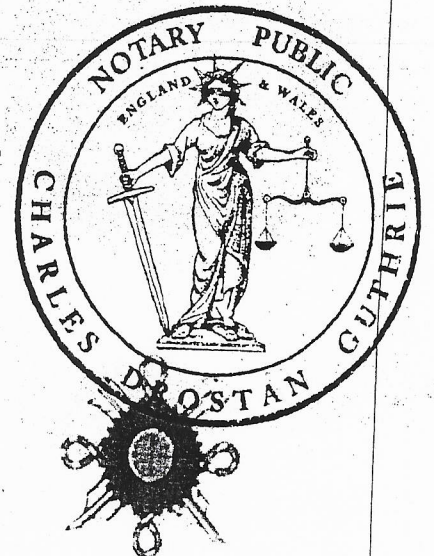
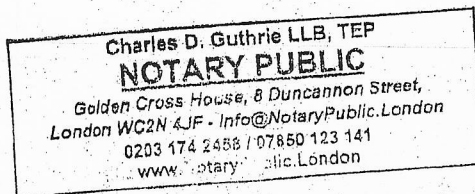



NOTARIAL CERTIFICATE

**I** CHARLES DROSTAN GUTHRIE, Notary Public in and for London, England and Wales, in the United Kingdom of Great Britain, by Royal Authority, do hereby certify that attached to this certificate is a true and genuine and authentic report dated 03 September 2019, commissioned by NASIR MEHMOOD identified to me, having been prepared by CYFOR of Becket House, Old Jewry London EC2R 8DD being a specialist organisation providing services in the areas of eDiscovery, Digital Forensics and Cyber Security provider and with expertise in advanced data analytics and data recovery.

GIVEN under my hand and Seal of Office this Friday, 13 September 2019.



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*Sto pro veritate - I stand for truth*

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# **CYFOR**

eDISCOVERY | DIGITAL FORENSICS | CYBER SECURITY

Case Alias: **Rockcorry 2**

Case Reference: **SO-105998**

Report Date: **3<sup>rd</sup> September 2019**

Report reference: **JZ/01**

**Strictly Confidential**

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## 1 INTRODUCTION

### 1.01 Company

Cyfor are a UK based Digital Forensics company, holding both ISO 9001 and ISO 27001 accreditation.

### 1.02 Examiner

My name is James Zjalic. My specialist field is multimedia forensics. I have performed over 500 examinations within my area of expertise and hold degrees in both Media Forensics (MSc) and Audio Engineering (BSc, 1<sup>st</sup> Class Hons). Experience includes participation in a US Air Force and DARPA funded Multimedia Analysis Research Project (Codename: MEDIFOR), peer-reviewed and published research on the subjects of multimedia authentication and enhancement, and a number of articles in magazines including Sound on Sound, Digital Forensics Magazine and Forensic Focus. I also attend and give presentations at international forensics conferences on an annual basis, partake in CPD training within my field of expertise, and have provided peer review of research papers in the field of audio forensics put forward for publishing in the Journal of The Audio Engineering Society.

Full details of the qualifications which entitle me to give expert opinion evidence are documented within the Appendix of this report.

### 1.03 Information Provided Regarding Instruction

I was instructed on the 28<sup>th</sup> of August 2019 by Lex Law Solicitors and Advocates on behalf of their client, Mr Nasir Mehmood. The following is taken verbatim from the Letter of Instruction, dated the 28<sup>th</sup> of August 2019:

*'You are instructed to carry out a forensic analysis and authentication examination of the Original Recording and opine on the following issues:*

*4.1 Whether the recording is authentic and an original recording;*

*4.2 Whether editing, modification and/or manipulation of any form of the recording has occurred whether audio, picture or otherwise;*

*4.3 Whether the recording has been spliced and/or has had any audio element added i.e. a voiceover, or removed;*

*4.4 The time and date of the recording;*

*4.5 Whether the phone at the time of the recording was synced to Pakistan time zone or UK time zone in order to provide the time and date stamp; and*

*4.6 The make and the serial number of the device used to capture the Original Recording.'*

#### **1.04 Points of Instruction**

1. Perform authentication examinations of two (2) video exhibits to opine on the questions raised by the instructing party.

#### **1.05 Purpose of this Report**

To provide an expert opinion in the field of digital video and mobile phone forensics, and more specifically, authentication, to assist the court in this case.

#### **1.06 Technical Terms**

All technical terms have been indicated in italicised typeface when they first occur within this report. These terms are defined in a glossary located within the Appendix. A list of references which have been consulted in the creation of this report can also be found in the Appendix.

#### **1.07 Exhibits**

Please refer to the Appendix 'Exhibits Reviewed' for details of the exhibits on which the results of analysis documented within this report rely.

#### **1.08 Conflicts of Interest**

Some of the audio analyses are performed using software coded by myself and have all been repeatedly tested to ensure their reliability.

Further to that, I have no personal or business connection with any of the parties involved in this case. I am independent of the parties and intend to remain so throughout the course of this matter before the Court.

### **1.09 Scope**

The analysis presented within this report pertains to only the exhibit analysed for this examination, as instructed. No other exhibits were reviewed, thus minimising exposure to potentially biasing information which may impact any conclusions drawn.

### **1.10 Disclaimer**

Any information supplied by the client and relied upon within this report can affect the validity of the results.

## 2 EXECUTIVE SUMMARY

The work instructed consisted of a single (1) stage, as defined by the points of instruction.

**Perform authentication examinations of two (2) exhibits to opine on questions raised by the instructing party.**

These examinations resulted in four (4) conclusions:

1. It is my opinion, based on the analysis performed in this examination, that the exhibit entitled 'VID\_20190506\_201705.mp4' is consistent with an original recording.
2. It is my opinion, based on the analysis performed in this examination, that the exhibit entitled 'VID\_20190506\_211010.mp4' is consistent with an original recording.
3. Although the metadata of the exhibits contains information relating to the time of capture, it is my opinion, based on the analysis performed in this examination, that this information cannot be verified.
4. No opinion can be given on the serial number of the device used to capture the original recordings.



### 3 FACTS, ASSUMPTIONS, AND LIMITATIONS

#### 3.01 Facts

The following is a fact relied upon for the analysis documented within this report:

1. According to the instructing party the pertinent video files stored on the phone are entitled 'VID\_20190506\_201705.mp4' and 'VID\_20190506\_211010.mp4';
2. According to the instructing party, the pertinent video files were captured using a Huawei mobile phone, transferred to a laptop using a direct cable transfer, and then further transferred to the exhibit device provided.

#### 3.02 Assumptions

There are no assumptions made within this report.

#### 3.03 Limitations

The following are limitations of the analysis documented within this report:

1. It is not possible to conclusively state that all data was extracted from the device due to technical limitations associated with mobile phone forensics;
2. It is not possible to perform comparisons against reference recordings from the purported capture device as the device was not made available.

## 4 MOBILE PHONE ANALYSIS

### 4.01 Statement of Methodology

To ensure an exhaustive examination was performed, the following framework was employed:

1. Identification of the device – The exhibit make, and model was identified;
2. Tool selection – The device capabilities were reviewed to determine the optimal method of extraction. It was decided that a logical extraction was the most suitable option based on the examination requirements;
3. Memory acquisition – A *Logical extraction* via cable transfer was performed;
4. Sequestered Files– The pertinent exhibit requested by the instructing party was identified;
5. Analysis – Unique tags were created for the requested audio file which was then exported.

