FILE STRUCTURE ANALYSIS OF VIDEOS TRANSFERRED THROUGH THE TELEGRAM APP USING MOBILE PHONES

by

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File Structure Analysis of Videos Transferred Through the Telegram App Using Mobile Phones

Thesis directed by Associate Professor Catalin Grigoras

ABSTRACT

This thesis examines the changes made to videos through the Telegram transfer process

using mobile phones. Telegram is a secure messaging application that is currently in the top five

most-downloaded applications worldwide. By transferring videos from mobile phones through

Telegram to other mobile phones, any changes made to those videos can be analyzed by

comparing the original video to the received counterpart. This thesis analyzes videos transferred

through Telegram and the original videos through hash value, stream hash value, metadata, and

hex analysis. After analyzing the Telegram-transferred videos and comparing them to the

original videos, the analysis concluded the hash values and stream hash values of the received

videos did not match the original videos concluding Telegram transfers do not keep the integrity

of transferred videos intact. The analysis of the metadata and hex data proved further the

Telegram transfer process affected the videos, because the metadata and the hex data were

changed with every transfer.

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

Approved: Catalin Grigoras

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DEDICATION

This thesis is dedicated to my amazing family and friends who supported me through it all.

To my husband, Travis, who supported me through every phase I went through during my degree, whose encouragement lifted me, and who took daily household tasks off my plate.

To my family, who endlessly loved me and believed in me throughout my degree, but, most importantly, throughout my life.

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ABBREVIATIONS

AAC LC – Advanced Video Coding Low Complexity

API – Application Programming Interface

AVC – Advanced Video Coding

CABAC – Context-based Adaptive Binary Arithmetic Coding

FPS – Frames Per Second

GOP – Group of Pictures

HEVC - High Efficiency Video Coding

MPEG – Moving Picture Experts Group

QT – QuickTime

SHA-256 – Secure Hash Algorithm 256-bit

I. INTRODUCTION

In this day, messaging applications are used to communicate with anyone who has access to the application, wherever they can access the application. This freedom to communicate almost instantaneously with anyone else using the same app is relatively new. Applications such as Telegram offer fast and secure messaging. Telegram is known for its security features, and this has led to the application being used for not just staying in touch with friends or family, but terrorist group recruiting and lone wolf attacks [1], as well as distribution of underground economy apps that provide services such as gambling and pornography [2].

There was no research found that studied the effects of the Telegram app on videos transferred through the app, which is what this thesis studies. This thesis examines the hash, stream hash, metadata, and hexadecimal changes made specifically to videos sent through Telegram. The results of this study help to find consistencies between video evidence for cases and videos transferred via the Telegram app. This study is useful in understanding which messaging application videos were distributed with, authenticating video evidence transferred through the Telegram app, ensuring the evidence's integrity is intact, and proving the evidence is what it purports to be. The hash, stream hashes, metadata, and hexadecimal information for original videos and their counterparts transferred through Telegram will be compared to analyze the changes made to the videos throughout the transfer process. Different mobile phones were used for this study: one Samsung Galaxy 23 Ultra, an iPhone 15, an iPhone 14, an iPhone 16e, and a Google Pixel 10 to determine if using different mobile phones affects the transferred videos.

Telegram

Telegram is a free-to-use cloud-based messaging app that first launched in 2013. It advertises on speed and security, currently has over a billion active users, and is in the top five most-downloaded apps today [3]. Telegram users can send any type of file with the unlimited messaging the app offers, provided the files are 2 GB or less. Users can create messaging groups of up to 200,000 users and create channels for broadcasting to an unlimited number of people [3].

This messaging app boasts its security features. The app includes end-to-end encryption on voice calls, video calls, voice chats, and text messages that may contain video files. Secret chats are supported which self-destruct messages and media files. A passcode can be placed on the app by a user, and users can delete messaging on both the sending and receiving side of the message. If a user deletes their account, Telegram will remove all data from that account in their system. Their goal is to protect private messages and personal data.

There are many features within the Telegram app. Messages synchronize across different devices, allowing users to view messages on all their devices: mobile phones, tablets, and computers. There is a built-in photo editor. By utilizing cloud-based storage and caching, the app does not take up much space on the user's device. The cache can be manually cleared by the user. The API and code are open which allows people to connect third-party functionalities to add tools and collect payments through Telegram.

Telegram makes money by sponsored messages that are sent in the public channels and users can purchase a premium subscription which allows users access to additional features such as doubled file limits (up to 4 GB) and faster download speed for large files [4].

As a first-time Telegram user, the user creates an account by selecting their country, entering their phone number, and entering their first and last name. The app will then send a code to the phone number to verify it. This code must be input on the app before the user starts messaging. The user can create videos within a chat, but these videos cannot be saved directly to their mobile phone before sending the video. After sending the video, the user can save the video to their camera roll or elsewhere on their device. These videos can be edited, before being sent, with Telegram's built-in editing tools that include trimming, cropping, drawing, quality adjustments, brightness, contrast, saturation, and color adjustments. During testing for this thesis, five videos were taken using this method, and downloaded onto the Files app of the iPhone 15 used for video capture. The metadata and structure data were the same throughout all five videos and the results of one of the video's format data is shown in the figure below.

```
General
 Complete name
Format
Format profile
Codec ID
                                                                                              : U:\Thesis Simplified\Telegram Messaged video\video 2.mp4
                                                                                              : MPEG-4
: Base Media / Version 2
: mp42 (isom/mp41/mp42)
: 1.47 MiB
 File size
                                                                                              : 1.47 M1B

7 s 567 ms

: 1 628 kb/s

: 30.000 FPS

: 2025-10-18 16:06:23 UTC

: 2025-10-18 16:06:24 UTC
Duration
Overall bit rate
 Frame rate
Encoded date
 Tagged date
 Video
 ID
Format
                                                                                              : AVC
Format
Format/Info
Format profile
Format settings
Format settings, CABAC
Format settings, Refere
Format settings, GOP
Codec ID
                                                                                                 Advanced Video Codec
High@L3.1
CABAC / 4 Ref Frames
                                                                                              : CABAC / 4 KET Frames
: Yes
: 4 frames
: M=4, N=29
: avc1
: Advanced Video Coding
                                      Reference frames
 Codec ID/Info
Duration
Bit rate
Width
                                                                                                  7 s 567 ms
1 576 kb/s
464 pixels
 Height
                                                                                                  848 pixels
Display aspect ratio
Frame rate mode
Frame rate
                                                                                                  9:16
                                                                                                  Constant
30.000 FPS
YUV
 Color space
Chroma subsampling
Bit depth
Scan type
Bits/(Pixel*Frame)
                                                                                                  4:2:0
                                                                                              : 8 bits
: Progressive
: 0.133
: 1.42 MiB (97%)
 Stream size
                                                                                                  Core Media Video
2025-10-18 16:06:23 UTC
2025-10-18 16:06:24 UTC
 Title
 Encoded date
Tagged date
                                                                                              : Limited
 Color range
Color primaries
Transfer characteristics
Matrix coefficients
Codec configuration box
                                                                                              : BT.709
: BT.709
: BT.709
                                                                                              : avcC
Audio
ID
Format
                                                                                             : AAL LL
: Advanced Audio Codec Low Complexity
: mp4a-40-2
: 7 s 550 ms
: 7 s 616 ms
 Format/Info
Codec ID
Duration
Source duration
Bit rate mode
Bit rate
Nominal bit rate
Channel(s)
Channel layout
                                                                                                  Constant
                                                                                              : 45.5 kh/s
                                                                                              : 43.3 kb/s
: 64.0 kb/s
: 2 channels
: L R
 Channel layout
 Sampling rate
Frame rate
Compression mode
Stream size
                                                                                               : 43.066 FPS (1024 SPF)
                                                                                             : 43.000 FF3 (1024 3.17)
: Lossy
: 41.9 KiB (3%)
: 42.4 KiB (3%)
: Core Media Audio
: 2025-10-18 16:06:23 UTC
: 2025-10-18 16:06:24 UTC
 Source stream size
 Encoded date
 Tagged date
```

Figure 1. Telegram Video Format Data

As shown in the format data figure, Telegram videos created within the messaging portion of the application are in an MPEG-4 format, recorded at 30 FPS, the video format is AVC, the aspect ratio is 9:16, the chroma subsampling is 4:2:0, the video is 8 bits, the audio is stereo with two channels, the audio sampling rate is 44.1kHz, and the audio format is AAC LC. The format metadata was consistent throughout all five test video files, the differences being the times/dates, the sizes, and the duration which are typical differences for nonidentical videos. The Telegram video structure information was consistent across all five of the test videos except for

the size and specific video information that is expected to change with every video that is nonidentical: duration, sizes, etc. This information is shown in the figure below.

Figure 2. Telegram Video Structure

Previous Research

There has been previous research relating to transferred media files over apps such as WhatsApp [5], Discord [6], and Signal [7], but none found with a focus on videos transferred via Telegram. Those papers explain what changes are made to certain media files through the transfer process using an application, and this thesis will explain hash, stream hash, metadata, and hexadecimal data changes made to videos that occurs during the Telegram transfer process.

II. TECHNICAL OVERVIEW

Hash

Hash values are numerical values that are calculated using hashing functions, which are mathematical calculations that generate a numerical value based on the input data [8]. These values can be used to help verify the integrity of files because it is normally unique for each file no matter how miniscule the difference when compared to another file. The only times that hash values of two different files have been the same is in a lab, and this is referred to as a collision.

Stream Hash

Stream hashes are numerical values like hashes, but the calculation for the stream hash is for each stream of data. With the focus of this thesis on videos, the stream hash of the audio stream and the video stream were calculated for both the original and transferred files.

Metadata

Metadata is data that can be embedded in a file that describes a file or directory. This data can include dates and times of creation or modification, permissions, and locations where data is stored [8].

Hex Data

Hexadecimal is a number system that uses 16 symbols: 0-9 and then instead of 10 after 9, it begins with A and goes through F. This system is used to show binary data for a file and can be used to analyze the structure of a video. An example of hex data is shown in the figure below.

```
Offset(h) 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F Decoded text
00000000 00 00 00 1C 66 74 79 70 6D 70 34 32 00 00 00 01 ....ftypmp42....
00000010
          69 73 6F 6D 6D 70 34 31 6D 70 34 32 00 00 00 01
                                                           isommp41mp42....
          6D 64 61 74 00 00 00 00 00 17 67 3B 21 00 03 40
                                                           mdat....g;!..@
00000030
          68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C 21 00
                                                           h.!..@h.!..@h.!.
00000040
         03 40 68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C
                                                           .@h.!..@h.!..@h.
00000050
         21 00 03 40 68 1C 21 00 03 40 68 1C 21 00 03 40
                                                           !..@h.!..@h.!..@
00000060
         68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C 21 00
                                                           h.!..@h.!..@h.!.
00000070
         03 40 68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C
                                                           .@h.!..@h.!..@h.
08000000
         21 00 03 40 68 1C 21 00 03 40 68 1C 21 00 03 40
                                                           !..@h.!..@h.!..@
00000090
          68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C 21 00
                                                           h.!..@h.!..@h.!.
000000A0
         03 40 68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C
                                                           .@h.!..@h.!..@h.
000000B0
         21 00 03 40 68 1C 21 00 03 40 68 1C 21 00 03 40
                                                           !..@h.!..@h.!..@
00000000
          68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C 21 00
                                                           h.!..@h.!..@h.!.
000000D0
         03 40 68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C
                                                           .@h.!..@h.!..@h.
000000E0
         21 00 03 40 68 1C 21 00 03 40 68 1C 21 00 03 40
                                                           !..@h.!..@h.!..@
000000F0
          68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C 21 00
                                                           h.!..@h.!..@h.!.
00000100
         03 40 68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C
                                                           .@h.!..@h.!..@h.
00000110
         21 00 03 40 68 1C 21 00 03 40 68 1C 21 00 03 40
                                                           !..@h.!..@h.!..@
00000120
         68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C 21 00
                                                           h.!..@h.!..@h.!.
00000130
         03 40 68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C
                                                           .@h.!..@h.!..@h.
00000140
         21 00 03 40 68 1C 21 00 03 40 68 1C 21 00 03 40
                                                           !..@h.!..@h.!..@
00000150
          68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C 21 00
                                                           h.!..@h.!..@h.!.
00000160
         03 40 68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C
                                                           .@h.!..@h.!..@h.
00000170
         21 00 03 40 68 1C 21 00 03 40 68 1C 21 00 03 40
                                                           !..@h.!..@h.!..@
00000180
         68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C 21 00
                                                           h.!..@h.!..@h.!.
00000190
         03 40 68 1C 21 00 03 40 68 1C 21 00 03 40 68 1C
                                                           .@h.!..@h.!..@h.
000001A0
         21 09 C4 33 30 36 BE 1A 25 45 2E 54 5A DC 82 24
                                                           !.Ä306%.%E.TZÜ,$
000001B0
         24 52 49 60 C6 1A 5B A9 AB 2B 1D 14 21 AA CA C7
                                                           $RI`Æ.[@«+..!ªÊÇ
                                                           Ahÿ ....åE.È"Bà
000001C0
         41 68 FF A0 00 00 00 00 02 E5 45 AD C8 22 42 E0
000001D0 21 09 C4 3D B2 8F 0A 63 08 40 64 9D 54 4E 29 AA
                                                           !.Ä=:..c.@d.TN) =
000001E0
         C3 4E E5 CC 54 05 4C A5 CA BF 1C B2 CB 9E 80 2C
                                                           ÃNÅÌT.L¥Ê¿.ºËž€,
000001F0 E8 BD 0E D7 18 30 62 1F 28 DD 98 DC B6 D6 1B 85
                                                           è3.×.0b.(Ý~ܶÖ....
```

Figure 3. Hex Data Example

III. MATERIALS

Device Information

The videos analyzed during this study were collected and transferred using five mobile phones. These mobile phones created the videos using their native cameras, uploaded these videos to Telegram and sent them to the receiving mobile phones via Telegram. Within the receiving mobile phone, the video was downloaded to the phone then uploaded to Dropbox. Dropbox is a cloud-based storage service that was used in this study to collect all original and transferred video files from the mobile phones. The videos from the sending phone and the receiving phone were both downloaded from Dropbox onto the computer used for analysis. The computer used for analysis then downloaded the original and received videos from Dropbox. The information for the mobile phones and the computer used for testing are shown in the table below.

Table 1. Device Specifications

Device	Operating System
iPhone 14 Pro	iOS 18.6.2
iPhone 15	iOS 18.6.2
iPhone 16e	iOS 18.6.2
Samsung Galaxy 23 Ultra	Android v 16
Google Pixel 10	Android v 16
MacBook Pro	Sonoma 14.5

Software Information

Software was utilized in this study to transfer and analyze the videos. The software names and versions used are shown in the table below.

Table 2. Software Specifications

Software	Version
Telegram	12.1.1
Hasher	2.0.0.0
ffmpeg	2025-03-24-git- cbbc927a67-full_build- www.gyan.dev Copyright (c) 2000- 2025 the FFmpeg developers
Powershell	5.1.19041.6456
MediaInfo	25.04
MP4 File Dumper	1.2
MediaConch	25.04
HxD	2.4.0.0
Dropbox	446.2

Test Video Creation

A total of ten videos with a length of approximately five-seconds were created, with the exception, of seven created with the iPhone 16e, using each mobile phone' native camera app. These original videos were automatically saved into the photo gallery of the mobile phones and then uploaded to Dropbox. These videos were then transferred through Telegram to the other phones. The original videos were compared against the received videos to analyze any changes made throughout the Telegram transfer process.

IV. METHODOLOGY

Methods for Video Transfers

After the test videos were created with the mobile phones, the original videos were uploaded to Dropbox from each phone. The original videos located in the photo gallery of the mobile phones were then sent through the Telegram app to other mobile phones. Not all mobile phones sent videos to all of the other phones, the table below shows the details of the video transfers.

