Digital Forensics
Lecture Week 5

Hex View of Data
File Metadata

Nelson – Ch 8

Readings

- In December 2012, anti-virus programmer John McAfee was arrested in Guatemala while fleeing from persecution in Belize, over the border.
- Vice (magazine) had published an exclusive interview with McAfee "on the run" that included a photo of McAfee with a Vice reporter taken with an iPhone 4S smart phone.
- The photo's metadata included GPS coordinates locating McAfee in Guatemala, and he was captured two days later.

The Panama papers

The Panama Papers was a collection of leaked documents that showed the Pakistani prime minister had a large fortune that exceed what he got legitimately.

A team was set up to determine where the money came from, so he gave them a document that appeared to show that the money had been acquired through legitimate methods.

The issue was the font used in the document was Microsoft Calibri, a font that was released to the public in 2007 but the document's date was 2006.

Objectives

- To look at Disk Bytes as Hex
- To understand metadata
- To examine image metadata
- To examine file metadata
- To examine metadata in some documents
- To understand hashing

Hex Editors

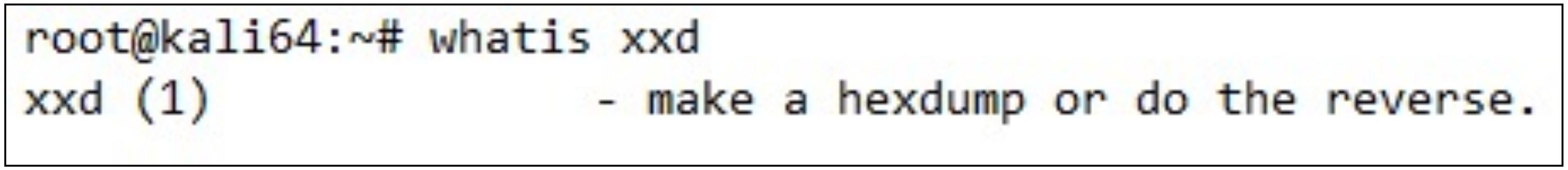
- Editor apps expect the file to contain certain coding
- Notepad expects ascii (txt)
- WordPad expects rich text (rtf)
- Open Office expects open document format (odt)
- MS Word expects Office XML (docx)
- How do we read raw data? (no coding at all)
- In particular, disk sectors
- We need a Hex Editor

Hex Editors

- We Use Hxd
- Edits disk sectors, memory and files of any size
- http://mh-nexus.de/en/hxd/
- There is also WinHex (paid)
- http://www.x-ways.net/winhex/
- Notepad++ can also edit hex
- http://notepad-plus-plus.org/
- http://en.wikipedia.org/wiki/Hex_editor

Hex Viewers

- In Linux use xxd

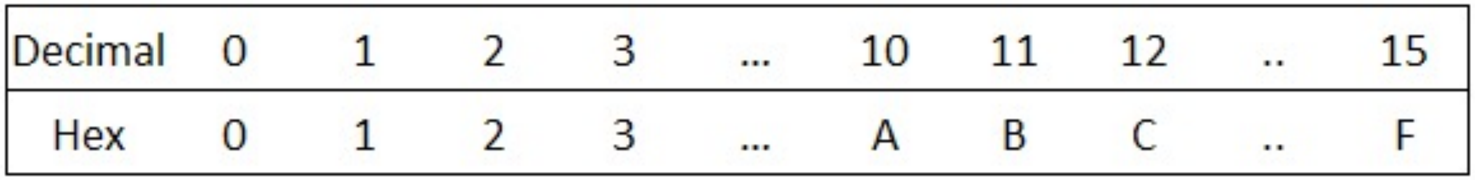


```
root@kali64:~# whatis xxd
xxd (1)              - make a hexdump or do the reverse.
```

- There are other hex viewer tools
- There are python versions

Hex Displays

- The unit of data is the byte – 8 bits
- This can contain $2^8 = 256$ combinations
- These combinations can be represented in base 16 notation (Hex)