## 4.02 Exhibit Specifications

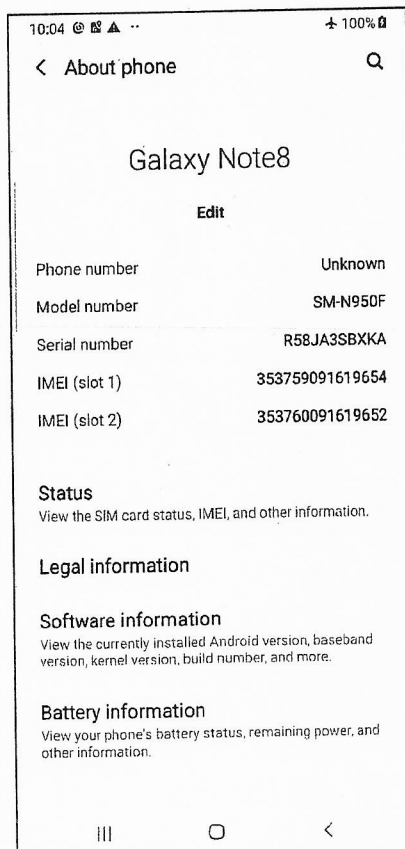
The specifications of the device from which the exhibits were extracted is reported as 'samsung' with model number 'SM-N950F' (Table. 1).

The Serial number was documented during a manual examination of the device (Fig. 1). As the provided device is not the purported capture device, analysis of the exhibit device would not provide any information in relation to the video exhibits, so none was performed.

**Table 1: Device Specifications**

Android ID	564068e5560f2eee
Detected manufacturer	samsung
Detected model	SM-N950F
Phone date/time	19/08/2019 16:18:42 +01:00
Phone revision	9 PPR1.180610.011 N950FXXS6DSE1
Time Zone	(UTC+00:00) London (Europe)
IMEI	3.53759E+14

**Figure 1: Device information**



## 5 AUTHENTICITY ANALYSIS

To perform an exhaustive assessment, multiple analyses were performed following a framework taken from a number of research papers on the subjects of video and audio authentication.

A subjective conclusion is then drawn from the results of the various analyses, based on the consistency of the exhibit with an original recording. The use of the term 'original (or authentic) recording' within this report is taken from the definition provided by the Audio Engineering Society standard AES27-1996 (r2007,s2012):

*'A recording made simultaneously with the acoustic events it purports to have recorded, made in a manner fully and completely consistent with the methods of recording claimed by the party who produced the recording and free from unexplained artifacts, alterations, additions, deletions or edits'*

An authenticity examination seeks to establish if the recording is original, and in doing so eliminates the possibility of deliberate tampering having occurred. An artefact that is consistent with an edit may have an innocent explanation, **but a lack of evidence with regards to editing cannot be considered to be proof that editing has not taken place.** Only by establishing the originality can it be accepted that the recording has not been edited.

In this case, as the capture device is purported to be a Huawei mobile phone, two (2) original recordings were captured using a Huawei P10 phone running the same Operating System as found in the metadata of the exhibits (Android 8.0). These were created in accordance with the audible and visual capture environment of the exhibits (indoors and of speech) and of the same lengths.

**5.01 Abbreviations**

From this point forward, the abbreviations in Table 2 are used to prevent the repetition of lengthy filenames.

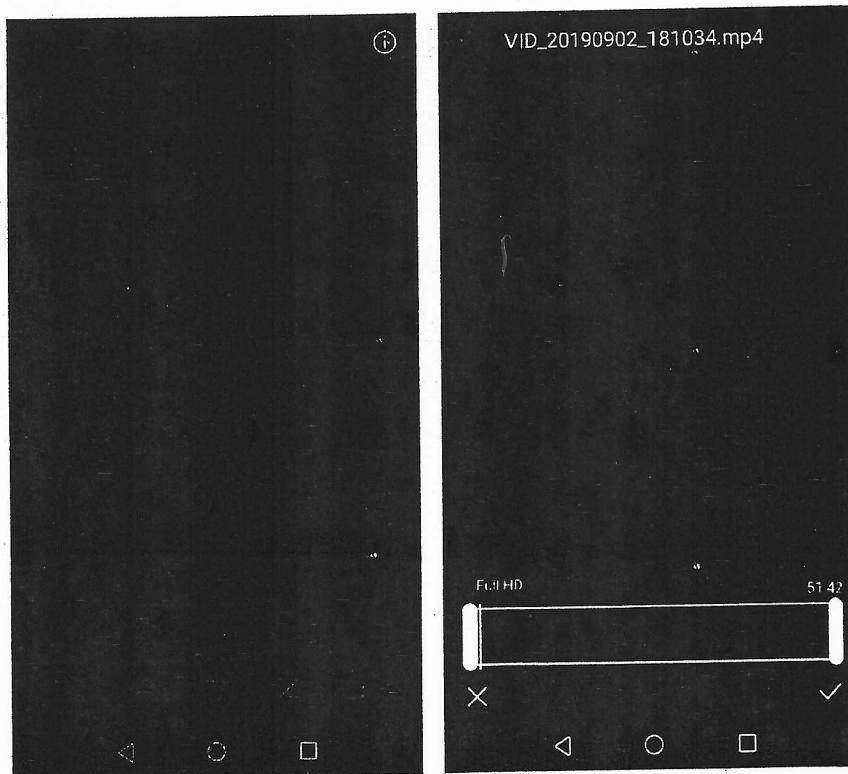
**Table 2: Exhibit abbreviations**

Exhibit Recordings	Abbreviation
VID_20190506_201705.mp4	VideoEx1
VID_20190506_211010.mp4	VideoEx2
Reference Recordings	
VID_20190902_200821.mp4	RefVideo1
VID_20190902_195633.mp4	RefVideo2

**5.02 Software Capabilities**

A review of the software application for video capture and editing within a device matching the model and operating system of the purported capture device found that it is only possible to trim the recording (Fig. 2). It is not possible to manipulate sections from within the length of the recording.

**Figure 2: Huawei P10 / Android 8.0 editing capabilities**



### 5.03 Critical Viewing

Critical viewing was performed to document any visual traces which can provide information as to the authenticity of the recordings. Table 3 contains a summary of the findings in relation to potential editing from the critical viewing process.

There are no instantaneous changes to brightness, content or quality, no areas of complete signal loss or visible artefacts for either exhibit.

There is no on-screen time display for either exhibit, so no analysis of such could be performed.

The audio and visual events are synchronised throughout, and there are no issues with the chronology of events within either exhibit.

**Table 3: Critical Viewing Summary**

Feature	ExVideo1	ExVideo2
Content	Camera onboard a motorbike following a vehicle.  Moves inside around 4 minutes into the capture.	Camera in portrait mode inside property.  Continuation of the previous recording
Onscreen Time Display Start	No on-screen time display	No on-screen time display
Onscreen Time Display End	No on-screen time display	No on-screen time display
Frame duplication	No	No
Frame dropouts	No	No
Signal loss	No	No
Artefacts	No	No
Instantaneous changes to brightness	No	No
Instantaneous changes to content	No	No
Instantaneous changes to quality	No	No
Overall synchronisation with audio track	No	No
Instantaneous loss of synchronisation with audio track	No	No
Audio and visual content mismatch	No	No
Chronology of events	No issues	No issues

### 5.04 Critical Listening

Critical listening was performed to determine any audible traces which can provide information as to the authenticity of the recording. Table 4 contains a summary of the findings in relation to potential editing from the critical listening process.

There are no clicks and pops which would be consistent with editing within either exhibit.

The perceptual quality of the recordings is consistent with the specifications.

There are no instantaneous changes in relation to the speaker to noise ratio, background noise ratio, broadband noise, speaker levels or reverberation profiles which would be indicative of butt-splicing where the ends of two sections of audio meet (as can occur during editing, dependent on conditions) for either exhibit.