Table 3. Device Information

Device	Devices Videos Were Sent To	How Many Analyzed Videos Were Sent to Each Phone
iPhone 14 Pro	iPhone 15 iPhone 16e Samsung Galaxy 23 Ultra Google Pixel 10	10
iPhone 15	iPhone 14 Pro Google Pixel 10 Samsung Galaxy 23 Ultra	10
iPhone 16e	iPhone 14 Pro Samsung Galaxy 23 Ultra Google Pixel 10	7
Samsung Galaxy 23 Ultra	iPhone 14 Pro iPhone 15 iPhone 16e Google Pixel 10	10
Google Pixel 10	iPhone 14 Pro iPhone 15 iPhone 16e Samsung Galaxy 23 Ultra	10

Each Android phone downloaded the received videos to the photo gallery app and then uploaded them to Dropbox. Each iPhone downloaded the received videos to the Files app and

then uploaded them to Dropbox. The videos were then downloaded from Dropbox to the computer for analysis.

Methods for Analysis

To analyze the changes made to video files by the Telegram transfer process, an analysis of the hash, stream hashes, metadata, and hexadecimal data were employed. The hash and stream hash values were calculated for the original videos and the received videos, then compared. The comparison showed if changes were made to the video file, as well as the individual video and audio streams. These hash calculations were calculated using Hasher.

The metadata information for each video was collected with MediaInfo. The data was studied to find changes made to the videos embedded information. The figure below shows an example of MediaInfo and some metadata information from a studied video file.

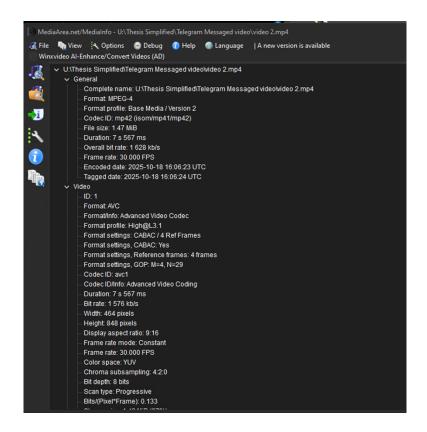


Figure 4. MediaInfo Metadata Example

The structures of the video files were analyzed using MP4 Dumper and MediaConch.

MP4 Dumper was used with Powershell. Examples of the MediaConch and MP4 Dumper

structure format are shown in the figures below. MediaTrace is a report within MediaConch that

shows the structure of a file, as reflected in the second figure below.

```
PS C:\Users\student_105> mp4dump "U:\Thesis Simplified\Telegram Messaged video\video 2.mp4"
[ftyp] sizes8-20
major_brand = mp42
minor_version = 1
compatible_brand = isom
compatible_brand = mp41
(compatible_brand = mp42
[mast] sizes16-1533739
[moov] sizes8-5809
[mvhd] sizes12-96
timescale = 44100
duration = 333690
duration = 3460
duration = 4640
entry/media rate = 1
[mdia] sizes8-3527
[mdia] sizes8-3527
[mdia] sizes8-3527
[mdia] sizes12-20
timescale = 600
duration = 4540
duration(ms) = 7566
language = und
[hdIr] size=12-37
handle_type = vide
handle_name = Core Media Video
[minf] size=8-348]
[vmhd] size=12-8, flags=1
graphics_mode = 0
op_color = 6000,0000,0000
[dinf] size=8-28
[dref] size=12-16
[url] size=12-16
[url] size=3-155
data_reference_index = 1
width = 464
height = 848
```

Figure 5. MP4 Dumper

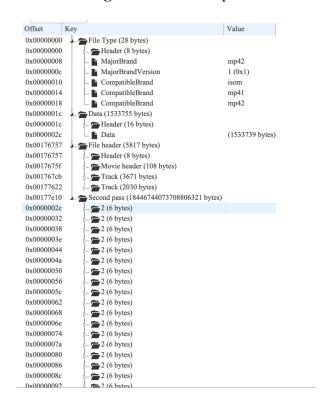


Figure 6. MediaConch MediaTrace Report

Changes made by the Telegram transfer process to the videos that affect the hash values, stream hash values, metadata, and structure of the file were studied in this thesis using the methods mentioned above.

V. RESULTS

File Hashes

The hash values of the files changed with every transfer indicating the files were changed during the Telegram transfer process. The table below shows an original video from the Samsung Galaxy 23 Ultra and its received counterparts from the other devices with their SHA-256 hash values.

Table 4. Samsung Galaxy Hash Value Comparison

Device	File Name	SHA-256 Hash Value
Samsung Galaxy 23 Ultra (Originating Device)	_	7E2154CE5E9482B7568659768E20591AB3C5DD416FFE7 BBB2DE314968A22F971
iPhone 14 Pro	_	F7317049BDBBB73AA643CC55F45968082656D5819C62 003BDEC9CE34CB5894FF
iPhone 15	_	F7317049BDBBB73AA643CC55F45968082656D5819C62 003BDEC9CE34CB5894FF
iPhone 16e	(1).mp4	F7317049BDBBB73AA643CC55F45968082656D5819C62 003BDEC9CE34CB5894FF
Google Pixel 10	VID_20251011 _182048_183. mp4	F7317049BDBBB73AA643CC55F45968082656D5819C62 003BDEC9CE34CB5894FF

The other mobile phones used in the study showed the same results as the Samsung Galaxy 23 Ultra results show in the table above. File names changed when videos were transferred through Telegram to other mobile phones. The hash values changed in the transfer process, but were consistent with the received videos indicating the change to the video files happened in Telegram, not by downloading to the mobile phone.

Stream Hashes

The test videos' stream hash values were calculated for the video and the audio streams.

Analysis of these values determined the stream hash values for the video and the audio streams

of a video change through the Telegram transfer process. The stream hash values for a received video are the same no matter the device to which they are downloaded. This indicates changes made to the streams are made in the Telegram app and those changes are not made by the downloading device or method. The stream hash results of an original video from the iPhone 14 device compared to the received versions from each device are shown in the table below.

 Table 5. iPhone 14 Stream Hash Value Comparison

Device	File Name	SHA-256 Video and Audio Stream Hash Values
iPhone 14 (Originating Device)	Video Oct 11 2025, 5 42 48 PM.mov	Video: 633904e86a4c6760c8633e276100766f09369a930d5f2510e7 941a8ed3bf9bbf Audio: ca80d7c615f89c4255fe32c169dc30aa9bbfc2665d55ae55679
Samsung Galaxy 23 Ultra	VID_20251011 _175709_174. mp4.mov	4bf17b9ba1089 Video: 74a8f8807adf90ea5edacdcd394a6bec02f581cfb67da120995c 7b156a6255c4 Audio: d30dddef915d0d02c6800e51415f197dcd0fa5222fa48c9052a
iPhone 15 IMG_6704		572af3a79e438 Video: 74a8f8807adf90ea5edacdcd394a6bec02f581cfb67da120995c 7b156a6255c4 Audio: d30dddef915d0d02c6800e51415f197dcd0fa5222fa48c9052a 572af3a79e438
iPhone 16e	IMG_6704	Video: 74a8f8807adf90ea5edacdcd394a6bec02f581cfb67da120995c 7b156a6255c4 Audio: d30dddef915d0d02c6800e51415f197dcd0fa5222fa48c9052a 572af3a79e438
Google Pixel 10	VID_20251011 _175612_211. mp4.mov	Video: 74a8f8807adf90ea5edacdcd394a6bec02f581cfb67da120995c

Metadata Analysis

MediaInfo was utilized to collect the metadata information for the test videos. There are differences in the metadata between the original videos and the received videos. All received videos for an original video had the same metadata information despite being downloaded onto different devices.

General Metadata

Many changes to the general information metadata of the videos occurred during the transfer process. If the original format profile was QuickTime, it was changed to Base Media / Version 2 during the transfer process. If the original format profile was Base Media or Base Media / Version 2, it changed to, or stayed with, Base Media after the transfer process. The codec ID changed from isom (iso/iso2/mp41) to isom (isom/iso2/avc1/mp41) in the Base Media videos, from qt 0000.00 (qt) to mp42 (isom/mp41/mp42) in QuickTime videos, and from mp42 (isom/mp42) to isom (iso/iso2/avc1/mp41) in Base Media / Version 2 videos. The file size of the received video was always smaller than the original video.

The overall bit rate mode information was variable and only in the original videos of each device except the iPhone 16e and the Samsung Galaxy 23 Ultra. The Samsung Galaxy 23 Ultra did not have the bit rate mode information in the original videos but did have it in the received versions, indicating it was variable. The iPhone 16e did not have the bit rate mode information in the original videos, nor the received videos. The overall bit rate was always lower in the received videos than the original videos. The duration was often shorter in the received video, except for all videos originating from the Samsung Galaxy 23 Ultra device and some videos originating from the Google Pixel 10. This was the same result for the video and audio metadata.

The framerate was the same for all videos originating from the iPhone 16e, some videos originating from the Samsung Galaxy 23 Ultra, and all videos originating from the iPhone 14. The framerate was lower in the received videos originating from the Google Pixel 10 and the iPhone 15. All iPhones had the recorded date in the original videos, but not in the received videos. The encoded and tagged dates and times for the original videos were all different in the received videos in the metadata of the general, video, and audio of the video. Information within the original videos such as recorded location, writing operating system, writing library, writing hardware, or other device-specific information were discarded during the transfer process. Video Metadata

The ID for the video stream was changed from one to two for the Samsung Galaxy 23 Ultra and the Google Pixel 10, it was changed from two to one for the iPhone 15, and remained the same for the iPhone 14 and the iPhone 16e. The format profile changed to High@L3.1 for each device. If the original video's format was HEVC, it is changed to AVC during the transfer process, and the codec ID changed as well from hvc1 to avc1. The codec configuration box changed from hvcC to avcC in the Android videos, and from hvcC+dvvC to avcC in the iPhone 14 videos.

The format settings, format settings CABAC, format settings reference frames, format settings GOP, and muxing mode are only in the original videos of the Samsung Galaxy 23 Ultra device, and the same settings excluding the muxing mode are only in the original videos from the Google Pixel 10, and in only the received videos from the iPhone 15. The iPhone 16e metadata information included the format settings' data, but the reference frame changed from one in the original videos to four in the received, changing the GOP and the reference frame numbers. The bit rate is lower in the received videos.

For the iPhones, the width and height of the videos changed from 1920x1080px to 464x848px during the transfer process, and the width and height of the Android videos changed from 1920x1080px to 720x1280px. All original videos had an aspect ratio of 16:9 and had rotation information of 90 degrees. There was no rotation information for the received videos, and the aspect ratio was 9:16 post-transfer.

The framerate was lower in the received videos from the Google Pixel 10, iPhone 15, some videos from the Samsung Galaxy 23 Ultra, and some videos from the iPhone 14. Real framerate information was in the original videos of both Android phones, but not in the received counterparts. The Bits/(Pixel*Frame) were smaller in the received videos, except for some videos from the iPhone 14, for which it was the same value. The bit depth was 10 bits in the original videos from the iPhone 14 and 8 bits in the received videos.

The study showed video metadata was discarded or added during the transfer process to certain device videos. The standard and mdhd duration information was present in the original videos from the Samsung Galaxy 23 Ultra, but not in the received videos.

Transfer_charcteristics_original information is only in the original videos for the Google Pixel 10, not in the received videos. HDR format information, writing library is only in the original videos from the iPhone 14. The writing library information is only in the original videos from the iPhone 16e and iPhone 15. The metas, also known as tracks, are included in the original videos from the iPhones, but not in the received counterparts. The Google Pixel 10 also had additional information in a section titled "Other" that was in the original videos, but not in the received videos.

Scan type information was in the received videos, not the originals, of the Samsung Galaxy 23 Ultra, Google Pixel 10, and the iPhone 14. Scan type information was in both the original and the received videos from the iPhone 15.

The stream size was smaller in the received videos from the Samsung Galaxy 23 Ultra, iPhone 14, iPhone 16e, and the iPhone 15. The stream size was the same for the original and received videos from the Google Pixel 10.

Two devices, the Samsung Galaxy 23 Ultra and the iPhone 14 had changes made to the color primaries, transfer characteristics, and matrix coefficients of their videos. The color primaries changed from BT.2020 in the original videos of the iPhone 14 to BT.709. In the Samsung Galaxy 23 Ultra, the color primaries of the original videos were BT.709 and this changed to BT.601 PAL in the received videos. The transfer characteristics of the iPhone 14 videos changed from HLG in the originals to BT.709 in the received. The transfer characteristics of the Samsung Galaxy 23 Ultra videos changed from BT.709 in the originals to BT.601 in the received. The matrix coefficients for the iPhone 14 changed from BT.2020 non-constant in the originals to BT.709 in the received. The matrix coefficients for the Samsung Galaxy 23 Ultra changed from BT.709 in the originals to BT.709 in the received.

Audio Metadata

In the Samsung Galaxy 23 Ultra and Google Pixel 10 videos, the audio stream ID changed from 2 to 1, and in the iPhone 15 audio, the ID changed from 1 to 2. The bit rate mode changed from variable in the originals to constant in the received for the iPhone 14 and iPhone 15 videos. For the Android phones, the bit rate mode changed from constant to variable. The Android phones also had nominal bit rate information in the received videos, but not in the original videos. After transferring the iPhone videos, the received videos had a smaller audio

stream and source stream size than their original counterparts. The bit rates were also lower in the videos received from the iPhone devices than the originals. For the Android devices, the stream size was the same for the original and received videos, but the stream size percentage was larger in the received videos than the originals.

The iPhone 16e videos experienced more changes to the audio information than the other devices after the transfer process. There were two audio sections in the original video and only one in the received. The sampling rate also decreased from 48kHz in the original videos to 44.1kHz in the received. The framerate was lower in the received videos than the originals. Other information such as the default, alternate group, fallback from, and audio section #2 were in the original videos, but not the received.

Metadata for one of the original videos of each device compared to that same video received from another device are shown in tables six through ten.

