Baseline@L3, 1072x1072 had Baseline@L3.2, 1280x720 and Baseline@L3.1, and

1920x1080 had High@L3. All the videos had audio formats of AAC (Advanced Audio Codec) with audio profiles of LC. In addition to this, all the videos had two audio channels with a 16 bit depth and 48000 sample rate. This information can all be viewed in Tables 1, 3 and 4 down below. Table 2 contains creation and modify data and Table 5 contains the original MD5 HASH's of the files.

	File Name		Container Specification
Set 1	640x480	20180305_092431.mp4	mp42
	1072x1072	20180305_092246.mp4	mp42
	1280x720	20180305_092332.mp4	mp42
	1920x1080	20180305_092145.mp4	mp42
Set 2	640x480	20180305_092443.mp4	mp42
	1072x1072	20180305_092258.mp4	mp42
	1280x720	20180305_092345.mp4	mp42
	1920x1080	20180305_092200.mp4	mp42

Table 1. Original Samsung Metadata Information 1

	File Name	Create01	Modify01	Create02	Modify02	Create03	Modify03
Set 1	640x480	2018:03:05 16:24:38	2018:03:05 16:24:38	2018:03:05 16:24:38	2018:03:05 16:24:38	2018:03:05 16:24:38	2018:03:05 16:24:38
	1072x1072	2018:03:05 16:22:53	2018:03:05 16:22:53	2018:03:05 16:22:53	2018:03:05 16:22:53	2018:03:05 16:22:53	2018:03:05 16:22:53
	1280x720	2018:03:05 16:23:39	2018:03:05 16:23:39	2018:03:05 16:23:39	2018:03:05 16:23:39	2018:03:05 16:23:39	2018:03:05 16:23:39
	1920x1080	2018:03:05 16:21:51	2018:03:05 16:21:51	2018:03:05 16:21:51	2018:03:05 16:21:51	2018:03:05 16:21:51	2018:03:05 16:21:51
Set 2	640x480	2018:03:05 16:24:50	2018:03:05 16:24:50	2018:03:05 16:24:50	2018:03:05 16:24:50	2018:03:05 16:24:50	2018:03:05 16:24:50
	1072x1072	2018:03:05 16:23:04	2018:03:05 16:23:04	2018:03:05 16:23:04	2018:03:05 16:23:04	2018:03:05 16:23:04	2018:03:05 16:23:04
	1280x720	2018:03:05 16:23:51	2018:03:05 16:23:51	2018:03:05 16:23:51	2018:03:05 16:23:51	2018:03:05 16:23:51	2018:03:05 16:23:51
	1920x1080	2018:03:05 16:22:06	2018:03:05 16:22:06	2018:03:05 16:22:06	2018:03:05 16:22:06	2018:03:05 16:22:06	2018:03:05 16:22:06

Table 2. Original Samsung Metadata Information 2

	File Name	Compressor ID	Video Format	Video Profile
Set 1	640x480	avc1	Advanced Video Codec	Baseline@L3
	1072x1072	avc1	Advanced Video Codec	Baseline@L3.2
	1280x720	avc1	Advanced Video Codec	Baseline@L3.1
	1920x1080	avc1	Advanced Video Codec	High@L4
Set 2	640x480	avc1	Advanced Video Codec	Baseline@L3
	1072x1072	avc1	Advanced Video Codec	Baseline@L3.2
	1280x720	avc1	Advanced Video Codec	Baseline@L3.1
	1920x1080	avc1	Advanced Video Codec	High@L4

Table 3. Original Samsung Video Information

	File Name	Audio Format	Audio Profile	Audio Format	Channels	Bit Depth	Sample Rate
Set 1	640x480	Advanced Audio Codec	LC	mp4a	2	16	48000
	1072x1072	Advanced Audio Codec	LC	mp4a	2	16	48000
	1280x720	Advanced Audio Codec	LC	mp4a	2	16	48000
	1920x1080	Advanced Audio Codec	LC	mp4a	2	16	48000
Set 2	640x480	Advanced Audio Codec	LC	mp4a	2	16	48000
	1072x1072	Advanced Audio Codec	LC	mp4a	2	16	48000
	1280x720	Advanced Audio Codec	LC	mp4a	2	16	48000
	1920x1080	Advanced Audio Codec	LC	mp4a	2	16	48000

Table 4. Original Samsung Audio Information

	File Name	File Hash	Video Stream Hash	Audio Stream Hash
Set 1	640x480	640dd242b29a6b6a1dfb95e42f73997f	MD5=5cc2358b808f135cc82babbc6520a32d	MD5=b69929a6d657758365ae22a4134a142e
	1072x1072	8fd8edb250da19da0775aa11d445100e	MD5=47b7b3d8699486cd95ba421f93f38f41	MD5=d7a433c1cc00b15cbb77304cd7161dff
	1280x720	039ff29b1a4fb93a3866bb6e89516034	MD5=f02a4de35db1a462de89e42ebe2fa777	MD5=a41a4c6168eb6bb66d2133a9c1a8a564
	1920x1080	91f6876a6692ca4e7d1024edabb895d3	MD5=78e826c50a244918dea96b4d6c122902	MD5=54427f8020f001447815b3c054c5c62c
Set 2	640x480	c5b57b6954f91d5ff510b553706fbd77	MD5=6203f3faee22bf4375fee7328e44bb56	MD5=a4236c6578495ca6891eba5c7ddf9a06
	1072x1072	165e38fc3ee109bb6d64f102f73a662c	MD5=f9df0c480a1dcee96319b0954263e71b	MD5=ff363fb02e18a1bb5d5645e7e088578c
	1280x720	480076faedea19b24e33c81709e7dbd7	MD5=0752ed1f8fabe0d8e6a58bdef81076b0	MD5=502d62efdc9e346f97c6c1c162ae0f5b
	1920x1080	02429d3fbf6686eac7e2c700f69381c8	MD5=4276bcaacb439cc1e8077f2d49c9a306	MD5=c54396b7aabfcd875311fa8ac9e61390

Table 5. Original Samsung MD5 HASH Values

The iPhone was capable of creating four videos as well. 1280x720p at 30fps, 1920x1080p at 30fps, 1920x1080p at 60fps and 3840x2160 (4k) at 30fps. The container for

all the videos was “qt” (QuickTime). The video format for all the videos was HEVC (High Efficiency Video Coding). The video profiles for all the videos was also slightly different from one another. 1280x720 30fps was Main@L3.1@Main, 1920x1080 30fps was Main@L4@Main, 1920x1080 60fps was Main@L4.1@Main, and 3840x2160 at 30fps was Main@L5@Main. All the videos had a LC audio profile with an mp4a audio format. Also all the videos were single channel with a 16 bit depth and a 44100 audio sample rate. The sound handler was also appl. This information can all be viewed in Tables 6, 8 and 9. Just like with the Samsung’s, Tables 7 contains creation and modification information while Table 10 contains the MD5 HASH’s for the original files.