**Table 4: Critical Listening**

Feature	ExVideo1	ExVideo2
Content	<p>00:00:00 – 00:05:00 Broadband and vehicle engine noise</p> <p>00:05:00 – Broadband and vehicle engine noise slowly decay over approximately 20 seconds.</p> <p>Cloth against microphone movement throughout</p> <p>01:07:40 – Movement to a different environment</p> <p>Language switches between English and another language</p> <p>Beginning and ending consistent with capture using a concealed device (cloth against microphone noise indicating movement of device to start and stop recording).</p>	<p>Stereo capture.</p> <p>Appears to be of same event as audio evidence.</p>
Clicks and Pops	All explainable, inconsistent with butt-splicing	No
Signal Loss	No	No

Distortion	No	No
Instantaneous changes to the speaker to noise ratio	No	No
Instantaneous changes to background noise ratio	01:09:09, 01:09:11 - No signs of butt-splicing	No
Instantaneous changes to broadband noise	01:09:09, 01:09:11 - No signs of butt-splicing	No
Reverberation tail cut-offs	No	No
Instantaneous changes to speaker levels	No	No
Instantaneous changes to reverberation profile	No	No
Audible Clipping	No	No
Conversation Chronology	No issues in English speaking areas.	No issues
Consistency with purported environment/transmission channel	Consistent with low sample-rate perceptually encoded capture.	Consistent with mobile phone capture

**5.05 Filename Analysis**

The filenames of the exhibits are consistent with that of the reference recordings, in which the date and timing information pertaining to the region exported are provided.

Dates: VID\_20190506\_201705.mp4, VID\_20190506\_211010.mp4

Times: VID\_20190506\_201705.mp4, VID\_20190506\_211010.mp4

Tests performed during the creation of reference recordings showed the device and operating system take the time from the internal clock of the device at the time the recording ended, rather than began.



### 5.06 Format Analysis

The format details of the exhibits in comparison to the reference recording are documented in Table 5.

The video and audio codec used are both consistent with those found within the MPEG-4 container format for both exhibits.

The audio streams consist of two (2) channels, as indicated by 'Stereo', consistent with critical listening findings.

The format of the exhibits is consistent with the reference recordings in all aspects.

**Table 5: File Format**

Feature	ExVideo1	RefVideo1		ExVideo2	RefVideo2
Container format	MPEG-4	MPEG-4		MPEG-4	MPEG-4
<b>Video Stream</b>					
Codec	AVC/H264	AVC/H264		AVC/H264	AVC/H264
Resolution	1920x1080	1920x1080		1920x1080	1920x1080
Aspect Ratio	16:9	16:9		16:9	16:9
FPS	30.25	30.21		30.25	30.21
Bit rate	17344 kb/s	17118 kb/s		17339 kb/s	17118 kb/s
<b>Audio Stream</b>					
Codec	AAC (LC)	AAC (LC)		AAC (LC)	AAC (LC)
Bit rate mode	Variable	Variable		Variable	Variable
Sample rate	48000 Hz	48000 Hz		48000 Hz	48000 Hz
Channel configuration	Stereo	Stereo		Stereo	Stereo
Compression mode	Lossy	Lossy		Lossy	Lossy
Bit rate	191 kb/s	191 kb/s		192 kb/s	192 kb/s

**5.07 EXIF Analysis**

EXIF data is stored within multimedia file containers to provide information pertaining to the content. The presence of EXIF data is dependent on the software used to encode the recording.

The EXIF data from both exhibits are consistent with the reference recordings (Table 6 and 7). The only disparity is the presence of base name, file extension, file type description within ExVideo1. Without analysis of the capture device itself it is not possible to provide a reason for this, but it can be surmised that it is in relation to differences between the models of the capture device and the device used for the capture of reference recordings.

There is no disparity between the create date and modify date, consistent with no editing having occurred within the capture device.

Edits were made to the reference recordings to determine if the EXIF data changed when trimming was performed, resulting in create and modify dates of 00:00:00 00:00:00, inconsistent with the exhibit recordings.

**Table 6: ExVideo1 EXIF data**

Exhibit	ExVid1	RefVid1
File Name	VID_20190506_201705.mp4	VID_20190902_200821.mp4
File Size	1453 MB	1452 MB
File Type	MP4	MP4
File Type Extension	mp4	mp4
MIME Type	video/mp4	video/mp4
Major Brand	MP4 v2 [ISO 14496-14]	MP4 v2 [ISO 14496-14]
Minor Version	0.0.0	0.0.0
Compatible Brands	isom mp42	isom mp42
Movie Header Version	0	0

Create Date	2019:05:06 15:17:05	2019:09:02 19:08:21
Modify Date	2019:05:06 15:17:05	2019:09:02 19:08:21
Time Scale	1000	1000
Duration	00:11:43	00:11:43
Preferred Rate	1	1
Preferred Volume	100.00%	100.00%
Preview Time	0 s	0 s
Preview Duration	0 s	0 s
Poster Time	0 s	0 s
Selection Time	0 s	0 s
Selection Duration	0 s	0 s
Current Time	0 s	0 s
Next Track ID	3	3
Com Android Version	8.0.0	8.0.0
Track Header Version	0	0
Track Create Date	2019:05:06 15:17:05	2019:09:02 19:08:21
Track Modify Date	2019:05:06 15:17:05	2019:09:02 19:08:21
Track ID	1	1
Track Duration	00:11:43	00:11:43
Track Layer	0	0
Track Volume	0.00%	0.00%
Image Width	1920	1920
Image Height	1080	1080
Graphics Mode	srcCopy	srcCopy
Op Color	0 0 0	0 0 0
Compressor ID	avc1	avc1
Source Image Width	1920	1920
Source Image Height	1080	1080
X Resolution	72	72
Y Resolution	72	72

Bit Depth	24	24
Pixel Aspect Ratio	65536:65536	65536:65536
Color Representation	nclx 1 1 1	nclx 1 1 1
Video Frame Rate	30.251	30.208
Matrix Structure	1 0 0 0 1 0 0 0 1	1 0 0 0 1 0 0 0 1
Media Header Version	0	0
Media Create Date	2019:05:06 15:17:05	2019:09:02 19:08:21
Media Modify Date	2019:05:06 15:17:05	2019:09:02 19:08:21
Media Time Scale	48000	48000
Media Duration	00:11:43	00:11:43
Handler Type	Audio Track	Audio Track
Handler Description	SoundHandle	SoundHandle
Balance	0	0
Audio Format	mp4a	mp4a
Audio Channels	2	2
Audio Bits Per Sample	16	16
Audio Sample Rate	48000	48000
Movie Data Size	1.52E+09	1522059287
Movie Data Offset	810286	810286
Avg Bitrate	17.3 Mbps	17.3 Mbps
Base Name		VID_20190902_200821
File Extension		mp4
File Type Description		MPEG-4 video
Image Size	1920x1080	1920x1080
Megapixels	2.1	2.1
Rotation	90	0

**Table 7: ExVideo2 EXIF data**

Exhibit	ExVideo2	RefVid2
File Name	VID_20190506_211010.mp4	VID_20190902_195633.mp4
File Size	6.3 GB	6.3 GB
File Type	MP4	MP4
File Type Extension	mp4	mp4
MIME Type	video/mp4	video/mp4
Major Brand	MP4 v2 [ISO 14496-14]	MP4 v2 [ISO 14496-14]
Minor Version	0.0.0	0.0.0
Compatible Brands	isom mp42	isom mp42
Movie Data Size	6.72E+09	6715053140
Movie Data Offset	810286	810286
Movie Header Version	0	0
Create Date	2019:05:06 16:10:10	2019:09:02 18:56:33
Modify Date	2019:05:06 16:10:10	2019:09:02 18:56:33
Time Scale	1000	1000
Duration	00:51:43	00:51:43
Preferred Rate	1	1
Preferred Volume	100.00%	100.00%
Preview Time	0 s	0 s
Preview Duration	0 s	0 s
Poster Time	0 s	0 s
Selection Time	0 s	0 s
Selection Duration	0 s	0 s
Current Time	0 s	0 s
Next Track ID	3	3
Com Android Version	8.0.0	8.0.0
Track Header Version	0	0
Track Create Date	2019:05:06 16:10:10	2019:09:02 18:56:33