Table 6. Samsung Galaxy 23 Ultra Original Video Metadata vs iPhone 16e Received Video Metadata

Samsung Galaxy 23 Ultra (Originating Device)		iPhone 16e (Receiving Device) Video	
Video "20251011 174533.mp4"		"telegram_video (1)"	
Format	: MPEG-4	Format	: MPEG-4
Format profile	: Base Media /	Format profile	: Base Media
Version 2		Codec ID	: isom
Codec ID	: mp42	(isom/iso2/avc1/mp41)	
(isom/mp42)		File size	: 2.18 MiB
File size	: 10.1 MiB	Duration	: 5 s 887 ms
Duration	: 5 s 887 ms	Overall bit rate mode	: Variable
Overall bit rate	: 14.4 Mb/s	Overall bit rate	: 3 104 kb/s
Frame rate	: 29.218 FPS	Frame rate	: 29.218 FPS
Encoded date	: 2025-10-11	Encoded date	: 2025-10-12
23:45:43 UTC		00:17:42 UTC	
Tagged date	: 2025-10-11	Tagged date	: 2025-10-12
23:45:43 UTC		00:17:42 UTC	

Table 6. Samsung Galaxy 23 Ultra Original Video Metadata vs iPhone 16e Received Video

Metadata cont'd

Samsung Galaxy 23 Ultra (Originating Device)			
		"telegram_video (1)"	
Recorded location	: +39.5352 -	Video	
104.8725		ID	: 2
Writing operating system	: Google	Format	: AVC
Android 16		Format/Info	: Advanced
Writing hardware	: Samsung	Video Codec	
Galaxy S23 Ultra (SM-S9	918U)	Format profile	: High@L3.1
com.samsung.android.utc	_offset : -0600		
		Format settings	: CABAC / 1
Video		Ref Frames	
ID	:1	Format settings, CABAC	: Yes
Format	: HEVC	Format settings, Reference	e frames : 1 frame
Format/Info	: High Efficiency	Format settings, GOP	: M=1, N=29
Video Coding		Muxing mode	: Container
Format profile	:	profile=High@L1.3	
Main@L4@High		Codec ID	: avc1
Codec ID	: hvc1	Codec ID/Info	: Advanced
Codec ID/Info	: High	Video Coding	
Efficiency Video Coding		Duration	: 5 s 887 ms
Duration	: 5 s 887 ms	Bit rate	: 2 840 kb/s
Bit rate	: 14.1 Mb/s	Width	: 720 pixels
Width	: 1 920 pixels	Height	: 1 280 pixels
Height	: 1 080 pixels	Display aspect ratio	: 9:16
Display aspect ratio	: 16:9	Frame rate mode	: Variable
Rotation	: 90°	Frame rate	: 29.218 FPS
Frame rate mode	: Variable	Minimum frame rate	: 5.306 FPS
Frame rate	: 29.218 FPS	Maximum frame rate	: 30.010
Minimum frame rate	: 5.306 FPS	FPS	
Maximum frame rate	: 30.010	Color space	: YUV
FPS		Chroma subsampling	: 4:2:0
Real frame rate	: 30.000 FPS	Bit depth	: 8 bits
Standard	: PAL	Scan type	: Progressive
Color space	: YUV	Bits/(Pixel*Frame)	: 0.105
Chroma subsampling	: 4:2:0	Stream size	: 1.99 MiB (92%)
Bit depth	: 8 bits	Title	: VideoHandle
Bits/(Pixel*Frame)	: 0.233	Language	: English
Stream size	: 9.90 MiB (98%)		

Table 6. Samsung Galaxy 23 Ultra Original Video Metadata vs iPhone 16e Received Video

Metadata cont'd

Samsung Galaxy 23 Ultra (Originating Device)		iPhone 16e (Receiving Device) Video	
Video "20251011_174533.mp4"		"telegram video (1)"	
Title : VideoHandle		Encoded date	: 2025-10-12
Language	: English	00:17:38 UTC	
Encoded date	: 2025-10-11	Tagged date	: 2025-10-12
23:45:43 UTC		00:17:42 UTC	
Tagged date	: 2025-10-11	Color range	: Limited
23:45:43 UTC		Color primaries	: BT.601 PAL
Color range	: Limited	Transfer characteristics	: BT.601
Color primaries	: BT.709	Matrix coefficients	: BT.470
Transfer characteristics	: BT.709	System B/G	
Matrix coefficients	: BT.709	Codec configuration box	: avcC
Codec configuration box	: hvcC	Audio	
		ID	:1
Audio		Format	: AAC LC
ID	: 2	Format/Info	: Advanced
Format	: AAC LC	Audio Codec Low Complexity	
Format/Info	: Advanced	Codec ID	: mp4a-40-2
Audio Codec Low Comple		Duration	: 5 s 867 ms
Codec ID	: mp4a-40-2	Bit rate mode	: Variable
Duration	: 5 s 867 ms	Bit rate	: 256 kb/s
Bit rate mode	: Constant	Nominal bit rate	: 48.0 kb/s
Bit rate	: 256 kb/s	Channel(s)	: 2 channels
Channel(s)	: 2 channels	Channel layout	: L R
Channel layout	: L R	Sampling rate	: 48.0 kHz
Sampling rate	: 48.0 kHz	Frame rate	: 46.875 FPS
Frame rate	: 46.875 FPS	(1024 SPF)	
(1024 SPF)		Compression mode	: Lossy
Compression mode	: Lossy	Stream size	: 183 KiB (8%)
Stream size	: 183 KiB (2%)	Title	: SoundHandle
Title	: SoundHandle	Language	: English
Language	: English	Encoded date	: 2025-10-12
Encoded date	: 2025-10-11	00:17:38 UTC	
23:45:43 UTC		Tagged date	: 2025-10-12
Tagged date	: 2025-10-11		
23:45:43 UTC		00:17:42 UTC	

 Table 7. iPhone 16e Original Video Metadata vs Google Pixel 10 Received Video Metadata

		Google Pixel 10 (Receiving Device) Video	
		"VID_20251011_182445_390.mp4.mov"	
General	** \ \ \ \	General	**\=
Complete name	: U:\Thesis	Complete name	: U:\Thesis
Simplified\Madison Origin		Simplified\Madison Original and	
Received\iPhone 16e Mad	_	Received\Madison Received -	
Oct 11 2025, 6 03 53 PM.r		Rachel\VID_20251011_182445_390.mp4.mov	
Format	: MPEG-4	Format	: MPEG-4
Format profile	•	Format profile	: Base Media /
Codec ID	: qt 0000.00 (qt	Version 2	
)		Codec ID	: mp42
File size	: 10.4 MiB	(isom/mp41/mp42)	
Duration	: 5 s 300 ms	File size	: 1.07 MiB
Overall bit rate	: 16.4 Mb/s	Duration	: 5 s 200 ms
Frame rate	: 30.000 FPS	Overall bit rate	: 1 725 kb/s
Recorded date	: 2025-10-	Frame rate	: 30.000 FPS
11T18:03:53-0600		Encoded date	: 2025-10-12
Encoded date	: 2025-10-12	00:22:40 UTC	
00:03:53 UTC		Tagged date	: 2025-10-12
Tagged date	: 2025-10-12	00:22:40 UTC	
00:03:58 UTC			
Writing library	: Apple	Video	
QuickTime		ID	:1
Writing operating system	: Apple iOS	Format	: AVC
18.6.2	• • •	Format/Info	: Advanced
Writing hardware	: Apple iPhone	Video Codec	
16e		Format profile	: High@L3.1
com.apple.quicktime.full-f	rame-rate-play: 1	Format settings	: CABAC / 4
	1 ,	Ref Frames	
Video		Format settings, CABAC	: Yes
ID	:1	Format settings, Reference	
Format	: AVC	frames	
Format/Info	: Advanced	Codec ID	: avc1
Video Codec		Codec ID/Info	: Advanced
Format profile	: High@L4	Video Coding	
Format settings	: CABAC / 1	Duration	: 5 s 200 ms
Ref Frames		Bit rate	: 1 653 kb/s
Format settings, CABAC	: Yes	Width	: 464 pixels
Format settings, Reference	frames : 1 frame		: 848 pixels
Format settings, GOP		Display aspect ratio	: 9:16
Codec ID	: avc1	Frame rate mode	: Constant
		Frame rate	: 30.000 FPS

Table 7. iPhone 16e Original Video Metadata vs Google Pixel 10 Received Video Metadata

cont'd

iPhone 16e (Originating Device) Video "Video		Google Pixel 10 (Receiving Device) Video	
Oct 11 2025 6 03 53 PM.mov"		"VID_20251011_182445_390.mp4.mov"	
Codec ID/Info	: Advanced	Color space	: YUV
Video Coding		Chroma subsampling	: 4:2:0
Duration	: 5 s 300 ms	Bit depth	: 8 bits
Bit rate	: 15.7 Mb/s	Scan type	: Progressive
Width	: 1 920 pixels	Bits/(Pixel*Frame)	: 0.140
Height	: 1 080 pixels	Stream size	: 1.02 MiB (96%)
Display aspect ratio	: 16:9	Title	: Core Media Video
Rotation	: 90°	Encoded date	: 2025-10-12
Frame rate mode	: Constant	00:22:40 UTC	
Frame rate	: 30.000 FPS	Tagged date	: 2025-10-12
Color space	: YUV	00:22:40 UTC	
Chroma subsampling	: 4:2:0	Color range	: Limited
Bit depth	: 8 bits	Color primaries	: BT.709
Scan type	: Progressive	Transfer characteristics	: BT.709
Bits/(Pixel*Frame)	: 0.252	Matrix coefficients	: BT.709
Stream size	: 9.90 MiB (96%)	Codec configuration box	: avcC
Title	: Core Media Video		
Writing library	: H.264	Audio	
Encoded date	: 2025-10-12	ID	: 2
00:03:53 UTC		Format	: AAC LC
Tagged date	: 2025-10-12	Format/Info	: Advanced
00:03:58 UTC		Audio Codec Low Compl	exity
Color range	: Limited	Codec ID	: mp4a-40-2
Color primaries	: BT.709	Duration	: 5 s 198 ms
Transfer characteristics	: BT.709	Source duration	: 5 s 248 ms
Matrix coefficients	: BT.709	Bit rate mode	: Constant
Metas	: 4,6,7	Bit rate	: 64.0 kb/s
Codec configuration box	: avcC	Channel(s)	: 2 channels
		Channel layout	: L R
Audio #1		Sampling rate	: 44.1 kHz
ID	: 2	Frame rate	: 43.066 FPS
Format	: AAC LC	(1024 SPF)	
Format/Info	: Advanced	Compression mode	: Lossy
Audio Codec Low Complexity		Stream size	: 41.1 KiB (4%)
Codec ID	: mp4a-40-2	Source stream size	: 41.5 KiB
Duration	: 5 s 298 ms	(4%)	
Source duration	: 5 s 355 ms	Title	: Core Media Audio
Bit rate mode	: Constant	Encoded date	: 2025-10-12
Bit rate	: 128 kb/s	00:22:40 UTC	

Table 7. iPhone 16e Original Video Metadata vs Google Pixel 10 Received Video Metadata cont'd

iPhone 16e (Origination Oct 11 2025 6 03 53 F	ng Device) Video "Video	Google Pixel 10 (Receiving Device) Video "VID 20251011 182445 390.mp4.mov"
Channel(s)	: 2 channels	Tagged date : 2025-10-12
Channel layout	: L R	00:22:40 UTC
Sampling rate	: 48.0 kHz	00.22110 010
Frame rate	: 46.875 FPS	
(1024 SPF)		
Compression mode	: Lossy	
Stream size	: 85.7 KiB (1%)	
Source stream size	: 86.3 KiB	
(1%)		
Title	: Core Media Audio	
Default	: Yes	
Alternate group	: 1	
Encoded date	: 2025-10-12	
00:03:53 UTC		
Tagged date	: 2025-10-12	
00:03:58 UTC		
Fallback From	: 3	
Audio #2		
ID	: 3	
Format	: apac	
Codec ID	: apac	
Duration	: 5 s 298 ms	
Source duration	: 5 s 355 ms	
Bit rate	: 392 kb/s	
Channel(s)	: 4 channels	
Sampling rate	: 48.0 kHz	
Stream size	: 254 KiB (2%)	
Source stream size	: 256 KiB	
(2%)		
Title	: Core Media Audio	
Default	: Inherited From: 2	
Alternate group	: 1	
Encoded date	: 2025-10-12	
00:03:53 UTC		
Tagged date	: 2025-10-12	
00:03:58 UTC	•	
Fallback To	: 2	
Metas	: 5	

Table 7. iPhone 16e Original Video Metadata vs Google Pixel 10 Received Video Metadata cont'd

iPhone 16e (Origina	ting Device) Video "Video	Google Pixel 10 (Receiving Device) Video
Oct 11 2025 6 03 53 PM.mov"		"VID_20251011_182445_390.mp4.mov"
Other #1		
ID	: 4	
Type	: meta	
Format	: mebx	
Codec ID	: mebx	
Duration	: 5 s 300 ms	
Title	: Core Media	
Metadata		
Encoded date	: 2025-10-12	
00:03:53 UTC		
Tagged date	: 2025-10-12	
00:03:58 UTC		
Other #2		
ID	: 5	
Type	: meta	
Format	: mebx	
Codec ID	: mebx	
	: 5 s 298 ms	
Duration		
Source duration	: 5 s 300 ms	
Stream size	: 386 Bytes	
Source stream size	: 386 Bytes	
Title	: Core Media	
Metadata		
Encoded date	: 2025-10-12	
00:03:53 UTC		
Tagged date	: 2025-10-12	
00:03:58 UTC		
Other #3		
ID	: 6	
Туре	: meta	
Format	: mebx	
Codec ID	: mebx	
Duration	: 5 s 300 ms	
Source duration	: 5 s 333 ms	
Source Duration La		
Bit rate mode	: Variable	
Die late mode	. , 4114010	

Table 7. iPhone 16e Original Video Metadata vs Google Pixel 10 Received Video Metadata cont'd

iPhone 16e (Originati	ng Device) Video "Video	Google Pixel 10 (Receiving Device) Video
Oct 11 2025 6 03 53 PM.mov"		"VID 20251011 182445 390.mp4.mov"
Stream size	: 50.6 KiB	
Source stream size	: 50.6 KiB	
Title	: Core Media	
Metadata		
Encoded date	: 2025-10-12	
00:03:53 UTC		
Tagged date	: 2025-10-12	
00:03:58 UTC		
Other #4		
ID	: 7	
Type	: meta	
Format	: mebx	
Codec ID	: mebx	
Duration	: 5 s 300 ms	
Bit rate mode	: Variable	
Title	: Core Media	
Metadata		
Encoded date	: 2025-10-12	
00:03:53 UTC		
Tagged date	: 2025-10-12	
00:03:58 UTC		
Other #5		
ID	: 8	
Type	: meta	
Format	: mebx	
Codec ID	: mebx	
Duration	: 5 s 300 ms	
Title	: Core Media	
Metadata	0000000	
Encoded date	: 2025-10-12	
00:03:53 UTC		
Tagged date	: 2025-10-12	
00:03:58 UTC		
		1

Table 8. iPhone 14 Original Video Metadata vs iPhone 15 Received Video Metadata

` • •		iPhone 15 (Receiving Device) Video	
,		"IMG_6706.MOV"	
General	TT \ TTI	General	TT\mi
Complete name	: U:\Thesis	Complete name	: U:\Thesis
Simplified\Livi Original		Simplified\Livi Original ar	
14 Pro originals Livi\Vid	eo Oct 11 2025, 5 43	to Tierney\IMG_6706.MOV	
21 PM.mov	1.675.0	Format	: MPEG-4
Format	: MPEG-4	Format profile	: Base Media /
Format profile	: QuickTime	Version 2	
Codec ID	: qt 0000.00 (qt	Codec ID	: mp42
)		(isom/mp41/mp42)	
File size	: 4.88 MiB	File size	: 1.06 MiB
Duration	: 5 s 260 ms	Duration	: 5 s 167 ms
Overall bit rate mode	: Variable	Overall bit rate	: 1 727 kb/s
Overall bit rate	: 7 789 kb/s	Frame rate	: 30.000 FPS
Frame rate		Encoded date	: 2025-10-11
Recorded date	: 2025-10-	23:55:18 UTC	
11T17:43:21-0600		Tagged date	: 2025-10-11
Encoded date	: 2025-10-11	23:55:19 UTC	
23:45:47 UTC			
Tagged date	: 2025-10-11	Video	
23:45:47 UTC		ID	: 1
Recorded location	: +39.5352 -	Format	: AVC
104.8726 +1824.351		Format/Info	: Advanced
Writing library	: Apple	Video Codec	
QuickTime		Format profile	: High@L3.1
Writing operating system	: Apple iOS	Format settings	: CABAC / 4
18.6.2	• •	Ref Frames	
Writing hardware	: Apple iPhone	Format settings, CABAC	: Yes
14 Pro		Format settings, Reference	frames : 4
com.apple.quicktime.loca	ation.accuracy.ho:	frames	
15.421540	•	Codec ID	: avc1
com.apple.quicktime.full-	-frame-rate-play: 1	Codec ID/Info	: Advanced
	1 ,	Video Coding	
Video		Duration	: 5 s 167 ms
ID	: 1	Bit rate	: 1 655 kb/s
Format	: HEVC	Width	: 464 pixels
Format/Info	: High Efficiency	Height	: 848 pixels
Video Coding	5 7	Display aspect ratio	: 9:16
Format profile	: Main	Frame rate mode	: Constant
10@L4@Main		Frame rate	: 30.000 FPS
		Color space	: YUV
		Chroma subsampling	: 4:2:0
		- III o III a da comin prinis	. 1.2.0