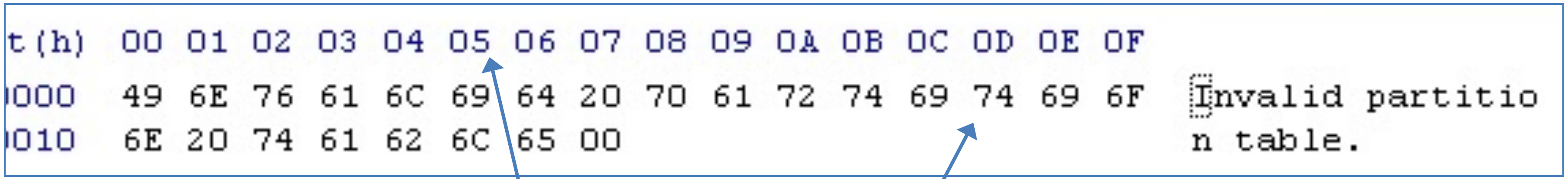


Decimal	0	1	2	3	...	10	11	12	..	15
Hex	0	1	2	3	...	A	B	C	..	F

- So the range of data 0 – 255 is now 00 – FF in Hex

The Hex view of data

- By using a hex editor, we see data as hex



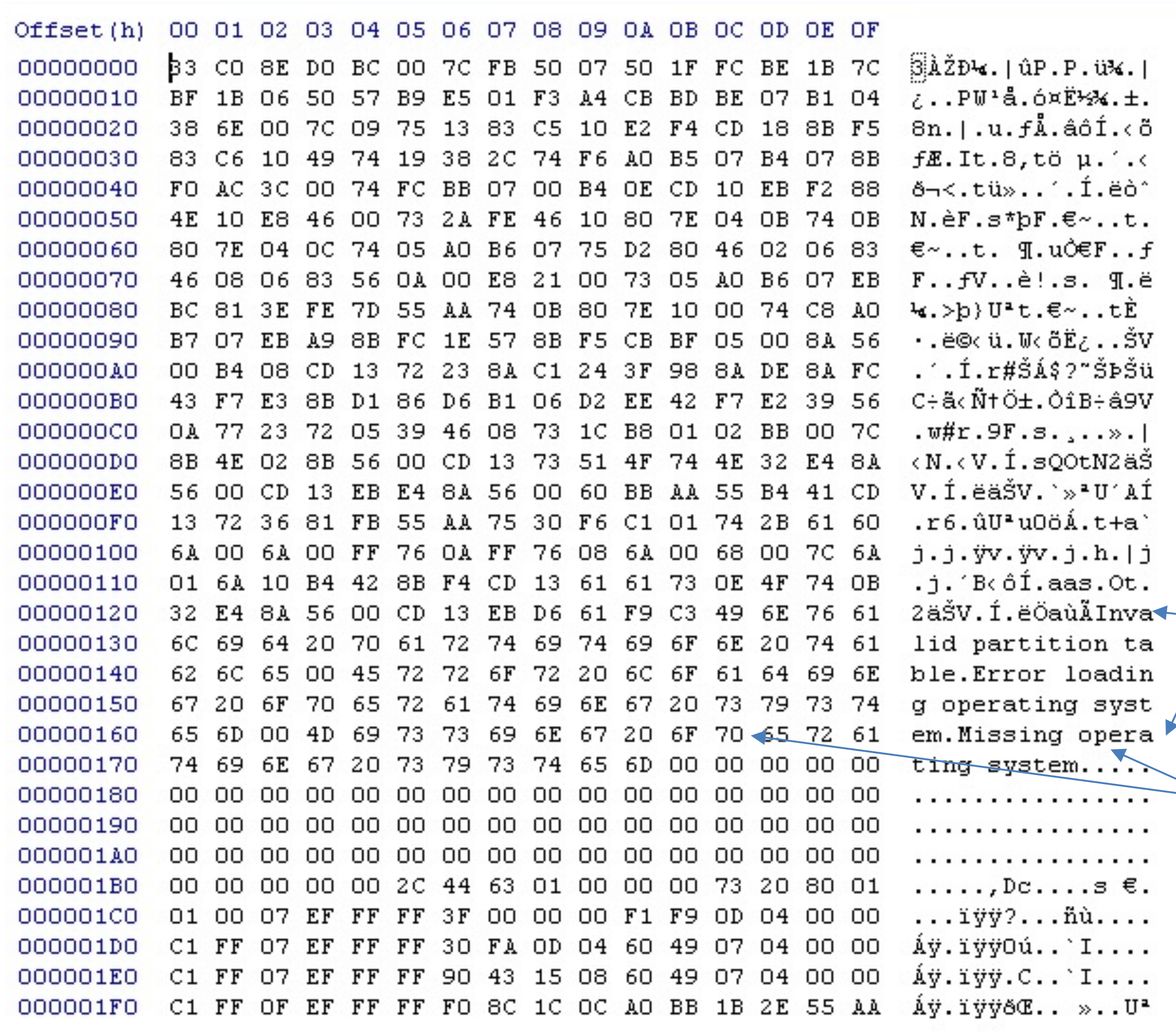
```
t(h)  00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F
)000  49 6E 76 61 6C 69 64 20 70 61 72 74 69 74 69 6F   Invalid partitio
)010  6E 20 74 61 62 6C 65 00                           n table.
```