Track Modify Date	2019:05:06 16:10:10	2019:09:02 18:56:33
Track ID	1	1
Track Duration	00:51:43	00:51:43
Track Layer	0	0
Track Volume	0.00%	0.00%
Image Width	1920	1920
Image Height	1080	1080
Graphics Mode	srcCopy	srcCopy
Op Color	0 0 0	0 0 0
Compressor ID	avc1	avc1
Source Image Width	1920	1920
Source Image Height	1080	1080
X Resolution	72	72
Y Resolution	72	72
Bit Depth	24	24
Pixel Aspect Ratio	65536:65536	65536:65536
Color Representation	nclx 1 1 1	nclx 1 1 1
Video Frame Rate	30.252	30.208
Matrix Structure	1 0 0 0 1 0 0 0 1	1 0 0 0 1 0 0 0 1
Media Header Version	0	0
Media Create Date	2019:05:06 16:10:10	2019:09:02 18:56:33
Media Modify Date	2019:05:06 16:10:10	2019:09:02 18:56:33
Media Time Scale	48000	48000
Media Duration	00:51:43	00:51:43
Handler Type	Audio Track	Audio Track
Handler Description	SoundHandle	SoundHandle
Balance	0	0
Audio Format	mp4a	mp4a
Audio Channels	2	2
Audio Bits Per Sample	16	16

<b>Audio Sample Rate</b>	48000	48000
<b>Avg Bitrate</b>	17.3 Mbps	17.3 Mbps
<b>Base Name</b>	VID_20190506_211010	VID_20190902_195633
<b>File Extension</b>	mp4	mp4
<b>File Type Description</b>	MPEG-4 video	MPEG-4 video
<b>Image Size</b>	1920x1080	1920x1080
<b>Megapixels</b>	2.1	2.1
<b>Rotation</b>	90	90



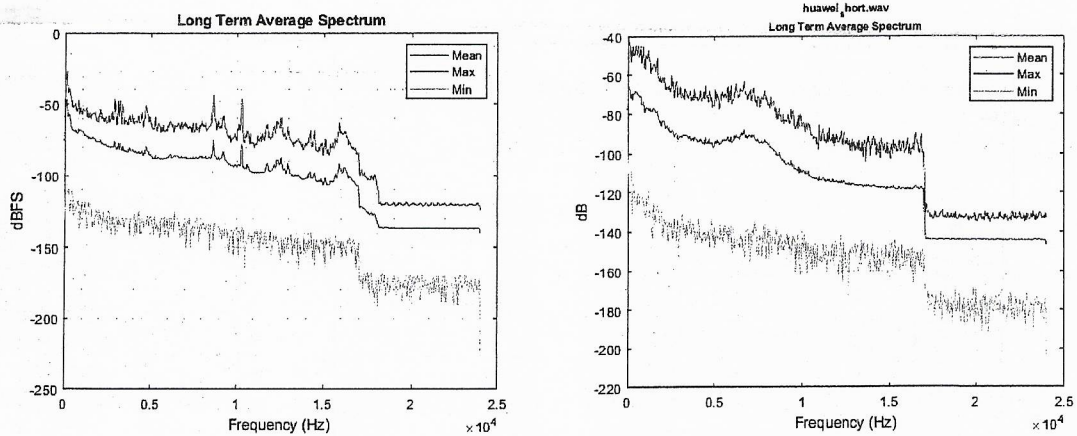


### 5.09 Spectrum Analysis

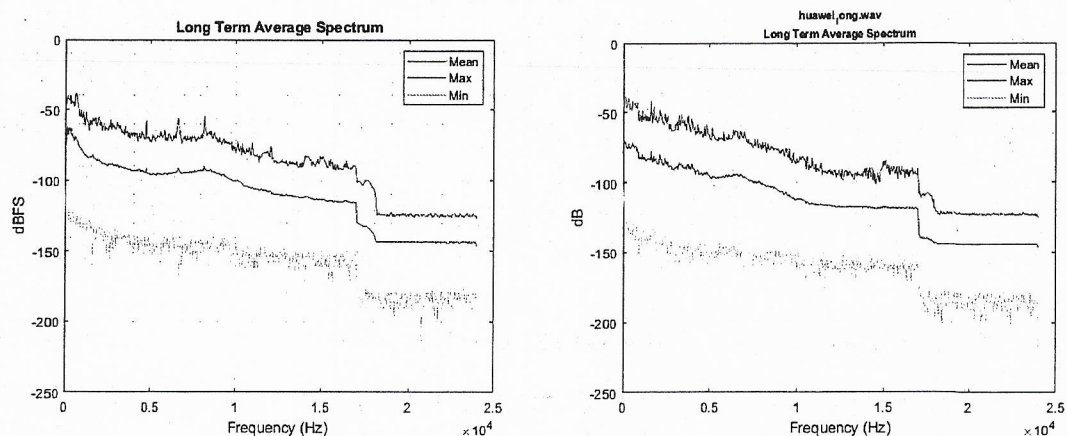
The mean, maximum and minimum Long-Term Average Spectrums of the exhibit and the reference recording are consistent in bandwidth, separation and anti-aliasing filtering (Fig. 6).

Anti-Aliasing filters are applied at a specific frequency during codec to remove any frequencies above the Nyquist point (half the sampling frequency) to ensure no artefacts due to aliasing occur. The frequency at which the filter is applied is codec dependent, and in this case, the exhibits are consistent with the reference recordings in this respect (Fig. 6 and 7). The difference in amplitude can be explained by the difference between the content of the exhibit and reference recordings.