	File Name		Container Specification
Set 1	720p HD at 30fps	IMG_0694.MOV	qt
	1080p HD at 30 fps	IMG_0696.MOV	qt
	1080p HD at 60fps	IMG_0698.MOV	qt
	4K at 30fps	IMG_0700.MOV	qt
Set 2	720p HD at 30fps	IMG_0694.MOV	qt
	1080p HD at 30 fps	IMG_0697.MOV	qt
	1080p HD at 60fps	IMG_0699.MOV	qt
	4K at 30fps	IMG_0701.MOV	qt

Table 6. Original iPhone File Information 1

	File Name	Create01	Modify01	Create02	Modify02	Create03	Modify03
Set 1	720p HD at 30fps	2018:03:01 20:37:08	2018:03:01 20:37:11	2018:03:01 20:37:08	2018:03:01 20:37:11	2018:03:01 20:37:08	2018:03:01 20:37:11
	1080p HD at 30 fps	2018:03:01 20:37:56	2018:03:01 20:38:00	2018:03:01 20:37:56	2018:03:01 20:38:00	2018:03:01 20:37:56	2018:03:01 20:38:00
	1080p HD at 60fps	2018:03:01 20:38:39	2018:03:01 20:38:44	2018:03:01 20:38:39	2018:03:01 20:38:44	2018:03:01 20:38:40	2018:03:01 20:38:44
	4K at 30fps	2018:03:01 20:39:22	2018:03:01 20:39:27	2018:03:01 20:39:22	2018:03:01 20:39:27	2018:03:01 20:39:22	2018:03:01 20:39:27
Set 2	720p HD at 30fps	2018:03:01 20:37:08	2018:03:01 20:37:11	2018:03:01 20:37:08	2018:03:01 20:37:11	2018:03:01 20:37:08	2018:03:01 20:37:11
	1080p HD at 30 fps	2018:03:01 20:38:04	2018:03:01 20:38:09	2018:03:01 20:38:04	2018:03:01 20:38:09	2018:03:01 20:38:04	2018:03:01 20:38:09
	1080p HD at 60fps	2018:03:01 20:38:47	2018:03:01 20:38:52	2018:03:01 20:38:47	2018:03:01 20:38:52	2018:03:01 20:38:47	2018:03:01 20:38:52
	4K at 30fps	2018:03:01 20:39:32	2018:03:01 20:39:37	2018:03:01 20:39:32	2018:03:01 20:39:37	2018:03:01 20:39:32	2018:03:01 20:39:37

Table 7. Original iPhone Metadata Information 2

	File Name	Resolution	Compressor ID	Video Format	Video Profile
Set 1	720p HD at 30fps	1280x720	hvc1	High Efficiency Video Coding	Main@L3.1@Main
	1080p HD at 30 fps	1920x1080	hvc1	High Efficiency Video Coding	Main@L4@Main
	1080p HD at 60fps	1920x1080	hvc1	High Efficiency Video Coding	Main@L4.1@Main
	4K at 30fps	3840x2160	hvc1	High Efficiency Video Coding	Main@L5@Main
Set 2	720p HD at 30fps	1280x720	hvc1	High Efficiency Video Coding	Main@L3.1@Main
	1080p HD at 30 fps	1920x1080	hvc1	High Efficiency Video Coding	Main@L4@Main
	1080p HD at 60fps	1920x1080	hvc1	High Efficiency Video Coding	Main@L4.1@Main
	4K at 30fps	3840x2160	hvc1	High Efficiency Video Coding	Main@L5@Main

Table 8. Original iPhone Video Information

	File Name	Audio Format	Audio Profile	Audio Format	Channels	Bit Depth	Sample Rate	Sound Handler
Set 1	720p HD at 30fps	Advanced Audio Codec	LC	mp4a	1	16	44100	appl
	1080p HD at 30 fps	Advanced Audio Codec	LC	mp4a	1	16	44100	appl
	1080p HD at 60fps	Advanced Audio Codec	LC	mp4a	1	16	44100	appl
	4K at 30fps	Advanced Audio Codec	LC	mp4a	1	16	44100	appl
Set 2	720p HD at 30fps	Advanced Audio Codec	LC	mp4a	1	16	44100	appl
	1080p HD at 30 fps	Advanced Audio Codec	LC	mp4a	1	16	44100	appl
	1080p HD at 60fps	Advanced Audio Codec	LC	mp4a	1	16	44100	appl
	4K at 30fps	Advanced Audio Codec	LC	mp4a	1	16	44100	appl

Table 9. Original iPhone Audio Information

	File Name	File Hash	Video Stream Hash	Audio Stream Hash
Set 1	720p HD at 30fps	35b6fd97858b4a3420dceb2b4ed4f106	MD5=8c510541e87daaed4e0705e6328cfecf	MD5=ac569421e7ae23e7d8a63c07cdd78ab3
	1080p HD at 30 fps	1dfc2b7fd214f71aca9471ac0082ee22	MD5=e165b2a112cbc9de2e1fbc4ad25074c0	MD5=36d160f5b36867f6c445b9e3030216e5
	1080p HD at 60fps	419663d77a49da1a47dc212d5341be28	MD5=2fa06177deda7a40034865b3324cf6f6	MD5=e8c9046e905712d5882eb29961ee34be
	4K at 30fps	1f0b8b60ef977886f4483c84ffd6d70f	MD5=90d5c31374846df3be4b7aae61add323	MD5=a7a8acde2c7ee597b770a261f69bdea9
Set 2	720p HD at 30fps	35b6fd97858b4a3420dceb2b4ed4f106	MD5=8c510541e87daaed4e0705e6328cfecf	MD5=ac569421e7ae23e7d8a63c07cdd78ab3
	1080p HD at 30 fps	74fcd84a726f336a7f9b63c94c1f2c6b	MD5=68614d570da677e90fd50a34481e0ae6	MD5=874ac5a7d2d44caa5beb5de23d658981
	1080p HD at 60fps	bf24aaad7ac94e60dd0b997524ff978b	MD5=cb9df01851af4e0fe70ec5eef7324ac1	MD5=ec80ecdc16a32f5a4c5167e23fe7ec06
	4K at 30fps	a9944ae3ce2e682340103e45c8ad3ff6	MD5=8a45f5c35c6007aae781e066fbbc8864	MD5=e4f7858a219c716d23859f5950604a55