Table 8. iPhone 14 Original Video Metadata vs iPhone 15 Received Video Metadata cont'd

		iPhone 15 (Receiving Device) Video "IMG 6706.MOV"	
HDR format : Dolby Vision, I		_	: 8 bits
			-
		Scan type	: Progressive
no metadata compression,	: hvc1	Bits/(Pixel*Frame)	: 0.140
Codec ID		Stream size	: 1.02 MiB (96%)
Codec ID/Info	: High	Title	: Core Media Video
Efficiency Video Coding	5 260	Encoded date	: 2025-10-11
Duration		23:55:18 UTC	2025 10 11
Source duration		Tagged date	: 2025-10-11
Source_Duration_LastFra		23:55:19 UTC	T ' ', 1
Bit rate	: 7 508 kb/s	Color range	: Limited
Width	: 1 920 pixels	Color primaries	: BT.709
Height	: 1 080 pixels	Transfer characteristics	: BT.709
Display aspect ratio	: 16:9	Matrix coefficients	: BT.709
Rotation	: 90°	Codec configuration box	: avcC
Frame rate mode	: Constant		
Frame rate	: 30.000 FPS	Audio	
Color space	: YUV	ID	: 2
Chroma subsampling	: 4:2:0	Format	: AAC LC
Bit depth	: 10 bits	Format/Info	: Advanced
Bits/(Pixel*Frame)	: 0.121	Audio Codec Low Compl	•
Stream size	: 4.71 MiB (97%)		: mp4a-40-2
Source stream size	: 4.75 MiB	Duration	: 5 s 160 ms
(97%)		Source duration	: 5 s 224 ms
Title	: Core Media Video	Bit rate mode	: Constant
Writing library	: HEVC	Bit rate	: 64.0 kb/s
Encoded date	: 2025-10-11	Channel(s)	: 2 channels
23:45:47 UTC		Channel layout	: L R
Tagged date	: 2025-10-11	Sampling rate	: 44.1 kHz
23:45:47 UTC		Frame rate	: 43.066 FPS
Color range	: Limited	(1024 SPF)	
Color primaries	: BT.2020	Compression mode	: Lossy
Transfer characteristics	: HLG	Stream size	: 40.9 KiB (4%)
Matrix coefficients	: BT.2020 non-	Source stream size	: 41.4 KiB
constant		(4%)	
Metas	: 3,4	Title	: Core Media Audio
Codec configuration box	:	Encoded date	: 2025-10-11
hvcC+dvvC		23:55:18 UTC	-
		Tagged date 23:55:19 UTC	: 2025-10-11
		23.33.17 010	

Table 8. iPhone 14 Original Video Metadata vs iPhone 15 Received Video Metadata cont'd

iPhone 14 (Originatin	g Device) Video "Video	iPhone 15 (Receiving Device) Video
		"IMG_6706.MOV"
Audio		
ID	: 2	
Format	: AAC LC	
Format/Info	: Advanced	
Audio Codec Low Co	omplexity	
Codec ID	: mp4a-40-2	
Duration	: 5 s 260 ms	
Source duration	: 5 s 317 ms	
Bit rate mode	: Variable	
Bit rate	: 192 kb/s	
Channel(s)	: 2 channels	
Channel layout	: L R	
Sampling rate	: 44.1 kHz	
Frame rate	: 43.066 FPS	
(1024 SPF)		
Compression mode	: Lossy	
Stream size	: 125 KiB (2%)	
Source stream size	: 126 KiB	
(3%)		
Title	: Core Media Audio	
Encoded date	: 2025-10-11	
23:45:47 UTC		
Tagged date	: 2025-10-11	
23:45:47 UTC		
Other #1		
ID	: 3	
Type	: meta	
Format	: mebx	
Codec ID	: mebx	
Duration	: 5 s 260 ms	
Title	: Core Media	
Metadata		
Encoded date	: 2025-10-11	
23:45:47 UTC		
Tagged date	: 2025-10-11	
23:45:47 UTC		

Table 8. iPhone 14 Original Video Metadata vs iPhone 15 Received Video Metadata cont'd

	ating Device) Video "Video	iPhone 15 (Receiving Device) Video
Oct 11 2025, 5 43	21 PM.mov ²²	"IMG_6706.MOV"
Other #2	•	
ID	: 4	
Type	: meta	
Format	: mebx	
Codec ID	: mebx	
Duration	: 5 s 260 ms	
Title	: Core Media	
Metadata		
Encoded date 23:45:47 UTC	: 2025-10-11	
Tagged date 23:45:47 UTC	: 2025-10-11	
Other #3		
ID	: 5	
Туре	: meta	
Format	: mebx	
Codec ID	: mebx	
Duration	: 5 s 260 ms	
Bit rate mode	: Constant	
Title	: Core Media	
Metadata		
Encoded date 23:45:47 UTC	: 2025-10-11	
Tagged date 23:45:47 UTC	: 2025-10-11	
Other #4		
ID	: 6	
Type	: meta	
Format	: mebx	
Codec ID	: mebx	
Duration	: 5 s 260 ms	
Title	: Core Media	
Metadata		
Encoded date 23:45:47 UTC	: 2025-10-11	
Tagged date 23:45:47 UTC	: 2025-10-11	

Table 9. iPhone 15 Original Video Metadata vs Google Pixel 10 Received Video Metadata

		Google Pixel 10 (Receiving Device) Video	
		"VID_20251011_183030_975.mp4.mov"	
	: U:\Thesis	General	. II.\Theria
Complete name		Complete name	: U:\Thesis
Simplified\D1 Originals\II		Simplified\Tierney Original and	
Format	: MPEG-4	Received\Tierney Received - Rachel\VID_20251011_183030_975.mp4.mov	
Format profile	: QuickTime		
Codec ID	: qt 0000.00 (qt	Format	: MPEG-4
)	7 (7 M'D	Format profile	: Base Media /
File size	: 7.67 MiB	Version 2	42
Duration	: 6 s 235 ms	Codec ID	: mp42
Overall bit rate mode		(isom/mp41/mp42)	4.00.1675
Overall bit rate	: 10.3 Mb/s	File size	: 1.22 MiB
Frame rate	: 30.000 FPS	Duration	: 6 s 133 ms
Recorded date	: 2025-09-	Overall bit rate	: 1 664 kb/s
01T16:25:22-0600		Frame rate	: 29.837 FPS
Encoded date	: 2025-09-16	Encoded date	: 2025-10-12
22:44:14 UTC		00:23:18 UTC	
Tagged date	: 2025-09-16	Tagged date	: 2025-10-12
22:44:15 UTC		00:23:19 UTC	
Recorded location	: +39.5352 -		
104.8727 +1833.232		Video	
Writing library	: Apple	ID	: 1
QuickTime		Format	: AVC
Writing operating system	: Apple iOS	Format/Info	: Advanced
18.6		Video Codec	
Writing hardware	: Apple iPhone	Format profile	: High@L3.1
15		Format settings	: CABAC / 4
com.apple.quicktime.locat	tion.accuracy.ho:	Ref Frames	
22.648142	-	Format settings, CAF	BAC : Yes
com.apple.quicktime.full-	frame-rate-play: 1	Format settings, Refe	erence frames : 4
		frames	
Video		Codec ID	: avc1
ID	: 2	Codec ID/Info	: Advanced
Format	: AVC	Video Coding	
Format/Info	: Advanced	Duration	: 6 s 133 ms
Video Codec		Bit rate	: 1 593 kb/s
Format profile	: High@L4	Width	: 464 pixels
Format settings	: CABAC / 4	Height	: 848 pixels
Ref Frames		Display aspect ratio	: 9:16
Format settings, CABAC	: Yes	Frame rate mode	: Variable
٥		Frame rate	: 29.837 FPS

Table 9. iPhone 15 Original Video Metadata vs Google Pixel 10 Received Video Metadata cont'd

iPhone 15 (Originating De	evice) Video	Google Pixel 10 (Receiving	,
		"VID_20251011_183030	
Format settings, Reference	e frames : 4	Minimum frame rate	: 15.000 FPS
frames			
Codec ID	: avc1	Maximum frame rate	: 30.000
Codec ID/Info	: Advanced	FPS	
Video Coding		Color space	: YUV
Duration	: 6 s 235 ms	Chroma subsampling	: 4:2:0
Bit rate	: 10.1 Mb/s	Bit depth	: 8 bits
Width	: 1 920 pixels	Scan type	: Progressive
Height	: 1 080 pixels	Bits/(Pixel*Frame)	: 0.136
Display aspect ratio	: 16:9	Stream size	: 1.16 MiB (96%)
Rotation	: 90°	Title	: Core Media Video
Frame rate mode	: Variable	Encoded date	: 2025-10-12
Frame rate	: 30.000 FPS	00:23:18 UTC	
Minimum frame rate	: 28.571 FPS	Tagged date	: 2025-10-12
Maximum frame rate	: 30.000	00:23:19 UTC	
FPS		Color range	: Limited
Color space	: YUV	Color primaries	: BT.709
Chroma subsampling	: 4:2:0	Transfer characteristics	: BT.709
Bit depth	: 8 bits	Matrix coefficients	: BT.709
Scan type	: Progressive	Codec configuration box	: avcC
Bits/(Pixel*Frame)	: 0.163		
Stream size	: 7.52 MiB (98%)	Audio	
Title	: Core Media Video		: 2
Writing library	: H.264	Format	: AAC LC
Encoded date		Format/Info	: Advanced
22:44:14 UTC		Audio Codec Low Compl	
Tagged date	: 2025-09-16	Codec ID	: mp4a-40-2
22:44:15 UTC		Duration	: 6 s 133 ms
Color range	: Limited	Source duration	: 6 s 200 ms
Color primaries	: BT.709	Bit rate mode	: Constant
Transfer characteristics	: BT.709	Bit rate	: 64.0 kb/s
Matrix coefficients	: BT.709	Channel(s)	: 2 channels
Metas	: 3,4,5	Channel layout	: L R
Codec configuration box	: avcC	Sampling rate	: 44.1 kHz
2 3 3 4 Contribution OOA		Frame rate	: 43.066 FPS
Audio		(1024 SPF)	5.000115
ID	: 1	Compression mode	: Lossy
Format	: AAC LC	Stream size	: 47.6 KiB (4%)
ı oma	. AAC LC	Sucam size	. T/.U KID (T/0)

Table 9. iPhone 15 Original Video Metadata vs Google Pixel 10 Received Video Metadata cont'd

, , ,		Google Pixel 10 (Receiving Device) Video "VID 20251011 183030 975.mp4.mov"		
Format/Info	: Advanced	Source stream size	: 48.1 KiB	
Audio Codec Low Com		(4%)	. 40.1 KID	
Codec ID	: mp4a-40-2	Title	: Core Media Audio	
Duration	: 6 s 233 ms	Encoded date	: 2025-10-12	
Source duration	: 6 s 293 ms	00:23:18 UTC		
Bit rate mode	: Variable	Tagged date	: 2025-10-12	
Bit rate	: 144 kb/s	00:23:19 UTC		
Channel(s)	: 2 channels			
Channel layout	: L R			
Sampling rate	: 44.1 kHz			
Frame rate	: 43.066 FPS			
(1024 SPF)				
Compression mode	: Lossy			
Stream size	: 111 KiB (1%)			
Source stream size	: 112 KiB			
(1%)				
Title	: Core Media Audio			
Encoded date	: 2025-09-16			
22:44:14 UTC	2027.00.46			
Tagged date	: 2025-09-16			
22:44:15 UTC				
Other #1				
ID	: 3			
Type	: meta			
Format	: mebx			
Codec ID	: mebx			
Duration	: 6 s 233 ms			
Title	: Core Media			
Metadata				
Encoded date	: 2025-09-16			
22:44:14 UTC				
Tagged date	: 2025-09-16			
22:44:15 UTC				
Other #2				
ID	: 4			
Туре	: meta			
Format	: mebx			

Table 9. iPhone 15 Original Video Metadata vs Google Pixel 10 Received Video Metadata cont'd

iPhone 15 (Originating Device) Video		Google Pixel 10 (Receiving Device) Video
"IMG_0671.MOV"		"VID 20251011 183030 975.mp4.mov"
Codec ID	: mebx	
Duration	: 6 s 233 ms	
Title	: Core Media	
Metadata		
Encoded date	: 2025-09-16	
22:44:14 UTC		
Tagged date	: 2025-09-16	
22:44:15 UTC		
Other #3		
ID	: 5	
Type	: meta	
Format	: mebx	
Codec ID	: mebx	
Duration	: 6 s 233 ms	
Bit rate mode	: Constant	
Title	: Core Media	
Metadata	. Core Media	
Encoded date	: 2025-09-16	
22:44:14 UTC	. 2025 05 10	
Tagged date	: 2025-09-16	
22:44:15 UTC	. 2028 07 10	
041 #4		
Other #4	. 6	
ID True a	: 6	
Type	: meta	
Format Codec ID	: mebx : mebx	
Duration	: 6 s 232 ms	
Bit rate mode	: Constant	
Title	: Core Media	
Metadata	. Core ivicula	
Encoded date	: 2025-09-16	
22:44:14 UTC	. 2023-07-10	
Tagged date	: 2025-09-16	
22:44:15 UTC	. 2025-09-10	
22.44.13 UIC		

Table 9. iPhone 15 Original Video Metadata vs Google Pixel 10 Received Video Metadata cont'd

iPhone 15 (Originating Device) Video		Google Pixel 10 (Receiving Device) Video
"IMG_0671.MOV"		"VID_20251011_183030_975.mp4.mov"
Other #5		
ID	: 7	
Type	: meta	
Format	: mebx	
Codec ID	: mebx	
Duration	: 6 s 233 ms	
Title	: Core Media	
Metadata		
Encoded date	: 2025-09-16	
22:44:14 UTC		
Tagged date	: 2025-09-16	
22:44:15 UTC		

 Table 10. Google Pixel 10 Original Video Metadata vs Samsung Galaxy 23 Ultra Received

Video Metadata

Google Pixel 10 (Originating Device) Video Samsung Galaxy 23 Ultra (Receiving Device) 'PXL 20251011 234331967.mp4" Video "VID 20251011 180345 905.mp4" General General Complete name : U:\Thesis Complete name Simplified\Rachel Original and Received\RachelReceivedJared\VID 20251011 Received\Tierney Thesis - Google Pixel 10 -180345 905.mp4 Original\PXL 20251011 234331967.mp4 Format : MPEG-4 Format : MPEG-4 Format profile : Base Media Format profile : Base Media Codec ID : isom Codec ID (isom/iso2/avc1/mp41) : isom (isom/iso2/mp41) File size : 2.27 MiB File size : 15.9 MiB Duration : 6 s 430 ms Overall bit rate mode Duration : 6 s 430 ms : Variable Overall bit rate : 2 959 kb/s Overall bit rate : 20.7 Mb/s : 28.614 FPS : 28.303 FPS Frame rate Frame rate Encoded date : 2025-10-11 Encoded date : 2025-10-11 23:43:39 UTC 23:55:34 UTC Tagged date : 2025-10-11 Tagged date : 2025-10-11 23:43:39 UTC 23:55:34 UTC

Table 10. Google Pixel 10 Original Video Metadata vs Samsung Galaxy 23 Ultra Received

Video Metadata cont'd

Google Pixel 10 (Originating Device) Video		Samsung Galaxy 23 Ultra	
		Video "VID_20251011_180345_905.mp4"	
Recorded location	: +39.5352 -	Video	
104.8726		ID	: 2
Writing hardware	: Google Pixel	Format	: AVC
10		Format/Info	: Advanced
		Video Codec	
Video		Format profile	: High@L3.1
ID	: 1	Format settings	: CABAC / 1
Format	: HEVC	Ref Frames	
Format/Info	: High Efficiency	Format settings, CABAC	: Yes
Video Coding		Format settings, Reference	e frames : 1 frame
Format profile	:	Format settings, GOP	: M=1, N=28
Main@L4.1@Main		Codec ID	: avc1
Codec ID	: hvc1	Codec ID/Info	: Advanced
Codec ID/Info	: High	Video Coding	
Efficiency Video Coding		Duration	: 6 s 430 ms
Duration	: 6 s 430 ms	Bit rate	: 2 759 kb/s
Bit rate	: 20.4 Mb/s	Width	: 720 pixels
Width	: 1 920 pixels	Height	: 1 280 pixels
Height	: 1 080 pixels	Display aspect ratio	: 9:16
Display aspect ratio	: 16:9	Frame rate mode	: Variable
Rotation	: 90°	Frame rate	: 28.303 FPS
Frame rate mode	: Variable	Minimum frame rate	: 9.998 FPS
Frame rate	: 28.614 FPS	Maximum frame rate	: 30.000
Minimum frame rate	: 9.998 FPS	FPS	
Maximum frame rate	: 39.982	Color space	: YUV
FPS		Chroma subsampling	: 4:2:0
Real frame rate	: 30.000 FPS	Bit depth	: 8 bits
Color space	: YUV	Scan type	: Progressive
Chroma subsampling	: 4:2:0	Bits/(Pixel*Frame)	: 0.106
Bit depth	: 8 bits	Stream size	: 2.12 MiB (93%)
Bits/(Pixel*Frame)	: 0.344	Title	: VideoHandle
Stream size	: 15.7 MiB (99%)	Language	: English
Title	: VideoHandle	Encoded date	: 2025-10-11
Language	: English	23:55:28 UTC	
Encoded date	: 2025-10-11	Tagged date	: 2025-10-11
23:43:39 UTC		23:55:34 UTC	
Tagged date	: 2025-10-11	Color range	: Limited
23:43:39 UTC		Color primaries	: BT.709
		Transfer characteristics	: BT.709