**Figure 6: LTAS (Left: ExVideo1, Right RefVideo1)**

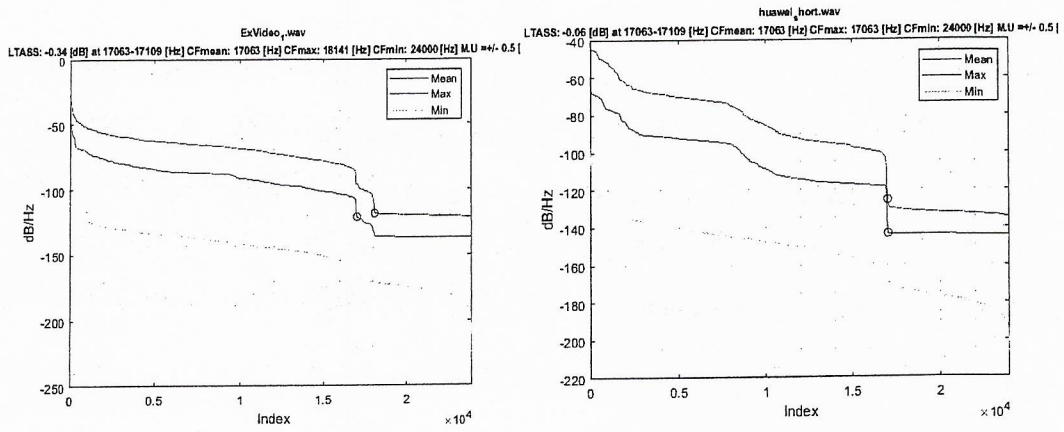


**Figure 7: LTAS (Left: ExVideo2, Right: RefVideo2)**

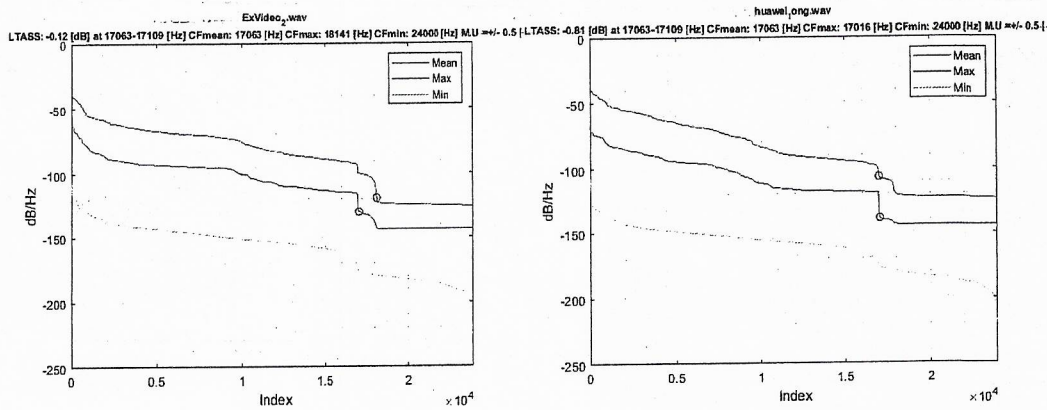


The consistency between the application of an anti-aliasing filter between the recordings is further evidenced when the Long-Term Average Sorted Spectrum is plotted (Fig. 8 and 9)

**Figure 8: Long Term Average Sorted Spectrum (Left: ExVideo1, Right RefVideo1)**

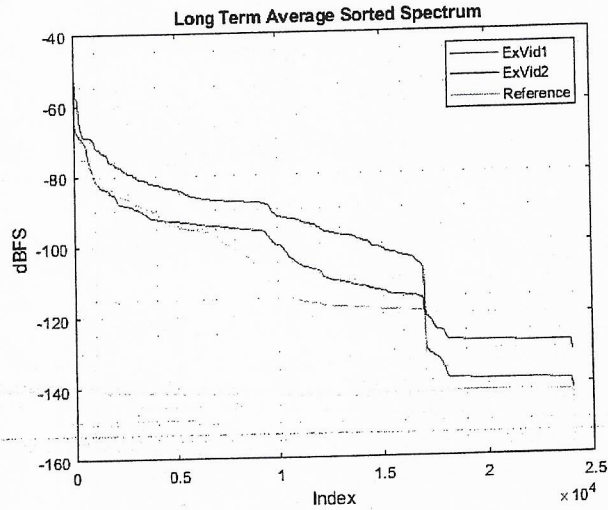


**Figure 9: Long Term Average Sorted Spectrum (Left: ExVideo2, Right: RefVideo2)**



The consistencies between the frequency response of the recordings become further visible when the mean of each is plotted within the same chart (Fig. 10). The difference in magnitude can be explained by differences in the amplitude of the speakers, the microphone position and the acoustic environment in which the exhibit and reference recordings were captured.

Figure 10: Left: Long Term Average Spectrum Comparison

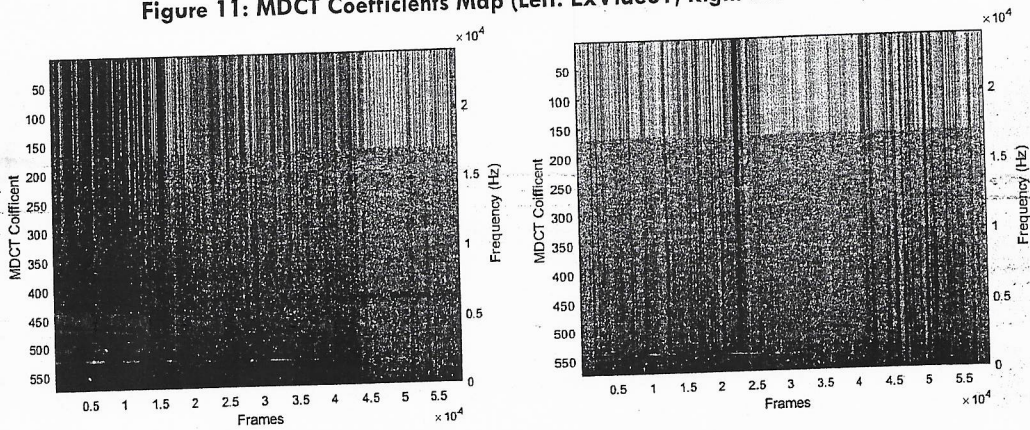


### 5.10 MDCT Analysis

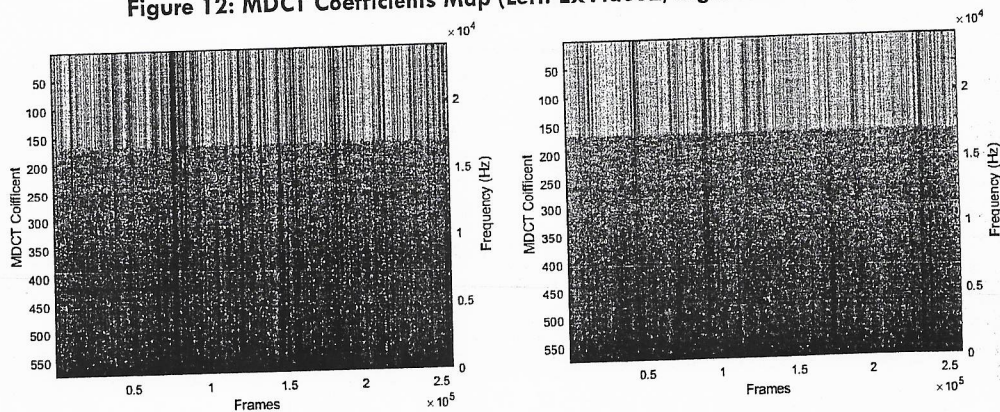
MDCT stands for Modified Discrete Cosine Transform and is used by the AAC codec to encode audio data for reduced file sizes. The distribution of the Coefficients can be visualised in the form of an MDCT coefficient Map, and different encoding formats will provide different distributions. This allows traces of other formats within the length of a recording to be visible, either in small sections or for the entirety of the recording.

In this case, the distribution of the MDCT coefficients is consistent between the exhibits and reference recordings (Fig. 11 and 12).