Table 10. Original iPhone MD5 HASH Values

Uploads

Once all the videos were created and information extracted, they were uploaded through the Facebook application on the smartphones and uploaded through a browser on the computers.

The Samsung's Facebook applications version was 161.0.0.35.93 and the iPhone's version was 160.0.0.34.96. The videos were uploaded to the timeline as that was the only place to upload all the videos using the smartphones. In the settings of the Facebook application there was a function that allowed the videos to be uploaded in HD. Figure 12 shows where the setting can be changed. All videos were uploaded with the setting on and off.

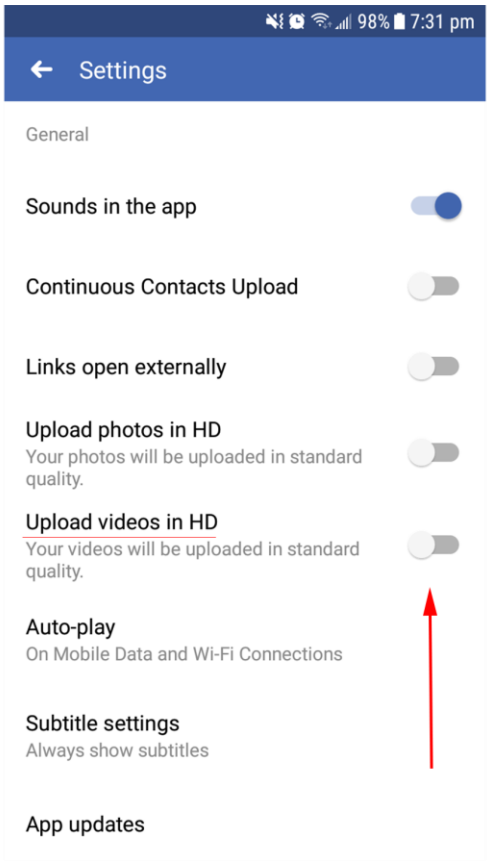

Figure 2. Network Upload Mobile Settings

Once the uploads were done with the smartphones, they were transferred to the computers via USB cable and uploaded using Google Chrome on both computers. The settings in Facebook for both computers video default quality was set to default. Which can be seen in Figure 3 just below.

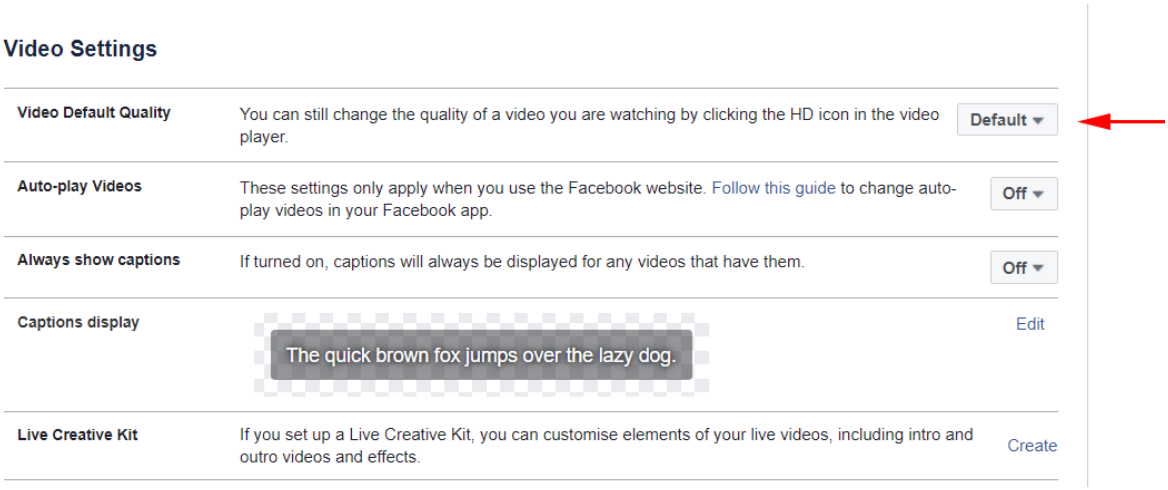

Figure 3. Network Upload Desktop Settings

Downloads

Due to how Facebook currently functions, all videos had to be downloaded from the user's personal account because the videos could not be downloaded from a different account. In addition to this, all the videos had to be downloaded via computer because the Mobile Facebook Application does not have the capability to download videos. The downloads were done using three different computers because of the three browsers that were used for the test. Videos that were downloaded using Google Chrome and Firefox were

downloaded by a Lenovo Z50 laptop and the videos that were downloaded by Safari were done by a MacBook Pro and an iMac.

CHAPTER IV

Data Overview

This chapter goes over the changes that happened to the originals after they were downloaded using the three major browsers. After the videos files were downloaded (procedure explained in the previous chapter), a batch script was created to extract information about the files using command line tools: FFMPEG, Mediainfo, Exiftool and Atomic Parsley.

Some of the outcomes were expected; for example all creation times and modification times were all wiped from the metadata. Another expected change was the renaming of the files by Facebook. All the video files were got renamed with 8 numerical characters at the beginning followed by a underscore with another 15 or 16 numerical characters followed by another underscore with 18 or 19 numerical characters followed by the last underscore with the letter “n” at the end. In addition all the files got an extension of mp4. An example can be seen below.