Table 10. Google Pixel 10 Original Video Metadata vs Samsung Galaxy 23 Ultra Received

Video Metadata cont'd

Google Pixel 10 (Originating Device) Video	Samsung Galaxy 23 Ultra (Receiving Device)	
"PXL_20251011_234331967.mp4"	Video "VID_20251011_180345_905.mp4"	
Color range : Limited	Matrix coefficients : BT.709	
Color primaries : BT.709	Codec configuration box : avcC	
Transfer characteristics : BT.709		
transfer_characteristics_Original :	Audio	
sRGB/sYCC	ID : 1	
Matrix coefficients : BT.709	Format : AAC LC	
Codec configuration box : hvcC	Format/Info : Advanced	
	Audio Codec Low Complexity	
Audio	Codec ID : mp4a-40-2	
ID : 2	Duration : 6 s 383 ms	
Format : AAC LC	Bit rate mode : Variable	
Format/Info : Advanced	Bit rate : 192 kb/s	
Audio Codec Low Complexity	Nominal bit rate : 48.0 kb/s	
Codec ID : mp4a-40-2	Channel(s) : 2 channels	
Duration : 6 s 401 ms	Channel layout : L R	
Bit rate mode : Constant	Sampling rate : 48.0 kHz	
Bit rate : 192 kb/s	Frame rate : 46.875 FPS	
Channel(s) : 2 channels	(1024 SPF)	
Channel layout : L R	Compression mode : Lossy	
Sampling rate : 48.0 kHz	Stream size : 150 KiB (6%)	
Frame rate : 46.875 FPS	Title : SoundHandle	
(1024 SPF)	Language : English	
Compression mode : Lossy	Encoded date : 2025-10-11	
Stream size : 150 KiB (1%)	23:55:28 UTC	
Title : SoundHandle	Tagged date : 2025-10-11	
Language : English	23:55:34 UTC	
Encoded date : 2025-10-11		
23:43:39 UTC		
Tagged date : 2025-10-11		
23:43:39 UTC		
Other		
ID : 3		
Type : meta		
Format : mett-		
application/meta		
Codec ID : mett-		
application/meta		
Duration : 6 s 430 ms		

Table 10. Google Pixel 10 Original Video Metadata vs Samsung Galaxy 23 Ultra Received Video Metadata cont'd

Google Pixel 10 (Originating Device) Video		Samsung Galaxy 23 Ultra (Receiving
"PXL 20251011 234331967.mp4"		Device) Video
	_	"VID_20251011_180345_905.mp4"
Bit rate mode	: Variable	
Title	: MetaHandle	
Language	: English	
Encoded date	: 2025-10-11	
23:43:39 UTC		
Tagged date	: 2025-10-11	
23:43:39 UTC		

Hex Analysis

Mp4Dump was used to collect the file structure information for the videos. For this analysis, with the received videos for each original video being the same, one original video and one received counterpart for each device were analyzed. Tables 11 through 15 show the hex data for the analyzed videos and beneath each table is a summary of the changes to the file structure. The values shown for the atoms that make up the file structure differ, and most of the causes of those changed values are analyzed in the metadata section of this thesis. Atoms are units that make up the video file, with each having its own header and size depending on what information is help within it. These atoms contain data and/or other atoms. The atom changes will be analyzed in this section.

Table 11. Samsung Galaxy 23 Ultra Original Video Hex Data vs Received Video Hex Data

Samsung Galaxy 23 Ultra Original Video	Video After Transfer
[ftyp] size=8+16	[ftyp] size=8+24
major_brand = mp42	major_brand = isom
minor_version = 0	minor_version = 200
compatible_brand = isom	compatible_brand = isom
compatible_brand = mp42	compatible_brand = iso2

Table 11. Samsung Galaxy 23 Ultra Original Video Hex Data vs Received Video Hex Data cont'd

Samoung Galaxy 22 Liltra Original Video	Video After Transfer
Samsung Galaxy 23 Ultra Original Video	Video After Transfer
[mdat] size=16+10481780	compatible brand = avc1
[moov] size=8+4309	compatible brand = mp41
[mvhd] size=12+96	[mdat] size=8+2054965
timescale = 10000	[moov] size=8+6383
duration = 57694	[moov] size=6+6363 [mvhd] size=12+96
$\frac{\text{duration} - 37094}{\text{duration(ms)}} = 5769$	timescale = 6000
[udta] size=8+167	duration = 34616
[SDLN] size=8+8	$\frac{\text{duration} - 34010}{\text{duration(ms)}} = 5769$
[smrd] size=8+8	[trak] size=8+3599
[auth] size=12+19	[tkhd] size=12+80, flags=7
language = eng	enabled = 1
value = Galaxy S23 Ultra	id = 1
[.xyz] size=8+22	duration = 34559
[.xyz] size=8+22 [smta] size=8+34	width = 0.000000
2 3	height = 0.000000
[cami] size=8+24	
[meta] size=8+236 [hdlr] size=12+21	[mdia] size=8+3499
	[mdhd] size=12+20 timescale = 48000
handler_type = mdta	duration = 276475
handler_name =	
[keys] size=8+104	duration(ms) = 5759
[ilst] size=8+83	language = eng
[] size=8+18	[hdlr] size=12+32
[] size=8+20	handler_type = soun
[] size=8+21	handler_name = SoundHandle
[trak] size=8+2119	[minf] size=8+3415
[tkhd] size=12+80, flags=7	[smhd] size=12+4
enabled = 1	balance = 0
id = 1	[dinf] size=8+28
duration = 57694	[dref] size=12+16
width = 1920.000000	[url] size=12+0, flags=1
height = 1080.000000	location = [local to file]
[mdia] size=8+2019	[stbl] size=8+3355
[mdhd] size=12+20	[stsd] size=12+79
timescale = 90000	entry-count = 1
duration = 519250	[mp4a] size=8+67
duration(ms) = 5769	data_reference_index = 1
language = ```	channel_count = 2
[hdlr] size=12+32	$sample_size = 16$
handler_type = vide	sample_rate = 48000

Table 11. Samsung Galaxy 23 Ultra Original Video Hex Data vs Received Video Hex Data cont'd

Samsung Galaxy 23 Ultra Original Video	Video After Transfer
handler_name = VideoHandle	[esds] size=12+27
[minf] size=8+1935	[ESDescriptor] size=2+25
[vmhd] size=12+8, flags=1	$es_id = 0$
graphics_mode = 0	stream_priority = 0
$op_color = 0000,0000,0000$	[DecoderConfig] size=2+17
[dinf] size=8+28	stream_type = 5
[dref] size=12+16	object_type = 64
[url] size=12+0, flags=1	$up_stream = 0$
location = [local to file]	buffer_size = 1536
[stbl] size=8+1871	$max_bitrate = 256000$
[stsd] size=12+227	avg bitrate = 48000
entry-count = 1	DecoderSpecificInfo = 11 90
[hvc1] size=8+215	[Descriptor:06] size=2+1
data_reference_index = 1	[stts] size=12+84
width = 1920	entry_count = 10
height = 1080	[stsc] size=12+1372
compressor =	entry_count = 114
[hvcC] size=8+110	[stsz] size=12+1088
Configuration Version = 1	sample_size = 0
Profile Space = 0	sample_count = 270
Profile = Main	[stco] size=12+672
Tier = 1	entry_count = 167
Profile Compatibility = 60000000	[trak] size=8+2660
Constraint = $b00000000000$	[tkhd] size=12+80, flags=7
Level = 120	enabled = 1
Min Spatial Segmentation = 0	id = 2
Parallelism Type = 0	duration = 34616
Chroma Format = 1	width = 720.000000
Chroma Depth = 8	height = 1280.000000
Luma Depth = 8	[mdia] size=8+2560
Average Frame Rate = 0	[mdhd] size=12+20
Constant Frame Rate = 0	timescale = 90000
Number Of Temporal Layers = 0	duration = 519250
Temporal Id Nested = 0	duration(ms) = 5769
NALU Length Size = 4	language = eng
[colr] size=8+11	[hdlr] size=12+32
[stts] size=12+772	handler_type = vide
entry_count = 96	handler_name = VideoHandle
[stss] size=12+28	[minf] size=8+2476

Table 11. Samsung Galaxy 23 Ultra Original Video Hex Data vs Received Video Hex Data cont'd

Samsung Galaxy 23 Ultra Original Video	Video After Transfer
entry count = 6	[vmhd] size=12+8, flags=1
$[stsz]$ $\overline{size}=12+692$	graphics $mode = 0$
sample size = 0	op color = 0000,0000,0000
sample count = 171	[dinf] size=8+28
[stsc] size=12+28	[dref] size=12+16
entry count = 2	[url] size=12+0, flags=1
[co64] size=12+52	location = [local to file]
entry count = 6	[stb1] size=8+2412
[trak] size=8+1647	[stsd] size=12+136
[tkhd] size=12+80, flags=7	entry-count = 1
enabled = 1	[avc1] size=8+124
id = 2	data reference index = 1
duration = 57599	width = 720
width = 0.000000	height = 1280
height = 0.000000	compressor =
[mdia] size=8+1547	[avcC] size=8+38
[mdhd] size=12+20	Configuration Version = 1
timescale = 48000	Profile = High
duration = 276476	Profile Compatibility = 0
duration(ms) = 5759	Level = 13
language = ```	NALU Length Size = 4
[hdlr] size=12+32	Sequence Parameter = [67 64 00 1f ac
handler type = soun	b4 05 a0 50 d3 50 50 60 50 6d 0a 13 50]
handler name = SoundHandle	Picture Parameter = [68 ee 06 f2 c0]
[minf] size=8+1463	[stts] size=12+780
[smhd] size=12+4	entry count = 97
balance = 0	[stss] size=12+28
[dinf] size=8+28	entry count = 6
[dref] size=12+16	[stsc] size=12+40
[url] size=12+0, flags=1	entry_count = 3
location = [local to file]	[stsz] size=12+684
[stb1] size=8+1403	sample size = 0
[stsd] size=12+79	sample_count = 169
entry-count = 1	[stco] size=12+672
[mp4a] size=8+67	entry_count = 167
data reference index = 1	· -
channel_count = 2	
$sample_size = 16$	
sample rate = 48000	

Table 11. Samsung Galaxy 23 Ultra Original Video Hex Data vs Received Video Hex Data cont'd

Samsung Galaxy 23 Ultra Original Video	Video After Transfer
[esds] size=12+27	
[ESDescriptor] size=2+25	
es $id = 0$	
stream_priority = 0	
[DecoderConfig] size=2+17	
stream_type = 5	
object_type = 64	
$up_stream = 0$	
buffer_size = 768	
$max_bitrate = 256000$	
avg_bitrate = 256000	
DecoderSpecificInfo = 11 90	
[Descriptor:06] size=2+1	
[stts] size=12+84	
entry_count = 10	
[stsz] size=12+1088	
$sample_size = 0$	
sample_count = 270	
[stsc] size=12+40	
entry_count = 3	
[co64] size=12+52	
entry_count = 6	

For the Samsung Galaxy 23 Ultra, the File Type atom has 2 additional Compatible Brand sections in the received video. The File Header atom in the original video has User Data and Metadata sections the received video does not have. The User Data section is after the Movie Header and the Metadata follows the User Data.

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data

iPhone 14 Original Video	Received Video
[ftyp] size=8+12	[ftyp] size=8+20
major brand = qt	major brand = mp42
$ \frac{1}{\text{minor version}} = 0 $	minor version = 1
compatible brand = qt	compatible brand = isom
[wide] $size = 8+0$	compatible brand = mp41
[mdat] size=8+6449462	compatible_brand = mp42
[moov] size=8+13871	$[mdat]$ size= $\overline{16}+1208150$
[mvhd] size=12+96	[moov] size=8+4764
timescale = 600	[mvhd] size=12+96
duration = 3540	timescale = 44100
duration(ms) = 5900	duration = 255780
[trak] size=8+3737	duration(ms) = 5800
[tkhd] size=12+80, flags=f	[trak] size=8+2950
enabled = 1	[tkhd] size=12+80, flags=1
id = 1	enabled = 1
duration = 3540	id = 1
width = 1920.000000	duration = 255780
height = 1080.000000	width = 464.000000
[tapt] size=8+60	height = 848.000000
[edts] size=8+28	[edts] size=8+28
[elst] size=12+16	[elst] size=12+16
entry count = 1	entry count = 1
entry/segment duration = 3540	entry/segment duration = 255780
entry/media time = 0	entry/media time = 40
entry/media rate = 1	entry/media rate = 1
[mdia] size=8+3268	[mdia] size=8+2814
[mdhd] size=12+20	[mdhd] size=12+20
timescale = 600	timescale = 600
duration = 3540	duration = 3480
duration(ms) = 5900	duration(ms) = 5800
language = und	language = und
[hdlr] size=12+37	[hdlr] size=12+37
handler_type = vide	handler_type = vide
handler_name = Core Media Video	handler_name = Core Media Video
[minf] size=8+3179	[minf] size=8+2725
[vmhd] size=12+8, flags=1	[vmhd] size=12+8, flags=1
graphics_mode = 64	graphics_mode = 0
$op_color = 0080,0080,0080$	$op_color = 0000,0000,0000$
[hdlr] size=12+44	[dinf] size=8+28
handler_type = alis	[dref] size=12+16
	[url] size=12+0, flags=1

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 14 Original Video	Received Video
handler name = Core Media Data	location = [local to file]
Handler	[stbl] size=8+2661
[dinf] size=8+28	[stsd] size=12+167
[dref] size=12+16	entry-count = 1
[alis] size=8+4	[avc1] size=8+155
[stb1] size=8+3059	data reference index = 1
[stsd] size=12+292	width = 464
entry-count = 1	height = 848
[hvc1] size=8+280	compressor =
data reference index = 1	[avcC] size=8+34
$\overline{\text{width}} = 1920$	Configuration Version = 1
height = 1080	Profile = High
compressor = HEVC	Profile Compatibility = 0
[hvcC] size=8+124	Level = 31
Configuration Version = 1	NALU Length Size = 4
Profile Space = 0	Sequence Parameter = [27 64 00 1f ac
Profile = Main 10	56 50 74 1a e9 a8 08 08 08 10]
Tier = 0	Picture Parameter = [28 ee 3c b0]
Profile Compatibility = 20000000	[colr] size=8+11
Constraint = $b000000000000$	[pasp] size=8+8
Level = 120	[stts] size=12+12
Min Spatial Segmentation = 0	entry count = 1
Parallelism Type = 0	[ctts] size=12+1396
Chroma Format = 1	entry count = 174
Chroma Depth = 10	[stss] size=12+28
Luma Depth = 10	entry count = 6
Average Frame Rate = 0	[sdtp] size=8+178
Constant Frame Rate = 0	[stsc] size=12+40
Number Of Temporal Layers = 1	entry count = 3
Temporal Id Nested = 0	[stsz] size=12+704
NALU Length Size = 4	sample size = 0
[dvvC] size=8+24	sample_count = 174
[colr] size=8+10	[stco] size=12+44
[amve] size=8+8	entry count = 10
[sgpd] size=12+32, version=1	[trak] size=8+1690
grouping type = tscl	[tkhd] size=12+80, flags=1
default_length = 20	enabled = 1
entry_count = 1	id = 2
entry $00 = [00\ 02\ 00\ 00\ 00\ 00\ b3\ 80\ 00]$	duration = 255707
00 00 00 78 00 00 00 00 00 00 00]	width = 0.000000
[sgpd] size=12+14, version=1	height = 0.000000