**Figure 11: MDCT Coefficients Map (Left: ExVideo1, Right RefVideo1)**



**Figure 12: MDCT Coefficients Map (Left: ExVideo2, Right RefVideo2)**

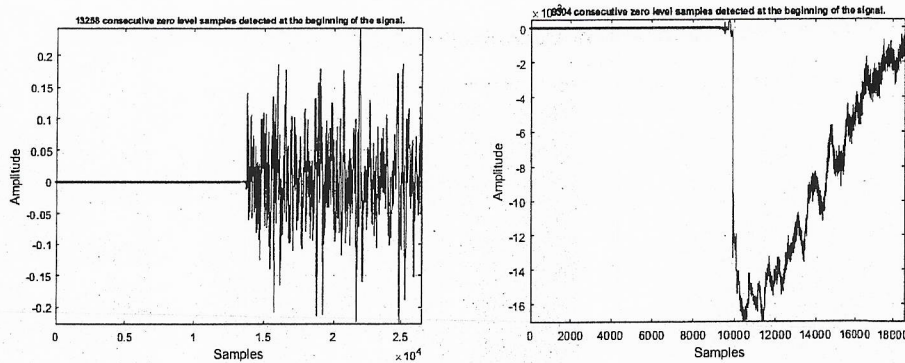


### 5.11 Zero Padding Analysis

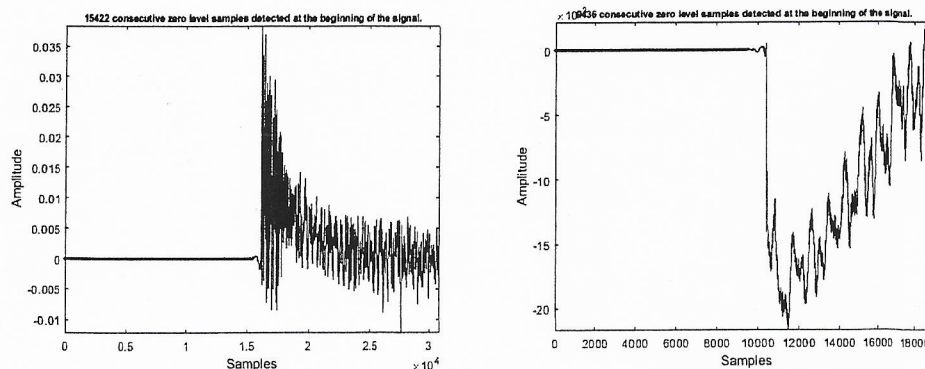
Consecutive zero samples at the beginning of a recording are often present on recordings that were originally compressed formats. Their importance is related to the encoding and decoding process, and specific codecs will use a specific number of zeros to ensure compatibility with other codecs. Comparison of the numbers of zero samples against reference recordings output by the software can, therefore, provide further information as to the consistency of said recording from the purported capture device.

In this case, 'ExVideo1' was padded with 13528 zero-value samples at the beginning of the recording as opposed to 9304 for 'ExRef1' (Fig. 13). 'ExVideo2' was padded with 15422 zero-value samples at the beginning of the recording as opposed to 9436 for 'ExRef2' (Fig. 14). The exhibits are therefore inconsistent with the reference recordings in this respect. Without analysis of the capture device itself it is not possible to provide a reason for this, but it can be surmised that it is in relation to differences between the models of the capture device and the device used for the capture of reference recordings.

**Figure 13: Zero Padding (Left: ExVideo1, Right RefVideo1)**



**Figure 14: Zero Padding (Left: ExVideo2, Right RefVideo2)**

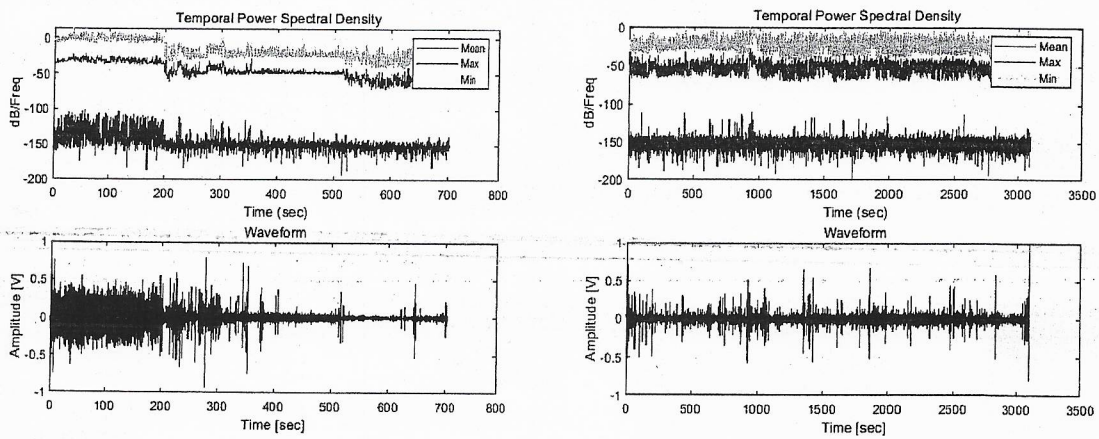


### 5.12 Power Spectral Density Analysis

Power Spectral Density analysis provides the energy of a signal in relation to frequency components and can be used to determine areas of signal loss and energy disparity within a recording.

In this case, there are no areas of signal loss at any point during the length of the recording (Fig. 15).

Figure 15: PSD (Left: ExVideo1, Right ExVideo2)

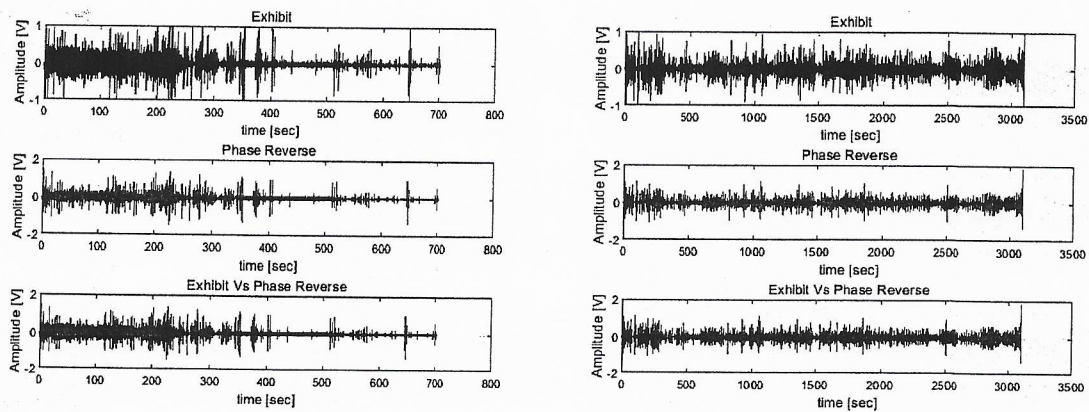


### 5.13 Reverse Phase Analysis

Reversing the phase of a signal essentially subtracts one channel from the other to reveal the difference in channel content. Original recordings which consist of two (2) channels would generally only be expected to do so if captured by two microphones, and hence would contain slightly different data, and as such would show differences when subtracted from one another. If an original recording is captured with a single microphone, only one channel of audio would be expected as it would be of no consequence to double this channel to two (2). Doing so would not add any new information and would increase the file size and hence reduce the number of recordings which could be stored on the device.

In this case, the exhibit recordings are true stereo (as indicated by the result of the subtraction, Fig. 16, centre plots). indicating it was captured with a stereo microphone configuration. This is consistent with the findings from the critical listening stage.

**Figure 16: Reverse Phase (Left: ExVideo1, Right ExVideo2)**



## 6 OPINION

The work instructed consisted of a single (1) stage, as defined by the points of instruction.

**Perform authentication examinations of two (2) exhibits to opine on questions raised by the instructing party.**

These examinations resulted in four (4) conclusions:

- 1. It is my opinion, based on the analysis performed in this examination, that the exhibit entitled 'VID\_20190506\_201705.mp4' is consistent with an original recording.**

This is based on the following premises:

- Exhibit file header consistent with an original recording;
- Exhibit file name consistent with an original recording;
- LTAS consistent with an original recording;
- LTASS consistent with an original recording;
- File container consistent with an original recording;
- File structure consistent with an original recording;
- Audio codec consistent with an original recording;
- Sample rate consistent with an original recording;
- Bit-rate mode consistent with an original recording;
- Create date matches modify date within EXIF data;
- Channel configuration consistent with an original recording;
- MDCT Coefficient distribution consistent with an original recording;
- No instances of signal loss throughout the recording, consistent with an original recording.