28304972_1898785643528556_8858641309544480768_n.mp4

Figure 4. File Name Sample

Samsung Download Overview

Metadata

The first videos that were examined were the videos that were originally produced by the Samsung Galaxy J7. After the downloads, the videos got re-encoded by Facebook into

Lavf version 56.40.101. This information can be viewed in Table 11 (page 17). Also the containers were changed from mp42 to isom.

As can be viewed in Table 12 (page 17), the resolution changed quite a bit in some of the videos and one of the original resolutions was dependent on how the video was uploaded. The 1920x1080 videos changed to 1280x720 and were not depended whether they were originally uploaded using a smartphone or computer. 1280x720 did not change at all in resolution compared to the originals. This is an interesting observation as later in this chapter this correlates to the iPhone results. Similarly to the 1280x720, the 1072x1072 also did not change from the original resolution. The most interesting resolution though was the 640x480. This is the only resolution that was upload dependent. If the original was uploaded using a smartphone the download resolution turned to 400x300 while if the video was uploaded with a computer the resolution stayed at 640x480 (Table 12, page 17).

Unlike the resolutions, most of the video information stayed the same excluding the smartphone upload of 640x480. All the videos got the same Compressor ID (avc1) and the same encoder library (x264 core148) no matter what resolution the original video was. The video format also stayed the same from the originals (AVC). One interesting result was that the 640x480 resolution Video Profile. Like the resolutions, this was dependent on whether the original video was uploaded using a smartphone or a computer. When the video was uploaded with a computer the Video Profile turned into High@L3.1 just like all the other resolutions, but if the video was uploaded using a smartphone the Video Profile was Baseline@L3 (Table 13, page 18).

The audio information stayed mostly the same comparatively to the original files. The audio information was still AAC, two channels, 16 bit, and 48k sample rate. The only

difference in the audio information was that the Audio Profile was changed to HE-AAC/ LC comparatively to the original which was just LC (Table 14, page 18).

	Resolution	Encoder	Container Specification
Set 1	640x480	Lavf56.40.101	isom
	1072x1072	Lavf56.40.101	isom
	1280x720	Lavf56.40.101	isom
	1920x1080	Lavf56.40.101	isom
Set 2	640x480	Lavf56.40.101	isom
	1072x1072	Lavf56.40.101	isom
	1280x720	Lavf56.40.101	isom
	1920x1080	Lavf56.40.101	isom

Table 11. Samsung Downloaded Encoder/Container

	File Name	New Computer Resolution	New Mobile Resolution
Set 1	640x480	640x480	400x300
	1072x1072	1072x1072	1072x1072
	1280x720	1280x720	1280x720
	1920x1080	1280x720	1280x720
Set 2	640x480	640x480	400x300
	1072x1072	1072x1072	1072x1072
	1280x720	1280x720	1280x720
	1920x1080	1280x720	1280x720

Table 12. Samsung Downloaded Resolution Change

	File Name	Compressor ID	Video Format	Computer Video Profile	Mobile Video Profile	Encoder Library Name
Set 1	640x480	avc1	Advanced Video Codec	High@L3.1	Baseline@L3	x264 core 148
	1072x1072	avc1	Advanced Video Codec	High@L3.1	High@L3.1	x264 core 148
	1280x720	avc1	Advanced Video Codec	High@L3.1	High@L3.1	x264 core 148
	1920x1080	avc1	Advanced Video Codec	High@L3.1	High@L3.1	x264 core 148
Set 2	640x480	avc1	Advanced Video Codec	High@L3.1	Baseline@L3	x264 core 148
	1072x1072	avc1	Advanced Video Codec	High@L3.1	High@L3.1	x264 core 148
	1280x720	avc1	Advanced Video Codec	High@L3.1	High@L3.1	x264 core 148
	1920x1080	avc1	Advanced Video Codec	High@L3.1	High@L3.1	x264 core 148

Table 13. Samsung Downloaded Video Information

	Resolution	Audio Format	Channels	Bit Depth	Sample Rate	Bit Depth
Set 1	640x480	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16
	1072x1072	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16
	1280x720	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16
	1920x1080	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16
Set 2	640x480	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16
	1072x1072	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16
	1280x720	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16
	1920x1080	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16

Table 14. Samsung Downloaded Audio Information

Atom Structure

Metadata within an ISO base media file is structured into unites of data which are called atoms. Atoms can be of various lengths and atoms are contained within other atoms. At the beginning of each atom there is a tag that are represented by ASCII character that help programs identify how to interpret the data within the atom. Atomic Paisley can extract these tags and organize them in successive order.

All the video files had the exact same atom structure except 640x480 that was uploaded using a smartphone. This video file is missing an atom that all the other files are not. The atom that it is missing is “ctts”. According to the QuickTime File Format

Specifications the ctts atom stands for “Composition Offset Atom”. This atom provides the decoding information and video presentation if they are not stored in order in a video file [15]. To see the location of were the atom is and where it is missing in the atom structure, refer to Appendix Figure A.

Encoder Settings

With the Samsung videos that were 1920x1080 and 1280x720 resolutions, the encoder settings were identical. A point of interest is that all the iPhone videos had the same encoder settings as these two resolutions had. See Appendix Figure B and C. In these figures the encoder settings start with CABAC = 1. This indicates whether a file was encoded using the CABAC algorithm; if the files starts with CABAC = 0 it means that it did not use the CABAC algorithm.

1072x1072 encoder settings were very similar to the ones that 1920x1080 and 1280x720 had. The only differences were two settings: threads = 33 and lookahead_threads = 5. 1920x1080 and 1280x720 had: thread = 40 and lookahead_threads = 6. See Appendix figure B and C, differences are highlighted.