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 14 Original Video	Received Video
grouping type = sync	[edts] size=8+28
default length = 1	[elst] size=12+16
entry_count = 2	entry count = 1
entry $00 = [14]$	entry/segment duration = 255707
entry $01 = [15]$	entry/media time = 2112
[sbgp] size=12+120	entry/media rate = 1
grouping_type = sync	[mdia] size=8+1554
entry_count = 14	[mdhd] size=12+20
[stts] size=12+12	timescale = 44100
entry_count = 1	duration = 258048
[ctts] size=12+1420	duration(ms) = 5851
entry_count = 177	language = und
[cslg] size=8+24	[hdlr] size=12+37
[stss] size=12+32	handler_type = soun
entry_count = 7	handler_name = Core Media Audio
[sdtp] size=8+181	[minf] size=8+1465
[stsc] size=12+28	[smhd] size=12+4
entry_count = 2	balance = 0
[stsz] size=12+716	[dinf] size=8+28
$sample_size = 0$	[dref] size=12+16
sample_count = 177	[url] size=12+0, flags=1
[stco] size=12+52	location = [local to file]
entry_count = 12	[stbl] size=8+1405
[meta] size=8+257	[stsd] size=12+91
[hdlr] size=12+22	entry-count = 1
handler_type = mdta	[mp4a] size=8+79
handler_name =	data_reference_index = 1
[keys] size=8+116	channel_count = 2
[ilst] size=8+91	sample_size = 16
[] size=8+55	$sample_rate = 44100$
[] size=8+20	[esds] size=12+39
[trak] size=8+1838	[ESDescriptor] size=5+34
[tkhd] size=12+80, flags=f	$es_id = 0$
enabled = 1	stream_priority = 0
id = 2	[DecoderConfig] size=5+20
duration = 3539	stream_type = 5
width = 0.000000	object_type = 64
height = 0.000000	$up_stream = 0$
[edts] size=8+28	buffer_size = 6144
[elst] size=12+16	$\max_{\text{bitrate}} = 64000$
entry count = 1	avg_bitrate = 64000

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 14 Original Video	Received Video
entry/segment duration = 3539 entry/media time = 2112 entry/media rate = 1 [mdia] size=8+1702 [mdhd] size=12+20 timescale = 44100 duration = 263168 duration(ms) = 5967 language = und [hdlr] size=12+37 handler_type = soun handler_name = Core Media Audio [minf] size=8+1613 [smhd] size=12+4 balance = 0 [hdlr] size=12+4 handler_type = alis handler_name = Core Media Data Handler [dinf] size=8+28 [dref] size=8+28 [dref] size=8+4 [stbl] size=8+1497 [stsd] size=8+147 entry-count = 1 [mp4a] size=8+135 data_reference_index = 1 channel_count = 2 sample_size = 16 sample_rate = 44100 qt_version = 1 [wave] size=8+4 original_format = mp4a [mp4a] size=8+4 [esds] size=12+39 [ESDescriptor] size=5+34 es_id = 0 stream_priority = 0 [DecoderConfig] size=5+20	DecoderSpecificInfo = 12 10 [Descriptor:06] size=5+1 [sgpd] size=12+14, version=1 grouping_type = roll default_length = 2 entry_count = 1 entry 00 = [ff ff] [sbgp] size=12+16 grouping_type = roll entry_count = 1 [stts] size=12+12 entry_count = 1 [stsc] size=12+124 entry_count = 10 [stsz] size=12+1016 sample_size = 0 sample_count = 252 [stco] size=12+48 entry_count = 11
stream_type = 5	

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 14 Original Video	Received Video
object type = 64	
up stream = 0	
buffer size = 6144	
$\overline{\text{max bitrate}} = 192000$	
avg_bitrate = 0	
DecoderSpecificInfo = 12 10	
[Descriptor:06] size=5+1	
[] size=8+0	
[sgpd] size=12+14, version=1	
grouping_type = roll	
default_length = 2	
entry_count = 1	
entry $00 = [ff ff]$	
[sbgp] size=12+16	
grouping_type = roll	
entry_count = 1	
[stts] size=12+12	
entry_count = 1	
[stsc] size=12+136	
entry_count = 11	
[stsz] size=12+1036	
sample_size = 0	
sample_count = 257	
[stco] size=12+52	
entry_count = 12 [trak] size=8+617	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 3	
duration = 3540	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3540	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+24	
[cdsc] size=8+4	
track_id_count = 1	

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 14 Original Video	Received Video
track id = 1	
[cdep] size=8+4	
[mdia] size=8+449	
[mdhd] size=12+20	
timescale = 600	
duration = 3540	
duration(ms) = 5900	
language = und	
[hdlr] size=12+40	
handler_type = meta	
handler_name = Core Media Metadata	
[minf] size=8+357	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	
handler_name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stb1] size=8+225	
[stsd] size=12+121	
entry-count = 1	
[mebx] size=8+109	
data_reference_index = 1	
[stts] size=12+12	
entry_count = 1	
[stsc] size=12+16	
entry_count = 1	
[stsz] size=12+8	
sample_size = 10	
$sample_count = 0$	
[stco] size=12+8	
entry_count = 1	
[trak] size=8+1126	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 4	
duration = 3540	
width = 0.000000	
height = 0.000000	

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 14 Original Video	Received Video
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3540	
entry/media time = 20	
entry/media rate = 1	
[tref] size=8+24	
[cdsc] size=8+4	
track id count = 1	
track id = 1	
[cdep] size=8+4	
[mdia] size=8+958	
[mdhd] size=12+20	
timescale = 600	
duration = 3560	
duration(ms) = 5933	
language = und	
[hdlr] size=12+40	
handler_type = meta	
handler_name = Core Media Metadata	
[minf] size=8+866	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	
handler_name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stb1] size=8+734	
[stsd] size=12+566	
entry-count = 1	
[mebx] size=8+554	
data_reference_index = 1	
[stts] size=12+20	
entry_count = 2	
[stsc] size=12+28	
entry_count = 2	
[stsz] size=12+8	
sample_size = 100	
$sample_count = 0$	

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 14 Original Video	Received Video
[stco] size=12+52	
entry count = 12	
[trak] size=8+1144	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 5	
duration = 3540	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3540	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+24	
[cdsc] size=8+4	
track_id_count = 1	
track id $= 1$	
[cdep] size=8+4	
[mdia] size=8+976	
[mdhd] size=12+20	
timescale = 600	
duration = 3540	
duration(ms) = 5900	
language = und	
[hdlr] size=12+40	
handler_type = meta	
handler_name = Core Media Metadata	
[minf] size=8+884	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	
handler_name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stbl] size=8+752	
[stsd] size=12+592	

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 14 Original Video	Received Video
entry-count = 1	
[mebx] size=8+580	
data reference index = 1	
[stts] size=12+12	
entry count = 1	
[stsc] size=12+28	
entry count = 2	
[stsz] size=12+8	
sample size = 208	
sample count = 0	
[stco] size=12+52	
entry count = 12	
[trak] size=8+1702	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 6	
duration = 3540	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3540	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+12	
[rndr] size=8+4	
[mdia] size=8+1546	
[mdhd] size=12+20	
timescale = 10000	
duration = 59003	
duration(ms) = 5900	
language = und	
[hdlr] size=12+40	
handler_type = meta	
handler_name = Core Media Metadata	
[minf] size=8+1454	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 14 Original Video	Received Video
handler name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stbl] size=8+1322	
[stsd] size=12+170	
entry-count = 1	
[mebx] size=8+158	
data reference index = 1	
[stts] size = 12 + 1004	
entry count = 125	
[stsc] size=12+28	
entry count = 2	
stsz size=12+8	
sample size = 12	
sample count = 0	
[stco] size=12+52	
entry count = 12	
[trak] size=8+630	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 7	
duration = 3540	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3540	
entry/media time = 0	
entry/media rate = 1	
[mdia] size=8+494	
[mdhd] size=12+20	
timescale = 600	
duration = 3540	
duration(ms) = 5900	
language = und	
[hdlr] size=12+40	
handler_type = meta	

Table 12. iPhone 14 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 14 Original Video	Received Video
handler name = Core Media Metadata	
[minf] size=8+402	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	
handler name = Core Media Data	
Handler —	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stb1] size=8+270	
[stsd] size=12+166	
entry-count = 1	
[mebx] size=8+154	
data reference index = 1	
[stts] size=12+12	
entry_count = 1	
[stsc] size=12+16	
entry_count = 1	
[stsz] size=12+8	
sample_size = 44	
sample_count = 0	
[stco] size=12+8	
entry_count = 1	
[udta] size=8+0	
[free] size=8+1016	
[meta] size=8+1641	
[hdlr] size=12+22	
handler_type = mdta	
handler_name =	
[keys] size=8+308	
[ilst] size=8+259	
[] size=8+24	
[] size=8+24	
[] size=8+43	
[] size=8+21	
[] size=8+29	
[] size=8+22	
[] size=8+40	
[free] size=8+1016	
[free] size=8+224	

The iPhone 14 device has two additional Compatible Brands within the File Type atom in the received video than it did in the original video. There is a Wide atom after the File Type atom in the original video, but not in the received video. In the original video, there are five additional tracks within the File Header atom which are not in the received video. These were mentioned in the metadata section and are called "metas" within the metadata. In the File Header atom in the original video, there is User Data, Metadata, and two free space sections not in the received video.

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data

iPhone 16e Original Video	Received Video
[ftyp] size=8+12	[ftyp] size=8+20
major_brand = qt	major brand = mp42
minor version = 0	minor version = 1
compatible brand = qt	compatible brand = isom
[wide] $size=8+0$	compatible brand = mp41
[mdat] size=8+10926217	compatible_brand = mp42
[moov] size=8+10599	[mdat] size=16+1160013
[mvhd] size=12+96	[moov] size=8+4441
timescale = 600	[mvhd] size=12+96
duration = 3239	timescale = 44100
duration(ms) = 5398	duration = 233730
[trak] size=8+2158	duration(ms) = 5300
[tkhd] size=12+80, flags=f	[trak] size=8+2751
enabled = 1	[tkhd] size=12+80, flags=1
id = 1	enabled = 1
duration = 3239	id = 1
width = 1920.000000	duration = 233730
height = 1080.000000	width = 464.000000
[tapt] size=8+60	height = 848.000000
[edts] size=8+28	[edts] size=8+28
[elst] size=12+16	[elst] size=12+16
entry count = 1	entry count = 1
entry/segment duration = 3239	entry/segment duration = 233730
entry/media time = 0	entry/media time = 40
entry/media rate = 1	entry/media rate = 1

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 16e Original Video	Received Video
[mdia] size=8+1693	[mdia] size=8+2615
[mdhd] size=12+20	[mdhd] size=12+20
timescale = 600	timescale = 600
duration = 3240	duration = 3180
duration(ms) = 5400	duration(ms) = 5300
language = und	language = und
[hdlr] size=12+37	[hdlr] size=12+37
handler type = vide	handler type = vide
handler name = Core Media Video	handler name = Core Media Video
[minf] size=8+1604	[minf] size=8+2526
[vmhd] size=12+8, flags=1	[vmhd] size=12+8, flags=1
graphics mode = 64	graphics $mode = 0$
op color = 0080,0080,0080	op color = 0000,0000,0000
[hdlr] size=12+44	[dinf] size=8+28
handler type = alis	[dref] size=12+16
handler name = Core Media Data	[url] size=12+0, flags=1
Handler	location = [local to file]
[dinf] size=8+28	[stbl] size=8+2462
[dref] size=12+16	[stsd] size=12+167
[alis] size=8+4	entry-count = 1
[stbl] size=8+1484	[avc1] size=8+155
[stsd] size=12+278	data_reference_index = 1
entry-count = 1	width = 464
[avc1] size=8+266	height = 848
data_reference_index = 1	compressor =
width = 1920	[avcC] size=8+34
height = 1080	Configuration Version = 1
compressor = H.264	Profile = High
[avcC] size=8+158	Profile Compatibility = 0
Configuration Version = 1	Level $= 31$
Profile = High	NALU Length Size = 4
Profile Compatibility = 0	Sequence Parameter = [27 64 00 1f ac
Level = 40	56 50 74 1a e9 a8 08 08 08 10]
NALU Length Size = 4	Picture Parameter = [28 ee 3c b0]
Sequence Parameter = [27 64 00 28	[colr] size=8+11
ad 84 30 80 91 01 01 31 02 30 84 44 21 82 80	[pasp] size=8+8
a8 50 14 05 61 40 a6 0a 21 48 43 02 00 21 04	[stts] size=12+12
00 40 04 30 40 08 30 20 41 04 21 88 29 04 16	entry_count = 1
42 62 24 84 30 40 11 08 02 00 8c 20 10 c1 04	[ctts] size=12+1276
21 08 60 e0 3a 1c 07 01 d8 70 39 83 88 72 10 ff	· -
a6 9a 4d 5a 31 52 6c 86 2c 92 c8 a4 31 cb 10 41	[stss] size=12+28

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

'DI 16 0 ' ' 1 17'1	D ' 137'1
iPhone 16e Original Video	Received Video
11 25 1c 28 c7 16 16 1d 1e 09 05 0b 05 d0 6d	ontwo count - 6
08 7f d7 af 93 f1 1f d7 e6 f8 af 08 70 d6 08 a0	entry_count = 6
	[sdtp] size=8+163
a1 5a 01 e0 08 9f 96 6a 02 02 02 04]	[stsc] size=12+40
Picture Parameter = [28 ee 3c b0]	entry_count = 3
[colr] size=8+10	[stsz] size=12+644
[stts] size=12+12	$sample_size = 0$
entry_count = 1	sample_count = 159
[stss] size=12+28	[stco] size=12+40
entry_count = 6	entry_count = 9
[sdtp] size=8+166	[trak] size=8+1566
[stsc] size=12+196	[tkhd] size=12+80, flags=1
entry_count = 16	enabled = 1
[stsz] size=12+656	id = 2
sample_size = 0	duration = 233657
sample_count = 162	width = 0.000000
[stco] size=12+68	height = 0.000000
entry_count = 16	[edts] size=8+28
[meta] size=8+253	[elst] size=12+16
[hdlr] size=12+22	entry count = 1
handler_type = mdta	entry/segment duration = 233657
handler_name =	entry/media time = 2112
[keys] size=8+116	entry/media rate = 1
[ilst] size=8+87	[mdia] size=8+1430
[] size=8+51	[mdhd] size=12+20
[] size=8+20	timescale = 44100
[trak] size=8+1780	duration = 236544
[tkhd] size=12+80, flags=f	duration(ms) = 5363
enabled = 1	language = und
id = 2	[hdlr] size=12+37
duration = 3239	handler_type = soun
width = 0.000000	handler_name = Core Media Audio
height = 0.000000	[minf] size=8+1341
[edts] size=8+28	[smhd] size=12+4
[elst] size=12+16	balance = 0
entry count = 1	[dinf] size=8+28
entry/segment duration = 3239	[dref] size=12+16
entry/media time = 0	[url] size=12+0, flags=1
entry/media rate = 1	location = [local to file]
[mdia] size=8+1644	[stb1] size=8+1281
[mdhd] size=12+20	[stsd] size=12+91