2. It is my opinion, based on the analysis performed in this examination, that the exhibit entitled 'VID\_20190506\_211010.mp4' is consistent with an original recording.

This is based on the following premises:

- Exhibit file header consistent with an original recording;
- Exhibit file name consistent with an original recording;
- LTAS consistent with an original recording;
- LTASS consistent with an original recording;
- File container consistent with an original recording;
- File structure consistent with an original recording;
- Audio codec consistent with an original recording;
- Sample rate consistent with an original recording;
- Bit-rate mode consistent with an original recording;
- Create date matches modify date within EXIF data;
- Channel configuration consistent with an original recording;
- MDCT Coefficient distribution consistent with an original recording;
- No instances of signal loss throughout the recording, consistent with an original recording.

3. Although the metadata of the exhibits contains information relating to the time of capture, it is my opinion, based on the analysis performed in this examination, that this information cannot be verified.

This is based on the followed premises:

- The exhibit was not captured with the device provided;
- Temporal information is taken from the date-time settings of the capture device;
- Date-time settings can be changed by a user before a capture is performed;
- The purported capture device was not made available.

4. No opinion can be given on the serial number of the device used to capture the original recording.

This is based on the following premises:

- Video files do not generally store serial number information;
- There are no traces of the serial number within the exhibit metadata.

## 7 STATEMENTS AND DECLARATIONS

I, JAMES ZJALIC, DECLARE THAT:

I understand that my duty is to help the court to achieve the overriding objective by giving independent assistance by way of objective, unbiased opinion on matters within my expertise, both in preparing reports and giving oral evidence. I understand that this duty overrides any obligation to the party by whom I am engaged or the person who has paid or is liable to pay me. I confirm that I have complied with and will continue to comply with that duty.

I confirm that I have not entered into any arrangement where the amount or payment of my fees is in any way dependent on the outcome of the case.

I know of no conflict of interest of any kind, other than any which I have disclosed in my report.

I do not consider that any interest which I have disclosed affects my suitability as an expert witness on any issues on which I have given evidence.

I will advise the party by whom I am instructed if, between the date of my report and the trial, there is any change in circumstances which affect my answers to points 3 and 4 above.

I have shown the sources of all information I have used.

I have exercised reasonable care and skill in order to be accurate and complete in preparing this report.

I have endeavoured to include in my report those matters, of which I have knowledge or of which I have been made aware, that might adversely affect the validity of my opinion. I have clearly stated any qualifications to my opinion.

I have not, without forming an independent view, included or excluded anything which has been suggested to me by others including my instructing lawyers.

I will notify those instructing me immediately and confirm in writing if for any reason my existing report requires any correction or qualification.

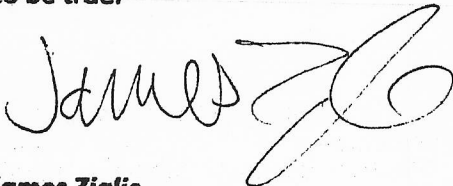
I understand that:

1. my report will form the evidence to be given under oath or affirmation;
2. the court may at any stage direct a discussion to take place between experts;
3. the court may direct that, following a discussion between the experts, a statement should be prepared showing those issues which are agreed and those issues which are not agreed, together with the reasons;
4. I may be required to attend court to be cross-examined on my report by a cross-examiner assisted by an expert.
5. I am likely to be the subject of public adverse criticism by the judge if the Court concludes that I have not taken reasonable care in trying to meet the standards set out above.

I have read Part 19 of the Criminal Procedure Rules and I have complied with its requirements.

I confirm that I have acted in accordance with the Association of Chief Police Officers (ACPO) Good Practice Guide for Digital Evidence version 5.

I confirm that the contents of this report are true to the best of my knowledge and belief and that I make this report knowing that, if it is tendered in evidence, I would be liable to prosecution if I have wilfully stated anything which I know to be false or that I do not believe to be true.



**James Zjalic**

**Media Forensics Consultant**

## APPENDIX 1 – GLOSSARY OF TERMS

Due to the technical nature of multimedia forensics, it is accepted that there will be terms used within an expert report that appear unfamiliar to the reader. The following glossaries are therefore intended to assist by defining these terms.

**Authentication:** The process of substantiating that the data is an accurate representation of what it purports to be.

**Critical Viewing:** Viewing of imagery using a 4K resolution monitor to look for visual artefacts within the image contents.

**DVR:** Digital Video Recorder. A device used for the capture of a CCTV system.

**EXIF:** Exchangeable Image File Format, used for the storage of metadata pertaining to the multimedia.

**Format analysis:** Analysis of the hex data upon which files are built. Through offset comparisons with other files produced by the same device, it can be determined if the image is authentic and detailed information can also be found in the human-readable ASCII conversion of the hex data.

**Structure analysis:** Analysis of EXIF data within the file structure and can provide detailed information such as GPS coordinates, camera type, camera settings, and more.

**Proprietary Format:** A format which cannot be readily played with ubiquitous software and requires a specific codec to allow the stream to be decoded.

**Structure Analysis:** Analysis of the recordings file structure, including the header and footer. Different software structure the data in different ways and any differences within the file structure can be indicative of being saved out of different software.

**APPENDIX 2 – CONCLUSION SCALE**

Due to the myriad of possibilities, devices and formats, there is no current statistical model to report results, so all are related to an exhibits consistency with an original recording. The result must be determined subjectively by the examiner based on the results of the analyses performed.

The scale of conclusions proposed and used by this company is documented below.

Analyses results	Verbal conclusion
<p>All analyses show the exhibit to be consistent with one captured using the purported device (or method if no information in relation to such is available).</p> <p>No signs of manipulation.</p>	<p>'Exhibit is <u>consistent with an original recording</u>.'</p>
<p>At least one (1) analysis shows the exhibit to be inconsistent with one captured with the purported device (or method if no information in relation to such is available).</p> <p>No signs of manipulation.</p>	<p>'Exhibit is <u>inconsistent with an original recording</u>. With that being said, there are <u>no signs of manipulation within the length of the exhibit</u>.'</p> <p>(‘Within the length of the exhibit’ is used when it is not possible to opine on whether the exhibit is a section extracted from a longer recording.)</p>
<p>At least one analysis shows the recording to be inconsistent with one (1) captured with the purported device (or method if no information in relation to such is available).</p> <p>At least one (1) analysis shows the recording has been edited.</p>	<p>'Exhibit is <u>inconsistent with an original recording</u>. Further to that, it is <u>consistent with one which has undergone manipulation</u>.'</p>
<p>At least one (1) artefact which can be consistent with editing, but may also have an innocent cause for which the cause cannot be determined.</p>	<p>'It is <u>not possible to provide a conclusion</u> due to a number of <u>artefacts for which the cause cannot be determined</u>.'</p> <p>(In this case the artefact/s and possible reasons for such are documented. If further analysis is possible with more information, the exhibits required for this are documented.)</p>

### APPENDIX 3 – TOOLS

All work took place on a forensic workstation running a Microsoft Windows 10 Operating System displayed on a single 43 inch, 4K Resolution monitor.

Critical Listening was performed using Beyerdynamic DT770 Pro Headphones and a Focusrite Scarlett 2i2 Interface.

Specific software and its application during the analysis featured in this report are documented in the table below.