Once again the 640x480 resolutions differed in encoder settings in whether they were originally uploaded via smartphone or computer. When the 640x480 resolution was uploaded using a smartphone and downloaded via computer there were many settings that were different comparatively to the other ones. The most significant observations would be that an entire section of the encoder settings is no present comparatively to the other files This missing section can be viewed just on the next page.

b_pyramid=2	b_adapt=1	b_bias=0	direct=1	weightb=1	open_gop=0

Figure 5. Missing Section

This section that is not present would be located between / bframes=3 / and / weightp=1 /. Another major difference is the 640x480 smartphone upload start with CABAC = 0 which none of the other files had, including the iPhone files. Like stated earlier, this means that this resolution in this upload style is the only one that is not encoded in CABAC. Other differences are: threads=12 , lookahead_threads=2 , weightp=0 , rc_lookahead=40 , vbv_maxrate=450 and vbv_bufsize=900. All of differences comparatively to the 1920x1080 and1280x720 can be viewed in the Appendix, Figures B and C, and are highlighted.

The last resolutions, 640x480 that was uploaded using a computer had similar differences that the 1072x1072 resolutions had. These changes were in the encoder settings of thread = 20 and lookahead_threads = 3. Unlike the other 640x480 that was uploaded via smartphone, no section was missing.

Browser Results

An interesting observation was that it did not matter what browser the video files were downloaded by; whether it was Chrome, Safari, or Firefox all the downloaded files were exactly the same to each other. In the table below are the HASH values that were created after the file was downloaded. The colors in the table are to easily view that across the different browsers the same HASH value was bring created indicating the files are the exact same.

Chrome	FireFox File Hash	Safari File Hash
be3e074e7085be28a6be79864cfa9aa8	be3e074e7085be28a6be79864cfa9aa8	be3e074e7085be28a6be79864cfa9aa8
5668d6fd2e4d254bf2e8a8869e8df27f	5668d6fd2e4d254bf2e8a8869e8df27f	5668d6fd2e4d254bf2e8a8869e8df27f
7d7e6f14d0926d162a6eddbe8b81048b	7d7e6f14d0926d162a6eddbe8b81048b	7d7e6f14d0926d162a6eddbe8b81048b
2502bec07d61b55985bf078eaa0d0432	2502bec07d61b55985bf078eaa0d0432	2502bec07d61b55985bf078eaa0d0432
c6b0449c10a1fdd5e15f10ddc6acff9f	c6b0449c10a1fdd5e15f10ddc6acff9f	c6b0449c10a1fdd5e15f10ddc6acff9f
3ab7fbcb984a96682bab86b9d39904dc	3ab7fbcb984a96682bab86b9d39904dc	3ab7fbcb984a96682bab86b9d39904dc
f1169f9e26792b03967e5c289fdae00e	f1169f9e26792b03967e5c289fdae00e	f1169f9e26792b03967e5c289fdae00e
aedb563db8d90f67088b9b8f49e4fb27	aedb563db8d90f67088b9b8f49e4fb27	aedb563db8d90f67088b9b8f49e4fb27
7d958ccd6f93f8f595a12c3630da0775	7d958ccd6f93f8f595a12c3630da0775	7d958ccd6f93f8f595a12c3630da0775
a8e21961a7f23e6f0d546d0e2929037c	a8e21961a7f23e6f0d546d0e2929037c	a8e21961a7f23e6f0d546d0e2929037c
378e6e905506111c378fa005525cbece	378e6e905506111c378fa005525cbece	378e6e905506111c378fa005525cbece
91b9a01d615429673c2c263ef2e38d56	91b9a01d615429673c2c263ef2e38d56	91b9a01d615429673c2c263ef2e38d56
37dea386cce6c567da87b2d7052dca64	37dea386cce6c567da87b2d7052dca64	37dea386cce6c567da87b2d7052dca64
28ff23223c2ec11f267aee4f3da7f093	28ff23223c2ec11f267aee4f3da7f093	28ff23223c2ec11f267aee4f3da7f093
0846440ddfce9e731a8252c6a5aa7c51	0846440ddfce9e731a8252c6a5aa7c51	0846440ddfce9e731a8252c6a5aa7c51
b19f949a99a5337022be92c7042a6f77	b19f949a99a5337022be92c7042a6f77	b19f949a99a5337022be92c7042a6f77
aef6f7469deae55e10ffe58b9680752e	aef6f7469deae55e10ffe58b9680752e	aef6f7469deae55e10ffe58b9680752e
de9e87f771c457c9c25d6e3ed97304f1	de9e87f771c457c9c25d6e3ed97304f1	de9e87f771c457c9c25d6e3ed97304f1
b371ff533b1daff853b9ca1ffb376bc9	b371ff533b1daff853b9ca1ffb376bc9	b371ff533b1daff853b9ca1ffb376bc9
9772310a8422352e608edf47b6fd7aae	9772310a8422352e608edf47b6fd7aae	9772310a8422352e608edf47b6fd7aae
45d16db14b799cba0bf2fa0dc9284018	45d16db14b799cba0bf2fa0dc9284018	45d16db14b799cba0bf2fa0dc9284018
4e45ab2c5767dbf745a2449ba91f87b1	4e45ab2c5767dbf745a2449ba91f87b1	4e45ab2c5767dbf745a2449ba91f87b1
349bc690de8f9be26245bffba04898e8	349bc690de8f9be26245bffba04898e8	349bc690de8f9be26245bffba04898e8
acc6433759130b960463cb2b0602e076	acc6433759130b960463cb2b0602e076	acc6433759130b960463cb2b0602e076

Table 15. Samsung Browser Hashes

iPhone Download Overview

Metadata

The most interesting observation that came from the iPhone video downloads was that no matter the original resolution or the previous Video Profile, all the videos were encoded exactly the same to one another. Every single video was modified to the same resolution, with the same Video Format, Profile and the same Encoder Library as the Samsung. The one thing that does stand out from the Samsung results is the Audio Sample rate of 44,100 got carried over from the originals (Table 19, page 22).

Like the Samsung results everything was encoded with Lavf version 56.40.101 and the container was changed to isom (Table 16). All the videos got a new resolution of 1280x720 which can be seen in Table 17 just below. One result that is interesting is that rather than being HEVC they are now H.264/AVC like the Samsung videos (Table 18, page 23). Another observation about the audio information is that originally the audio information showed that they were mono (see Chapter III, sub-chapter - Originals), but after being downloaded, they are now dual channel (Table 19, page 23).