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 16e Original Video	Received Video
timescale = 48000	entry-count = 1
duration = 262144	[mp4a] size=8+79
duration(ms) = 5461	data reference index = 1
language = und	channel count $= 2$
[elng] size=8+8	sample $\overline{\text{size}} = 16$
[hdlr] size=12+37	sample rate = 44100
handler type = soun	[esds] size=12+39
handler name = Core Media Audio	[ESDescriptor] size=5+34
[minf] size=8+1539	es $id = 0$
[smhd] size=12+4	stream_priority = 0
balance = 0	[DecoderConfig] size=5+20
[hdlr] size=12+44	stream type = $\frac{63}{5}$
handler type = alis	object type = 64
handler name = Core Media Data	up stream = 0
Handler	buffer size = 6144
[dinf] size=8+28	$\overline{\text{max bitrate}} = 64000$
[dref] size=12+16	avg bitrate = 64000
[alis] size=8+4	DecoderSpecificInfo = 12 10
[stbl] size=8+1423	[Descriptor:06] size=5+1
[stsd] size=12+147	[sgpd] size=12+14, version=1
entry-count = 1	grouping type = roll
[mp4a] size=8+135	default length = 2
data reference index = 1	entry $count = 1$
channel count = 2	entry $00 = [ff ff]$
sample $\overline{\text{size}} = 16$	[sbgp] size=12+16
sample rate = 48000	grouping_type = roll
qt version = 1	entry count = 1
[wave] size=8+83	[stts] size=12+12
[frma] size=8+4	entry count = 1
original_format = mp4a	[stsc] size=12+88
[mp4a] size=8+4	entry_count = 7
[esds] size=12+39	[stsz] size=12+932
[ESDescriptor] size=5+34	$sample_size = 0$
$es_id = 0$	sample_count = 231
stream_priority = 0	[stco] size=12+44
[DecoderConfig] size=5+20	entry_count = 10
stream_type = 5	
object_type = 64	
$up_stream = 0$	
buffer_size = 6144	
$max_bitrate = 128000$	

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 16e Original Video	Received Video
avg bitrate = 128000	
DecoderSpecificInfo = 11 90	
[Descriptor:06] size=5+1	
[] size=8+0	
[stts] size=12+12	
entry count = 1	
[stsc] size=12+124	
entry count = 10	
[stsz] size=12+1032	
$sample_size = 0$	
sample count = 256	
[stco] size=12+48	
entry count = 11	
[trak] size=8+2024	
[tkhd] size=12+80, flags=e	
enabled = 0	
id = 3	
duration = 3239	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3239	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+12	
[fall] size=8+4	
[mdia] size=8+1868	
[mdhd] size=12+20	
timescale = 48000	
duration = 262144	
duration(ms) = 5461	
language = und	
[elng] size=8+8	
[hdlr] size=12+37	
handler_type = soun	
handler_name = Core Media Audio	
[minf] size=8+1763	
[smhd] size=12+4	
balance = 0	

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 16e Original Video	Received Video
[hdlr] size=12+44	
handler type = alis	
handler name = Core Media Data	
Handler —	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stb1] size=8+1647	
[stsd] size=12+229	
entry-count = 1	
[apac] size=8+217	
data_reference_index = 1	
[sgpd] size=12+14, version=1	
grouping_type = prol	
default_length = 2	
entry_count = 1	
entry $00 = [00 \ 01]$	
[sbgp] size=12+72	
grouping_type = prol	
entry_count = 8	
[stts] size=12+12	
entry_count = 1	
[stss] size=12+20	
entry_count = 4 [stsc] size=12+124	
entry count = 10	
[stsz] size=12+1032	
sample size = 0	
sample count = 256	
[stco] size=12+48	
entry count = 11	
[trak] size=8+617	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 4	
duration = 3239	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 16e Original Video	Received Video
entry/segment duration = 3239	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+24	
[cdsc] size=8+4	
track id count = 1	
$\operatorname{track} \overline{\operatorname{id}} = 1$	
[cdep] size=8+4	
[mdia] size=8+449	
[mdhd] size=12+20	
timescale = 600	
duration = 3240	
duration(ms) = 5400	
language = und	
[hdlr] size=12+40	
handler_type = meta	
handler name = Core Media Metadata	
[minf] size=8+357	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	
handler_name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stb1] size=8+225	
[stsd] size=12+121	
entry-count = 1	
[mebx] size=8+109	
data_reference_index = 1	
[stts] size=12+12	
entry_count = 1	
[stsc] size=12+16	
entry_count = 1	
[stsz] size=12+8	
sample_size = 10	
$sample_count = 0$	
[stco] size=12+8	
entry_count = 1	
[trak] size=8+603	

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 16e Original Video	Received Video
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 5	
duration = 3239	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3239	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+12	
[cdsc] size=8+4	
track_id_count = 1	
track id = 3	
[mdia] size=8+447	
[mdhd] size=12+20	
timescale = 10000	
duration = 54001	
duration(ms) = 5400	
language = und	
[hdlr] size=12+40	
handler_type = meta	
handler_name = Core Media Metadata	
[minf] size=8+355	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	
handler_name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stbl] size=8+223	
[stsd] size=12+119	
entry-count = 1	
[mebx] size=8+107	
data_reference_index = 1	
[stts] size=12+12	

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 16e Original Video	Received Video
entry_count = 1	
[stsc] size=12+16	
entry count = 1	
[stsz] size=12+8	
sample_size = 386	
sample_count = 0	
[stco] size=12+8	
entry_count = 1	
[trak] size=8+1062	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 6	
duration = 3239	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3239	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+24	
[cdsc] size=8+4	
track_id_count = 1	
track id $= 1$	
[cdep] size=8+4	
[mdia] size=8+894	
[mdhd] size=12+20	
timescale = 600	
duration = 3240	
duration(ms) = 5400	
language = und	
[hdlr] size=12+40	
handler_type = meta	
handler_name = Core Media Metadata	
[minf] size=8+802	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	
handler_name = Core Media Data	
Handler	

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 16e Original Video	Received Video
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stbl] size=8+670	
[stsd] size=12+566	
entry-count = 1	
[mebx] size=8+554	
data reference index = 1	
[stts] size=12+12	
entry_count = 1	
[stsc] size=12+16	
entry_count = 1	
[stsz] size=12+8	
$sample_size = 8$	
$sample_count = 0$	
[stco] size=12+8	
entry_count = 1	
[trak] size=8+1114	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 7	
duration = 3239	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3239	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+24	
[cdsc] size=8+4	
track_id_count = 1	
track id = 1	
[cdep] size=8+4	
[mdia] size=8+946	
[mdhd] size=12+20 timescale = 600	
duration = 3240	
$\frac{\text{duration} - 3240}{\text{duration(ms)}} = 5400$	
language = und	
ianguage – unu	

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 16e Original Video	Received Video
[hdlr] size=12+40	
handler type = meta	
handler name = Core Media Metadata	
[minf] size=8+854	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler type = alis	
handler name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stbl] size=8+722	
[stsd] size=12+566	
entry-count = 1	
[mebx] size=8+554	
data reference index = 1	
[stts] size=12+12	
entry count = 1	
[stsc] size=12+28	
entry count = 2	
[stsz] size=12+8	
sample size = 176	
sample_count = 0	
[stco] size=12+48	
entry_count = 11	
[trak] size=8+630	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 8	
duration = 3239	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3239	
entry/media time = 0	
entry/media rate = 1	
[mdia] size=8+494	
[mdhd] size=12+20	

Table 13. iPhone 16e Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 16e Original Video	Received Video
timescale = 600	
duration = 3240	
duration(ms) = 5400	
language = und	
[hdlr] size=12+40	
handler_type = meta	
handler_name = Core Media Metadata	
[minf] size=8+402	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	
handler_name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stbl] size=8+270	
[stsd] size=12+166	
entry-count = 1	
[mebx] size=8+154	
data_reference_index = 1	
[stts] size=12+12	
entry_count = 1	
[stsc] size=12+16	
entry_count = 1	
[stsz] size=12+8	
sample_size = 44	
$sample_count = 0$	
[stco] size=12+8	
entry_count = 1	
[meta] size=8+431	
[hdlr] size=12+22	
handler_type = mdta	
handler_name =	
[keys] size=8+208	
[ilst] size=8+173	
[] size=8+24	
[] size=8+21	
[] size=8+26	
[] size=8+22	
[] size=8+40	
[free] size=8+2312	

The File Type atom in the original video from the iPhone 16e has one Compatible Brand section and the received video has three. After the File Type atom, there is a Wide atom in the original video that is not present in the received video. In the original video, the File Header atom has eight tracks and a Metadata section and the File Header atom in the received video only has two tracks and does not have a Metadata section. The original video also has a Free Space atom after the File Header the received video does not contain.

Table 14. Google Pixel 10 Original Video Hex Data vs Received Video Hex Data

Google Pixel 10 Original Video	Received Video
[ftyp] size=8+20	[ftyp] size=8+24
major brand = isom	major brand = isom
minor version = 20000	minor version = 200
compatible brand = isom	compatible brand = isom
compatible_brand = iso2	compatible brand = iso2
compatible brand = mp41	compatible brand = avc1
[mdat] size=16+16749107	compatible brand = mp41
[moov] size=8+10467	[mdat] size = 8 + 2327637
[mvhd] size=12+96	[moov] size=8+6522
timescale = 10000	[mvhd] size=12+96
duration = 65021	timescale = 6000
duration(ms) = 6502	duration = 39012
[udta] size=8+30	duration(ms) = 6502
[.xyz] size=8+22	[trak] size=8+3947
[meta] size=8+235	[tkhd] size=12+80, flags=7
[hdlr] size=12+21	enabled = 1
handler_type = mdta	id = 1
handler_name =	duration = 38680
[keys] size=8+96	width = 0.000000
[ilst] size=8+90	height = 0.000000
[] size=8+20	[mdia] size=8+3847
[] size=8+24	[mdhd] size=12+20
[] size=8+22	timescale = 48000
[trak] size=8+3078	duration = 309446
[tkhd] size=12+80, flags=7	duration(ms) = 6446
enabled = 1	language = eng
	[hdlr] size=12+32

Table 14. Google Pixel 10 Original Video Hex Data vs Received Video Hex Data cont'd

Google Pixel 10 Original Video	Received Video
id = 1	handler_type = soun
duration = 65021	handler_name = SoundHandle
width = 1920.000000	[minf] size=8+3763
height = 1080.000000	[smhd] size=12+4
[mdia] size=8+2978	balance = 0
[mdhd] size=12+20	[dinf] size=8+28
timescale = 90000	[dref] size=12+16
duration = 585192	[url] size=12+0, flags=1
duration(ms) = 6502	location = [local to file]
language = ```	[stb1] size=8+3703
[hdlr] size=12+32	[stsd] size=12+79
handler_type = vide	entry-count = 1
handler_name = VideoHandle	[mp4a] size=8+67
[minf] size=8+2894	data_reference_index = 1
[vmhd] size=12+8	channel_count = 2
graphics_mode = 0	sample size = 16
$op_color = 0000,0000,0000$	sample rate = 48000
[dinf] size=8+28	[esds] size=12+27
[dref] size=12+16	[ESDescriptor] size=2+25
[url] size=12+0, flags=1	$es_id = 0$
location = [local to file]	stream_priority = 0
[stb1] size=8+2830	[DecoderConfig] size=2+17
[stsd] size=12+250	stream_type = 5
entry-count = 1	object_type = 64
[hvc1] size=8+238	$up_stream = 0$
data_reference_index = 1	buffer_size = 1536
width = 1920	$max_bitrate = 192000$
height = 1080	avg_bitrate = 48000
compressor =	DecoderSpecificInfo = 11 90
[hvcC] size=8+117	[Descriptor:06] size=2+1
Configuration Version = 1	[stts] size=12+52
Profile Space = 0	entry_count = 6
Profile = Main	[stsc] size=12+1612
Tier = 0	entry_count = 134
Profile Compatibility = 60000000	[stsz] size=12+1220
Constraint = 0	$sample_size = 0$
Level = 123	sample_count = 303
Min Spatial Segmentation = 0	[stco] size=12+680
Parallelism Type = 0	entry_count = 169
Chroma Format = 1	[trak] size=8+2451

Table 14. Google Pixel 10 Original Video Hex Data vs Received Video Hex Data cont'd

Google Pixel 10 Original Video	Received Video
Chroma Depth = 8	[tkhd] size=12+80, flags=7
Luma Dept $\hat{h} = 8$	enabled = 1
Average Frame Rate = 0	id = 2
Constant Frame Rate = 0	duration = 39012
Number Of Temporal Layers = 1	width = 720.000000
Temporal Id Nested = 1	height = 1280.000000
NALU Length Size = 4	[mdia] size=8+2351
[pasp] size=8+8	[mdhd] size=12+20
[colr] size=8+11	timescale = 90000
[stts] size=12+108	duration = 585192
entry count = 13	duration(ms) = 6502
[stsz] size=12+788	language = eng
sample size = 0	[hdlr] size=12+32
sample count = 195	handler type = vide
[stsc] size=12+16	handler name = VideoHandle
entry count = 1	[minf] size=8+2267
[co64] size=12+1564	[vmhd] size=12+8, flags=1
entry count = 195	graphics mode = 0
[stss] size=12+32	op color = 0000,0000,0000
entry count = 7	[dinf] size=8+28
[trak] size=8+4155	[dref] size=12+16
[tkhd] size=12+80, flags=7	[url] size=12+0, flags=1
enabled = 1	location = [local to file]
id = 2	[stbl] size=8+2203
duration = 64674	[stsd] size=12+135
width = 0.000000	entry-count = 1
height = 0.000000	[avc1] size=8+123
[edts] size=8+56	data reference index = 1
[elst] size=12+44, version=1	width = 720
entry count = 2	height = 1280
entry/segment duration = 7	compressor =
entry/media time = -1	[avcC] size=8+37
entry/media rate = 1	Configuration Version = 1
entry/segment duration = 64674	Profile = High
entry/media time = 0	Profile Compatibility = 0
entry/media rate = 1	Level = 31
[mdia] size=8+3991	NALU Length Size = 4
[mdhd] size=12+20	Sequence Parameter = [67 64 00 1f ac
timescale = 48000	d2 02 d0 28 69 a8 08 08 08 3c 20 10 a8]
duration = 310436	Picture Parameter = [68 ea 8f 2c]
duration(ms) = 6467	[stts] size=12+108

Table 14. Google Pixel 10 Original Video Hex Data vs Received Video Hex Data cont'd

Google Pixel 10 Original Video	Received Video
language = ``` [hdlr] size=12+32 handler_type = soun handler_name = SoundHandle [minf] size=8+3907 [smhd] size=12+4 balance = 0 [dinf] size=8+28 [dref] size=12+16 [url] size=12+0, flags=1 location = [local to file] [stbl] size=8+3847 [stsd] size=12+79 entry-count = 1 [mp4a] size=8+67 data_reference_index = 1 channel_count = 2 sample_size = 16 sample_rate = 48000 [esds] size=12+27 [ESDescriptor] size=2+25 es_id = 0 stream_priority = 0 [DecoderConfig] size=2+17 stream_type = 5 object_type = 64 up_stream = 0 buffer_size = 768 max_bitrate = 192000 avg_bitrate = 192000 DecoderSpecificInfo = 11 90 [Descriptor:06] size=2+1 [stts] size=12+44 entry_count = 5 [stsz] size=12+1220 sample_size = 0 sample_count = 303 [stsc] size=12+16 entry_count = 1 [co64] size=12+2428	entry_count = 13 [stss] size=12+32 entry_count = 7 [stsc] size=12+400 entry_count = 33 [stsz] size=12+776 sample_size = 0 sample_count = 192 [stco] size=12+680 entry_count = 169

Table 14. Google Pixel 10 Original Video Hex Data vs Received Video Hex Data cont'd

Google Pixel 10 Original Video	Received Video
entry_count = 303	
[trak] size=8+2821	
[tkhd] size=12+80, flags=7	
enabled = 1	
id = 3	
duration = 65021	
width = 0.000000	
height = 0.000000	
[mdia] size=8+2721	
[mdhd] size=12+20	
timescale = 90000	
duration = 585192	
duration(ms) = 6502	
language = ```	
[hdlr] size=12+31	
handler_type = meta	
handler_name = MetaHandle	
[minf] size=8+2638	
[nmhd] size=12+0	
[dinf] size=8+28	
[dref] size=12+16	
[url] size=12+0, flags=1	
location = [local to file]	
[stbl] size=8+2582	
[stsd] size=12+46	
entry-count = 1	
[mett] size=8+34	
data_reference_index = 24948	
[stts] size=12+108	
entry_count = 13	
[stsz] size=12+788	
$sample_size = 0$	
sample_count = 195	
[stsc] size=12+16	
entry_count = 1	
[co64] size=12+1564	
entry_count = 195	

The Google Pixel 10 original video has three Compatible Brand sections in the File Type atom, and the received video has four. The File Header atom in the original video has a User Data and Metadata section the received video does not have. The User Data section is after the Movie Header in the original file, and the Metadata section is after the User Data. The received video has two tracks in the File Header atom, and the original video has three.