Software	Version	Task
Adobe Acrobat	Version 2018.11.2038	Report output
Cellebrite 4PC	7.18.0.199	Extract data from phones
Cellebrite Physical Analyser	7.19.0.130	Analysis of mobile phone image
Jacksum	Version 1.7.0	Calculation of hash sum
Microsoft Word	2016	Documentation
HXD	1.7.7.0	File structure analysis
Mathworks Matlab	2018B	Content analysis
ExifTool	11.43	Metadata analysis
FFprobe	4.1	Format analysis
Pot Player	1.7.19955	Critical Viewing

**APPENDIX 4 – EXHIBITS REVIEWED**

The following is a list of the exhibits reviewed during the work documented within this report to ensure a chain of custody is maintained and to aid in transparency in relation to the exhibits which may have influenced any conclusions reached.

Exhibit	Make	Model	Serial Number	Date Provided
Mobile Phone	Samsung	Samsung SM-N950F	R58JA3SBXKA	15/08/2019

The following are considered the pertinent video exhibits extracted from the device:

Filename: VID\_20190506\_201705.mp4

SHA1: 97dbf6ad30361065eff32a6ff786aad152b50e74

Filename: VID\_20190506\_211010.mp4

SHA1: 44a2ba8eff013153dec21a4a7b6c419e4a5901d7



## APPENDIX 5 – BIBLIOGRAPHY

### Company Guidance

Mobile Phone Logical Acquisition Standard Operating Procedure

Audio Authentication Standard Operating Procedure

Video Authentication Standard Operating Procedure

### Best Practice Guidance

ACPO, "Good Practice Guide for Digital Evidence." 2012.

SWGDE, "Digital and Multimedia Evidence Glossary Version 3.0." 20-Jun-2016.

SWGDE, "Best Practices for Forensic Audio." 08-Oct-2016.

SWGIT, "Best Practices for Image Authentication." 2013.

SWGIT, "Best Practices For Forensic Video Analysis," Version 1.0, Jan. 2009.

SWGDE, "Technical Overview of Digital Video Files," Version 1.0, Jul. 2017.

SWGDE, "Best Practices For Mobile Phone Forensics" Feb-2013

ENFSI, "Guidelines for Best Practice in the Forensic Examination of Digital Media." Apr-2009.

NIST, " Guidelines on Mobile Device Forensics" May 2014.

### Multimedia Forensics Theory

John C. Russ, *Forensic Uses of Digital Imaging*. CRC Press, 2001.

Hany Farid, *Photo Forensics*. London: MIT Press, 2016.

Anthony T.S Ho and Shujun Li, *Handbook of Digital Forensics and Multimedia Data Devices*.

UK: John Wiley & Sons, Ltd, 2015.

Vlado Damjanovski, *CCTV: From light to pixels*, 3rd Edition. Elsevier, 2014.

Spencer Ledesma, "A Proposed Framework for image enhancement," University of Colorado, Denver, 2015.

John Watkinson, *The Art of Digital Video*, 4th Edition. Focal Press, 2008.

Keith Jack, *Video Demystified*, 4th Edition. Newnes, 2005.

J. Randolph Hall, "MPEG-4 Video Authentication using File Structure and Metadata," University of Colorado, Denver, 2015.

Gregory Wales, "Proposed Framework for Digital Video Authentication," University of Colorado, Denver, 2019.

### **Mobile Phone Forensics Theory**

Heather Mahalik, Satish Bommisetty, Rohit Tamma, "Practical Mobile Forensics" May 2016.

**APPENDIX 6 – EXAMINER EXPERIENCE AND QUALIFICATIONS**

## Professional Experience:

- 500+ Multimedia Forensic examinations;
- Member of a team performing research as part of the MEDIFOR project, funded by the US Air Force and DARPA;
- Professional Field Advisor to Foclar, a forensic imagery software developer.

## Certificates and Qualifications:

- Media Forensics MSc - National Centre for Media Forensics, Denver, CO, USA;
- Sound Engineering BSc (1<sup>st</sup> Class Hons) - Birmingham City University, Birmingham, UK;
- Blackbag Certified Mobilyze Operator (CMO).

## Published, Presented, and Participated Research:

- Detection of In-App Apple Voice Memos Edits through Extrapolation Artifacts – Paper, AES Audio Forensics 2019 (Porto, Portugal);
- iPhone Video Metadata: What Can it Teach Us About a Recordings History? – Research Presentation, AAFS Annual Conference 2018 (Baltimore, MD, USA);
- A Proposed Image Authentication Triage, Chartered Society of Forensic Science Autumn Conference, Northampton (Nov 2018);
- European Network of Forensic Science Institutes (ENFSI) Facial Comparison Inter-Laboratory Proficiency Tests 2018 (June 2018);
- A Proposed Audio Enhancement Framework for Forensic Purposes – Research Presentation, AAFS Annual Conference 2018 (Seattle, WA, USA);
- A Proposed Forensic Audio Enhancement Framework – MSc Thesis, 2017;
- A Low Cost, Cloud-Based, Portable ENF System – Research Paper, AES Audio Forensics 2017 (Arlington, VA);
- Determining Dimension Specific Information for Monaural Sound Recordings – Research Poster, AES Audio Forensics 2017 (Arlington, VA);
- Medifor Project – DARPA (Department of Advanced Research Project Agency, USA).

## Member of the Following Organisations:

- Audio Engineering Society;
- American Academy of Forensic Science;
- The Chartered Society of Forensic Science;
- International Association of Identification.

## Security Clearances

- UK Security Clearance;
- UK Non-Police Personnel Vetting, Level 3.

## Parliamentary Published Evidence:

- Admissibility of Forensic Image Comparison Evidence (House of Lords Select Committee, Oct 2018).

## Conferences and Continuing Education:

- Audio Engineering Society Audio Forensics Conference (Porto, June 2019);
- Cognitive Bias Essentials: The Use and Abuse of Expert Evidence: How to Expose and Mitigate Bias in Experts (Webinar, March 2019);
- Signal Processing with MATLAB Training Course (Mathworks Headquarters, Cambridge, March 2019);
- Forensic Multimedia Authentication: Real Life Challenges and Solutions Workshop (AAFS 2019, Baltimore, 2019);
- American Academy of Forensic Science Annual Conference (Baltimore, Feb 2019);
- Chartered Society of Forensic Sciences Autumn Conference (Northampton, November 2018);
- Bond Solon Criminal Law and Procedure (Manchester, September 2018);
- Bond Solon Cross Examination (Manchester, September 2018);
- Chartered Society of Forensic Sciences Standard Operating Procedure Workshop (July 2018);
- Bond Solon Witness Familiarisation (Manchester, June 2018);
- Bond Solon Excellence in Report Writing (Manchester, June 2018);

- Media Forensics Seminar for the Legal Profession (Presenter, Birmingham, March 2018);
- Forensic Image Processing Workshop (AAFS 2018, Seattle, Feb 2018);
- American Academy of Forensic Science Annual Conference (Seattle, Feb 2018);
- AES Audio Forensics Conference (Arlington, June 2017);
- American Academy of Forensic Science Annual Conference (New Orleans, Feb 2017);
- American Academy of Forensic Science Annual Conference (Las Vegas, Feb 2016).

Published Articles:

- Imagery Forensics in 2019 (Digital Forensics Magazine, Aug 2019);
- Attack of The Clones: A.I. in Media Forensics (Digital Forensics Magazine, Aug 2018);
- True Crimes: Why Forensic Audio Isn't Audio Engineering (Sound on Sound Magazine, June 2018);
- Charlatans in Digital Forensics (Forensic Focus, Jan 2018);
- The CSI Effect: Limitations Vs. Expectations (Forensic Focus, Nov 2017);
- Iron Bars, Cement and Super Glue (Forensic Focus, Sept 2017);
- When No Conclusion is a Conclusion: Facial Comparison (Forensic Focus, Aug 2017);
- Audio Forensics in 2017 (Digital Forensics Magazine, Aug 2017);
- The Future of ENF Systems (Forensic Focus, Aug 2017).

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