	File Name	Encoder	Container Specification
Set 1	720p HD at 30fps	Lavf56.40.101	isom
	1080p HD at 30 fps	Lavf56.40.101	isom
	1080p HD at 60fps	Lavf56.40.101	isom
	4K at 30fps	Lavf56.40.101	isom
Set 2	720p HD at 30fps	Lavf56.40.101	isom
	1080p HD at 30 fps	Lavf56.40.101	isom
	1080p HD at 60fps	Lavf56.40.101	isom
	4K at 30fps	Lavf56.40.101	isom

Table 16. iPhone Downloaded Encoder/Container

	File Name	New Resolution for Computer and Mobile
Set 1	720p HD at 30fps	1280x720
	1080p HD at 30 fps	1280x720
	1080p HD at 60fps	1280x720
	4K at 30fps	1280x720
Set 2	720p HD at 30fps	1280x720
	1080p HD at 30 fps	1280x720
	1080p HD at 60fps	1280x720
	4K at 30fps	1280x720

Table 17. iPhone Downloaded Resolution

	File Name	Compressor ID	Video Format	Computer and Mobile Video Profile	Encoder Library Name
Set 1	720p HD at 30fps	avc1	Advanced Video Codec	High@L3.1	x264 core 148
	1080p HD at 30 fps	avc1	Advanced Video Codec	High@L3.1	x264 core 148
	1080p HD at 60fps	avc1	Advanced Video Codec	High@L3.1	x264 core 148
	4K at 30fps	avc1	Advanced Video Codec	High@L3.1	x264 core 148
Set 2	720p HD at 30fps	avc1	Advanced Video Codec	High@L3.1	x264 core 148
	1080p HD at 30 fps	avc1	Advanced Video Codec	High@L3.1	x264 core 148
	1080p HD at 60fps	avc1	Advanced Video Codec	High@L3.1	x264 core 148
	4K at 30fps	avc1	Advanced Video Codec	High@L3.1	x264 core 148

Table 18. iPhone Downloaded Video Information

	File Name	Audio Format	Audio Profile	Audio Format	Channels	Bit Depth	Sample Rate
Set 1	720p HD at 30fps	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16	44100
	1080p HD at 30 fps	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16	44100
	1080p HD at 60fps	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16	44100
	4K at 30fps	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16	44100
Set 2	720p HD at 30fps	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16	44100
	1080p HD at 30 fps	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16	44100
	1080p HD at 60fps	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16	44100
	4K at 30fps	Advanced Audio Codec	HE-AAC / LC	mp4a	2	16	44100

Table 19. iPhone Downloaded Audio Information

Atom Structure

Like in the metadata that was extracted from all the videos, the iPhone videos that were downloaded had all the same atom structure. It did not matter whether the video was downloaded with a different browser or had the HD on or off in the upload. The one thing that is interesting about this atom structure is that it is exactly the same as the Samsung atom structure (excluding the Samsung 640x480 mobile upload). See Appendix, Figure A.

Encoder Settings

Just like all the other information that was extracted from all the iPhone files, the results came back that every video resolution came out with the exact same encoder settings. Unlike the Samsung results, there were no discrepancies among the extracted information.

Another interesting observation to note is that the Encoder Settings are exactly the same as the Samsung 1920x1080 and 1280x720 resolution. (Appendix Figures B and C)

Browser Results

After all the videos were downloaded each video was hashed using MD5 just like the Samsung video files. In Table 20 it can be seen that between the three different browsers that were used none of them affected the download process of the videos.

Chrome File Hash	FireFox File Hash	Safari File Hash
0c4f8be50a92369c1f1fac09b2359cee	0c4f8be50a92369c1f1fac09b2359cee	0c4f8be50a92369c1f1fac09b2359cee
ff53507867630c4640ea20ac901a4a7c	ff53507867630c4640ea20ac901a4a7c	ff53507867630c4640ea20ac901a4a7c
667ac710195da0fec2a23ed4bc68e392	667ac710195da0fec2a23ed4bc68e392	667ac710195da0fec2a23ed4bc68e392
47f927cc9ceeb9080c385a4e559b4e9b	47f927cc9ceeb9080c385a4e559b4e9b	47f927cc9ceeb9080c385a4e559b4e9b
2cccf310897b402c8f2ac8e5ab2ae4f5	2cccf310897b402c8f2ac8e5ab2ae4f5	2cccf310897b402c8f2ac8e5ab2ae4f5
21014b3fcca446e3853b467792a7199e	21014b3fcca446e3853b467792a7199e	21014b3fcca446e3853b467792a7199e
7fbd3e1a8ec17eedfb294cf95f766547	7fbd3e1a8ec17eedfb294cf95f766547	7fbd3e1a8ec17eedfb294cf95f766547
61f64db1d17a43bb385e6322bfb2f03c	61f64db1d17a43bb385e6322bfb2f03c	61f64db1d17a43bb385e6322bfb2f03c
7ff61a6c9b6648a41f3ea6f51e8d189c	7ff61a6c9b6648a41f3ea6f51e8d189c	7ff61a6c9b6648a41f3ea6f51e8d189c
921e9a1feccd4a8446bf93436190f83d	921e9a1feccd4a8446bf93436190f83d	921e9a1feccd4a8446bf93436190f83d
f895c31fc4e8ad31a1ee6f44b330f4cf	f895c31fc4e8ad31a1ee6f44b330f4cf	f895c31fc4e8ad31a1ee6f44b330f4cf
1d52b6b01d2ebcf78e00bd8da183fe83	1d52b6b01d2ebcf78e00bd8da183fe83	1d52b6b01d2ebcf78e00bd8da183fe83
44ea19f07d64c4a0c454f374cf046f7a	44ea19f07d64c4a0c454f374cf046f7a	44ea19f07d64c4a0c454f374cf046f7a
fba91ef6746533153192655f562d36ad	fba91ef6746533153192655f562d36ad	fba91ef6746533153192655f562d36ad
23c3ef9188caf39323dcbef2956abb4f	23c3ef9188caf39323dcbef2956abb4f	23c3ef9188caf39323dcbef2956abb4f
120bc5b2971408cc373b66ac036f422a	120bc5b2971408cc373b66ac036f422a	120bc5b2971408cc373b66ac036f422a
98270fd7e5a877b7e2f3d4b6a600b333	98270fd7e5a877b7e2f3d4b6a600b333	98270fd7e5a877b7e2f3d4b6a600b333
54941f74c3ac6f9dd951429eec88638b	54941f74c3ac6f9dd951429eec88638b	54941f74c3ac6f9dd951429eec88638b
2c43a8a7b07b3f293d9d80f580bbd510	2c43a8a7b07b3f293d9d80f580bbd510	2c43a8a7b07b3f293d9d80f580bbd510
3169e2d7cb3952a27b9ed14c4303ac44	3169e2d7cb3952a27b9ed14c4303ac44	3169e2d7cb3952a27b9ed14c4303ac44
a68b37a233c927091092d8e856aac511	a68b37a233c927091092d8e856aac511	a68b37a233c927091092d8e856aac511
f5ed0454fd58b5668d1a3448a890d1a8	f5ed0454fd58b5668d1a3448a890d1a8	f5ed0454fd58b5668d1a3448a890d1a8
0174635e0e606344ec8d5b8130de9616	0174635e0e606344ec8d5b8130de9616	0174635e0e606344ec8d5b8130de9616
9d076cebf9f2a604ac6dc38d01e29c47	9d076cebf9f2a604ac6dc38d01e29c47	9d076cebf9f2a604ac6dc38d01e29c47