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data

iPhone 15 Original Video	Received Video
[ftyp] size=8+12	[ftyp] size=8+20
major brand = qt	major brand = mp42
minor version = 0	minor version = 1
compatible brand = qt	compatible brand = isom
[moov] size=8+12752	compatible brand = mp41
[mvhd] size=12+96	compatible brand = mp42
timescale = 600	[mdat] size=16+1268348
duration = 3621	[moov] size=8+4822
duration(ms) = 6035	[mvhd] size=12+96
[trak] size=8+1858	timescale = 44100
[tkhd] size=12+80, flags=f	duration = 261660
enabled = 1	duration(ms) = 5933
id = 1	[trak] size=8+2984
duration = 3620	[tkhd] size=12+80, flags=1
width = 0.000000	enabled = 1
height = 0.000000	id = 1
[edts] size=8+28	duration = 261660
[elst] size=12+16	width = 464.000000
entry count = 1	height = 848.000000
entry/segment duration = 3620	[edts] size=8+28
entry/media time = 2112	[elst] size=12+16
entry/media rate = 1	entry count = 1
[mdia] size=8+1722	entry/segment duration = 261660
[mdhd] size=12+20	entry/media time = 60
timescale = 44100	entry/media rate = 1
duration = 268288	[mdia] size=8+2848
duration(ms) = 6083	[mdhd] size=12+20
language = und	timescale = 600
[hdlr] size=12+37	duration = 3560

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 15 Original Video	Received Video
handler type = soun	duration(ms) = 5933
handler name = Core Media Audio	language = und
[minf] size=8+1633	[hdlr] size=12+37
[smhd] size=12+4	handler type = vide
balance = 0	handler name = Core Media Video
[hdlr] size=12+44	[minf] size=8+2759
handler type = alis	[vmhd] size=12+8, flags=1
handler name = Core Media Data	graphics $mode = 0$
Handler –	op color = 0000,0000,0000
[dinf] size=8+28	[dinf] size=8+28
[dref] size=12+16	[dref] size=12+16
[alis] size=8+4	[url] size=12+0, flags=1
[stbl] size=8+1517	location = [local to file]
[stsd] size=12+147	[stbl] size=8+2695
entry-count = 1	[stsd] size=12+167
[mp4a] size=8+135	entry-count = 1
data reference index = 1	[avc1] size=8+155
channel count = 2	data reference index = 1
sample $\overline{\text{size}} = 16$	width = 464
sample rate = 44100	height = 848
qt version = 1	compressor =
[wave] size=8+83	[avcC] size=8+34
[frma] size=8+4	Configuration Version = 1
original_format = mp4a	Profile = High
[mp4a] size=8+4	Profile Compatibility = 0
[esds] size=12+39	Level = 31
[ESDescriptor] size=5+34	NALU Length Size = 4
$es_id = 0$	Sequence Parameter = [27 64 00 1f ac
stream_priority = 0	56 50 74 1a e9 a8 08 08 08 10]
[DecoderConfig] size=5+20	Picture Parameter = [28 ee 3c b0]
stream_type = 5	[colr] size=8+11
object_type = 64	[pasp] size=8+8
$up_stream = 0$	[stts] size=12+28
buffer_size = 6144	entry_count = 3
$max_bitrate = 192000$	[ctts] size=12+1412
$avg_bitrate = 0$	entry_count = 176
DecoderSpecificInfo = 12 10	[stss] size=12+32
[Descriptor:06] size=5+1	entry_count = 7
[] size=8+0	[sdtp] size=8+180
[sgpd] size=12+14, version=1	[stsc] size=12+28
grouping_type = roll	entry_count = 2

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 15 Original Video	Received Video
default_length = 2	[stsz] size=12+712
entry_count = 1	$sample_size = 0$
entry $00 = [ff ff]$	sample count = 176
[sbgp] size=12+16	[stco] size=12+44
grouping_type = roll	entry count = 10
entry_count = 1	[trak] size=8+1714
[stts] size=12+12	[tkhd] size=12+80, flags=1
entry_count = 1	enabled = 1
[stsc] size=12+136	id = 2
entry_count = 11	duration = 261660
[stsz] size=12+1056	width = 0.000000
$sample_size = 0$	height = 0.000000
$sample_count = 262$	[edts] size=8+28
[stco] size=12+52	[elst] size=12+16
entry_count = 12	entry count = 1
[trak] size=8+3522	entry/segment duration = 261660
[tkhd] size=12+80, flags=f	entry/media time = 2112
enabled = 1	entry/media rate = 1
id = 2	[mdia] size=8+1578
duration = 3621	[mdhd] size=12+20
width = 1920.000000	timescale = 44100
height = 1080.000000	duration = 264192
[tapt] size=8+60	duration(ms) = 5990
[edts] size=8+28	language = und
[elst] size=12+16	[hdlr] size=12+37
entry count = 1	handler_type = soun
entry/segment duration = 3621	handler_name = Core Media Audio
entry/media time = 0	[minf] size=8+1489
entry/media rate = 1	[smhd] size=12+4
[mdia] size=8+3058	balance = 0
[mdhd] size=12+20	[dinf] size=8+28
timescale = 600	[dref] size=12+16
duration = 3621	[url] size=12+0, flags=1
duration(ms) = 6035	location = [local to file]
language = und	[stbl] size=8+1429
[hdlr] size=12+37	[stsd] size=12+91
handler_type = vide	entry-count = 1
handler_name = Core Media Video	[mp4a] size=8+79
[minf] size=8+2969	data_reference_index = 1
[vmhd] size=12+8, flags=1	channel_count = 2
	sample_size = 16

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 15 Original Video	Received Video
graphics_mode = 64	sample_rate = 44100
op_color = 0080,0080,0080	[esds] size=12+39
[hdlr] size=12+44	[ESDescriptor] size=5+34
handler_type = alis	$es_id = 0$
handler_name = Core Media Data	stream_priority = 0
Handler	[DecoderConfig] size=5+20
[dinf] size=8+28	stream_type = 5
[dref] size=12+16	object type = 64
[alis] size=8+4	up stream = 0
[stbl] size=8+2849	buffer size = 6144
[stsd] size=12+156	$\overline{\text{max bitrate}} = 64000$
entry-count = 1	avg $\overline{\text{bitrate}} = 64000$
[avc1] size=8+144	DecoderSpecificInfo = 12 10
data reference index = 1	[Descriptor:06] size=5+1
width = 1920	[sgpd] size=12+14, version=1
height = 1080	grouping type = roll
compressor = H.264	default length = 2
[avcC] size=8+36	entry count = 1
Configuration Version = 1	entry $00 = [ff ff]$
Profile = High	[sbgp] size=12+16
Profile Compatibility = 0	grouping type = roll
Level = 40	entry count = 1
NALU Length Size = 4	[stts] size=12+12
Sequence Parameter = [27 64 00 28 ac	
56 50 1e 00 89 f9 66 a0 20 20 20 40]	[stsc] size=12+124
Picture Parameter = [28 ee 3c b0]	entry count = 10
[colr] size=8+10	[stsz] size=12+1040
[stts] size=12+44	sample size = 0
entry count = 5	sample count = 258
[ctts] size=12+1452	[stco] size=12+48
entry count = 181	entry count = 11
[cslg] size=8+24	7-
[stss] size=12+32	
entry count = 7	
[sdtp] size=8+185	
[stsc] size=12+64	
entry_count = 5	
[stsz] size=12+732	
sample_size = 0	
sample_count = 181	

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 15 Original Video	Received Video
[stco] size=12+60	
entry count = 14	
[meta] size=8+252	
[hdlr] size=12+22	
handler type = mdta	
handler name =	
[keys] size=8+116	
[ilst] size=8+86	
[] size=8+50	
[] size=8+20	
[trak] size=8+617	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 3	
duration = 3620	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3620	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+24	
[cdep] size=8+4	
[cdsc] size=8+4	
track_id_count = 1	
track id $= 2$	
[mdia] size=8+449	
[mdhd] size=12+20	
timescale = 600	
duration = 3620	
duration(ms) = 6033	
language = und [hdlr] size=12+40	
_	
handler_type = meta handler_name = Core Media Metadata [minf] size=8+357 [gmhd] size=8+24 [hdlr] size=12+44 handler_type = alis	

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 15 Original Video	Received Video
handler_name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stb1] size=8+225	
[stsd] size=12+121	
entry-count = 1	
[mebx] size=8+109	
data_reference_index = 1	
[stts] size=12+12	
entry_count = 1	
[stsc] size=12+16	
entry_count = 1	
[stsz] size=12+8	
sample_size = 10	
sample_count = 0	
[stco] size=12+8	
entry_count = 1	
[trak] size=8+1062	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 4	
duration = 3620	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3620	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+24	
[cdep] size=8+4	
[cdsc] size=8+4	
track_id_count = 1	
track id = 2	
[mdia] size=8+894	
[mdhd] size=12+20	
timescale = 600	
duration = 3620	

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 15 Original Video	Received Video
duration(ms) = 6033	
language = und	
[hdlr] size=12+40	
handler type = meta	
handler name = Core Media Metadata	
[minf] size=8+802	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler type = alis	
handler name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stb1] size=8+670	
[stsd] size=12+566	
entry-count = 1	
[mebx] size=8+554	
data_reference_index = 1	
[stts] size=12+12	
entry_count = 1	
[stsc] size=12+16	
entry_count = 1	
[stsz] size=12+8	
sample_size = 8	
$sample_count = 0$	
[stco] size=12+8	
entry_count = 1	
[trak] size=8+1781	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 5	
duration = 3620	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1 entry/segment duration = 3620	
entry/segment duration – 3620 entry/media time = 0	
entry/media rate = 1	

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 15 Original Video	Received Video
[tref] size=8+24	
[cdep] size=8+4	
[cdsc] size=8+4	
track id count = 1	
track id = 2	
[mdia] size=8+1613	
[mdhd] size=12+20	
timescale = 600	
duration = 3620	
duration(ms) = 6033	
language = und	
[hdlr] size=12+40	
handler type = meta	
handler name = Core Media Metadata	
[minf] size=8+1521	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler type = alis	
handler name = Core Media Data	
Handler —	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stbl] size=8+1389	
[stsd] size=12+589	
entry-count = 1	
[mebx] size=8+577	
data_reference_index = 1	
[stts] size=12+52	
entry_count = 6	
[stsc] size=12+172	
entry_count = 14	
[stsz] size=12+8	
sample_size = 144	
$sample_count = 0$	
[stco] size=12+508	
entry_count = 126	
[trak] size=8+2498	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 6	

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 15 Original Video	Received Video
duration = 3619	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3619	
entry/media time = 0	
entry/media rate = 1	
[tref] size=8+12	
[rndr] size=8+4	
[mdia] size=8+2342	
[mdhd] size=12+20	
timescale = 10000	
duration = 60333	
duration(ms) = 6033	
language = und	
[hdlr] size=12+40	
handler type = meta	
handler name = Core Media Metadata	
[minf] size=8+2250	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	
handler_name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stb1] size=8+2118	
[stsd] size=12+170	
entry-count = 1	
[mebx] size=8+158	
data_reference_index = 1	
[stts] size=12+1156	
entry_count = 144	
[stsc] size=12+220	
entry_count = 18	
[stsz] size=12+8	
sample_size = 12	

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 15 Original Video	Received Video
sample count = 0	
[stco] size=12+504	
entry count = 125	
[trak] size=8+630	
[tkhd] size=12+80, flags=f	
enabled = 1	
id = 7	
duration = 3620	
width = 0.000000	
height = 0.000000	
[edts] size=8+28	
[elst] size=12+16	
entry count = 1	
entry/segment duration = 3620	
entry/media time = 0	
entry/media rate = 1	
[mdia] size=8+494	
[mdhd] size=12+20	
timescale = 600	
duration = 3620	
duration(ms) = 6033	
language = und	
[hdlr] size=12+40	
handler_type = meta	
handler_name = Core Media Metadata	
[minf] size=8+402	
[gmhd] size=8+24	
[hdlr] size=12+44	
handler_type = alis	
handler_name = Core Media Data	
Handler	
[dinf] size=8+28	
[dref] size=12+16	
[alis] size=8+4	
[stbl] size=8+270	
[stsd] size=12+166	
entry-count = 1	
[mebx] size=8+154	
data_reference_index = 1	
[stts] size=12+12	
entry_count = 1	

Table 15. iPhone 15 Original Video Hex Data vs Received Video Hex Data cont'd

iPhone 15 Original Video	Received Video
[stsc] size=12+16	
entry_count = 1	
[stsz] size=12+8	
sample size = 44	
sample count = 0	
[stco] size=12+8	
entry_count = 1	
[meta] size=8+612	
[hdlr] size=12+22	
handler_type = mdta	
handler_name =	
[keys] size=8+308	
[ilst] size=8+254	
[] size=8+25	
[] size=8+24	
[] size=8+43	
[] size=8+21	
[] size=8+25	
[] size=8+20	
[] size=8+40	
[wide] size=8+0	
[mdat] size=8+9669041	

The iPhone 15 original video has one Compatible Brand section in the File Type atom, whereas the received video has three Compatible Brand sections. The Data section of the original video is after the File Header and Wide atoms, but in the received video it is before the File Header atom and there is no wide atom. The File Header atom has seven tracks and a Metadata section in the original video, but only two tracks, and no Metadata section were in the received. The structure of a video file, from the mobile phones studied, is shown to have changed throughout the Telegram transfer process when the hex data was analyzed.

The table below summarizes the results of this study.

 Table 16.
 Summary of Results

Metric	Match Count	Total Files	Match Rate (%)
File Container Hash	0	47	0
Video Stream Hash	0	47	0
Audio Stream Hash	0	47	0
Metadata	0	47	0
File Structure (Atom Layout)	0	47	0

VI. CONCLUSIONS

The hash values, stream hash values, a portion of the metadata, and a portion of the hex data of videos created by mobile phones and transferred through Telegram via mobile phones, are changed during the transfer. The method of transferring videos through Telegram destroys the integrity of the video files and this transfer process compromises video evidence.

Discussion

Because the videos transferred through Telegram using mobile phones have structural and metadata changes, the videos are not authentic to the originals. This is shown through the lack of ability to verify hash and stream hashes of the videos, as well as changes shown from the metadata and hex analyses. Over 40 videos were tested for this thesis from five different mobile phones, and all of them were altered by Telegram.

The original videos transferred through Telegram resulted in multiple received videos.

All the received videos for an original video had matching hash values and stream hash values, along with metadata and hex verification that proved the received videos for each original video are the same file. This indicates the changes made to the videos did not happen on the downloading device, but during its transfer via the Telegram app.

The Telegram transfer process does not keep the integrity of videos intact. This transfer process is proven to change video evidence sent between mobile phones using the Telegram application.

Future Research

Future research related to this topic can include quantifying the differences of the original and received videos further by using analysis methods to reflect not only the transfer process did change the video, but how much the Telegram transfer process altered the video. Analysis can be

conducted with this data including color space analysis, motion detection changes, and perceptual hashing. Whether the transcoding of the videos is occurring when the user uploads a video to Telegram, when it sends, if it takes place on a Telegram server, etc. can be researched more. Lastly, there was no found research relating to Telegram-transferred media files, so more research can be conducted with Telegram using different devices and different forms of media.

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