Table 20. iPhone Browser Hashes

CHAPTER V

Conclusion

One very surprising discovery in this test were the results of the iPhone video files. Every video got the exact same encoding scheme even though they were all different from each other. In the end all the iPhone videos were re-encoded with a resolution of 1280x720 no matter what the original resolution was. Also all the iPhone videos got encoded with the same settings and which also includes all the same metadata information. The only information that was not altered was most of the audio information. The bit depth, same rate, audio format and sound handler stayed the same to the originals. Because all the video data, audio data, metadata, encoder settings and atom structure is the same among all the iPhone videos, there is nothing connecting the Facebook downloaded videos to the originals videos (excluding the content in the videos).

On the other hand the Samsung videos had some very interesting results especially the 640x480 resolutions. The fact that one of the resolutions is upload dependent compared to all the other (including the iPhone videos) shows that there is a correlation to the Samsung smartphone. This is not definite though because there is always a possibility that all videos uploaded at 640x480 with a smartphone go through the same encoding process that these showed. Just like all the videos that were 1280x720, 1920x1080, and 4K all ended with the same resolution of 1280x720 and the same metadata information, it is very likely that videos that are 640x480 and uploaded with a smartphone through the application will end up with the same metadata information, encoder settings and atom structure.

Future Research

With the data that has been collected there is still plenty of research that can be done to Facebook and its extensions. A larger group with more varying resolutions could show how different resolutions are effected when they are re-encoded by Facebook's settings. Another test that this study did not truly undertake was how different frame rate are effected by the encoder.

An approach that this test did not take is how different Facebook application updates effect video when it is downloaded. Because updates are controlled by Facebook, there is a possibility that a new version could have different encoder settings. Another possibility is Facebook might update to HEVC rather than keep H.264/AVC because smartphones and videos are moving towards higher resolutions and frame rates.

With the results of this test and seeing that 640x480 is upload depended, the most interesting test would be seeing if there is a difference in videos that are uploaded to Facebook using the Mobile Application and the smartphone's browser. This test would bring insight into whether the encoder settings are embedded in the application or whether they are smartphone related.

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APPENDIX

A. Atom Structures of all video files after download from Facebook.

Atom Structures			
All iPhone Structures	Other Samsung Structures	Samsung Browser 640x480	Samsung Mobile 640x480
ftyp	ftyp	ftyp	ftyp
moov	moov	moov	moov
mvhd	mvhd	mvhd	mvhd
trak	trak	trak	trak
tkhd	tkhd	tkhd	tkhd
edts	edts	edts	edts
elst	elst	elst	elst
mdia	mdia	mdia	mdia
mdhd	mdhd	mdhd	mdhd
hdlr	hdlr	hdlr	hdlr
minf	minf	minf	minf
vmhd	vmhd	vmhd	vmhd
dinf	dinf	dinf	dinf
dref	dref	dref	dref
url	url	url	url
stbl	stbl	stbl	stbl
stsd	stsd	stsd	stsd
avc1	avc1	avc1	avc1

avcC	avcC	avcC	avcC
stts	stts	stts	stts
stss	stss	stss	stss
ctts	ctts	ctts	
stsc	stsc	stsc	stsc
stsz	stsz	stsz	stsz
stco	stco	stco	stco
trak	trak	trak	trak
tkhd	tkhd	tkhd	tkhd
edts	edts	edts	edts
elst	elst	elst	elst
mdia	mdia	mdia	mdia
mdhd	mdhd	mdhd	mdhd
hdlr	hdlr	hdlr	hdlr
minf	minf	minf	minf
smhd	smhd	smhd	smhd
dinf	dinf	dinf	dinf
dref	dref	dref	dref
url	url	url	url
stbl	stbl	stbl	stbl
stsd	stsd	stsd	stsd
mp4a	mp4a	mp4a	mp4a
esds	esds	esds	esds

stts	stts	stts	stts
stsc	stsc	stsc	stsc
stsz	stsz	stsz	stsz
stco	stco	stco	stco
udta	udta	udta	udta
meta	meta	meta	meta
hdlr	hdlr	hdlr	hdlr
ilst	ilst	ilst	ilst
Â©nam	Â©nam	Â©nam	Â©nam
data	data	data	data
Â©too	Â©too	Â©too	Â©too
data	data	data	data
free	free	free	free
mdat	mdat	mdat	mdat
size:	size:	size:	size:
data:	data:	data:	data:
free	free	free	free
version:	version:	version:	version:

B. Comparative chart of encoder settings for all files after downloading from Facebook.

Samsung 1280x720 , 1920x1080 computer and smartphone upload									
cabac=1	ref=5	deblock=1:0:0	analyse=0x3:0x113	me=hex	subme=6	psy=0	mixed_ref=1	me_range=16	chroma_me=1
Samsung 1072x1072 computer and smartphone upload									
cabac=1	ref=5	deblock=1:0:0	analyse=0x3:0x113	me=hex	subme=6	psy=0	mixed_ref=1	me_range=16	chroma_me=1
Samsung 640x480 computer upload									
cabac=1	ref=5	deblock=1:0:0	analyse=0x3:0x113	me=hex	subme=6	psy=0	mixed_ref=1	me_range=16	chroma_me=1
Samsung 640x480 smartphone upload									
cabac=0	ref=5	deblock=1:0:0	analyse=0x1:0x111	me=hex	subme=7	psy=0	mixed_ref=1	me_range=16	chroma_me=1
iPhone computer and smartphone uploads									
cabac=1	ref=5	deblock=1:0:0	analyse=0x3:0x113	me=hex	subme=6	psy=0	mixed_ref=1	me_range=16	chroma_me=1
Samsung 1280x720 , 1920x1080 computer and smartphone upload (continuation)									
trellis=1	8x8dct=1	cqm=0	deadzone=21	11	fast_pskip=1	chroma_qp_offset=0	threads=40	lookahead_threads=6	sliced_threads=0
Samsung 1072x1072 computer and smartphone upload (continuation)									
trellis=1	8x8dct=1	cqm=0	deadzone=21	11	fast_pskip=1	chroma_qp_offset=0	threads=33	lookahead_threads=5	sliced_threads=0
Samsung 640x480 computer upload (continuation)									
trellis=1	8x8dct=1	cqm=0	deadzone=21	11	fast_pskip=1	chroma_qp_offset=0	threads=20	lookahead_threads=3	sliced_threads=0
Samsung 640x480 smartphone upload (continuation)									
trellis=1	8x8dct=0	cqm=0	deadzone=21	11	fast_pskip=1	chroma_qp_offset=0	threads=12	lookahead_threads=2	sliced_threads=0
iPhone computer and smartphone uploads (continuation)									
trellis=1	8x8dct=1	cqm=0	deadzone=21	11	fast_pskip=1	chroma_qp_offset=0	threads=40	lookahead_threads=6	sliced_threads=0
Samsung 1280x720 , 1920x1080 computer and smartphone upload (continuation)									
nr=0	decimate=1	interlaced=0	bluray_compat=0	constrained_intra=0	bframes=3	b_pyramid=2	b_adapt=1	b_bias=0	direct=1
Samsung 1072x1072 computer and smartphone upload (continuation)									
nr=0	decimate=1	interlaced=0	bluray_compat=0	constrained_intra=0	bframes=3	b_pyramid=2	b_adapt=1	b_bias=0	direct=1
Samsung 640x480 computer upload (continuation)									
nr=0	decimate=1	interlaced=0	bluray_compat=0	constrained_intra=0	bframes=3	b_pyramid=2	b_adapt=1	b_bias=0	direct=1
Samsung 640x480 smartphone upload (continuation)									
nr=0	decimate=1	interlaced=0	bluray_compat=0	constrained_intra=0	bframes=0				
iPhone computer and smartphone uploads (continuation)									
nr=0	decimate=1	interlaced=0	bluray_compat=0	constrained_intra=0	bframes=3	b_pyramid=2	b_adapt=1	b_bias=0	direct=1

C. Comparative chart of encoder settings for all files after downloading from Facebook (continuation of B.)

Samsung 1280x720 , 1920x1080 computer and smartphone upload (continuation)									
weightb=1	open_gop=0	weightp=1	keyint=90	keyint_min=9	scenecut=40	intra_refresh=0	rc_lookahead=30	rc=crf	mbtree=1
Samsung 1072x1072 computer and smartphone upload (continuation)									
weightb=1	open_gop=0	weightp=1	keyint=90	keyint_min=9	scenecut=40	intra_refresh=0	rc_lookahead=30	rc=crf	mbtree=1
Samsung 640x480 computer upload (continuation)									
weightb=1	open_gop=0	weightp=1	keyint=90	keyint_min=9	scenecut=40	intra_refresh=0	rc_lookahead=30	rc=crf	mbtree=1
Samsung 640x480 smartphone upload (continuation)									
		weightp=0	keyint=90	keyint_min=9	scenecut=40	intra_refresh=0	rc_lookahead=40	rc=crf	mbtree=1
iPhone computer and smartphone uploads (continuation)									
weightb=1	open_gop=0	weightp=1	keyint=90	keyint_min=9	scenecut=40	intra_refresh=0	rc_lookahead=30	rc=crf	mbtree=1
Samsung 1280x720 , 1920x1080 computer and smartphone upload (continuation)									
crf=27.0	qcomp=0.60	qpmin=0	qpmax=69	qpstep=4	vbv_maxrate=2500	vbv_bufsize=5000	crf_max=0.0	nal_hrd=none	filler=0
Samsung 1072x1072 computer and smartphone upload (continuation)									
crf=27.0	qcomp=0.60	qpmin=0	qpmax=69	qpstep=4	vbv_maxrate=2500	vbv_bufsize=5000	crf_max=0.0	nal_hrd=none	filler=0
Samsung 640x480 computer upload (continuation)									
crf=27.0	qcomp=0.60	qpmin=0	qpmax=69	qpstep=4	vbv_maxrate=2500	vbv_bufsize=5000	crf_max=0.0	nal_hrd=none	filler=0
Samsung 640x480 smartphone upload (continuation)									
crf=27.0	qcomp=0.60	qpmin=0	qpmax=69	qpstep=4	vbv_maxrate=450	vbv_bufsize=900	crf_max=0.0	nal_hrd=none	filler=0
iPhone computer and smartphone uploads (continuation)									
crf=27.0	qcomp=0.60	qpmin=0	qpmax=69	qpstep=4	vbv_maxrate=2500	vbv_bufsize=5000	crf_max=0.0	nal_hrd=none	filler=0
Samsung 1280x720 , 1920x1080 computer and smartphone upload (continuation)									
ip_ratio=1.40	aq=2:1.00								
Samsung 1072x1072 computer and smartphone upload (continuation)									
ip_ratio=1.40	aq=2:1.00								
Samsung 640x480 computer upload (continuation)									
ip_ratio=1.40	aq=2:1.00								
Samsung 640x480 smartphone upload (continuation)									
ip_ratio=1.40	aq=2:1.00								
iPhone computer and smartphone uploads (continuation)									
ip_ratio=1.40	aq=2:1.00								