- The data address (or location) is in hex
- The data value (or content) is also in hex
- We express the content in a way that has the most meaning, here it is an error message
- hex → ascii → error message

Hex Displays #2

- To display 256 bytes we use a 16 x 16 array
- In Hex this is a (00 – 0F) x (00 - F0) array
- To display 512 bytes we use a 16 x 32 array
- In Hex this is a (00 – 0F) x (000 - 1F0) array
- The hex editor will usually display an ascii view as well

Sample 512 byte Hex Display



```
Offset(h)  00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00000000   33 C0 8E D0 BC 00 7C FB 50 07 50 1F FC BE 1B 7C   3ÀŽÐ¼.|ûP.P.ü¾.|
00000010   BF 1B 06 50 57 B9 E5 01 F3 A4 CB BD BE 07 B1 04   ¿..PW¹å.ó¤Ë½¾.±.
00000020   38 6E 00 7C 09 75 13 83 C5 10 E2 F4 CD 18 8B F5   8n.|.u.ƒÅ.âôÍ.‹õ
00000030   83 C6 10 49 74 19 38 2C 74 F6 A0 B5 07 B4 07 8B   ƒÆ.It.8,tö µ.´.‹
00000040   F0 AC 3C 00 74 FC BB 07 00 B4 0E CD 10 EB F2 88   ð¬<.tü»..´.Í.ëòˆ
00000050   4E 10 E8 46 00 73 2A FE 46 10 80 7E 04 0B 74 0B   N.èF.s*þF.€~..t.
00000060   80 7E 04 0C 74 05 A0 B6 07 75 D2 80 46 02 06 83   €~..t. ¶.uÒ€F..ƒ
00000070   46 08 06 83 56 0A 00 E8 21 00 73 05 A0 B6 07 EB   F..ƒV..è!.s. ¶.ë
00000080   BC 81 3E FE 7D 55 AA 74 0B 80 7E 10 00 74 C8 A0   ¼.>þ}Uªt.€~..tÈ
00000090   B7 07 EB A9 8B FC 1E 57 8B F5 CB BF 05 00 8A 56   ·.ë©‹ü.W‹õË¿..ŠV
000000A0   00 B4 08 CD 13 72 23 8A C1 24 3F 98 8A DE 8A FC   .´.Í.r#ŠÁ$?˜ŠÞŠü
000000B0   43 F7 E3 8B D1 86 D6 B1 06 D2 EE 42 F7 E2 39 56   C÷ã‹Ñ†Ö±.ÒîB÷â9V
000000C0   0A 77 23 72 05 39 46 08 73 1C B8 01 02 BB 00 7C   .w#r.9F.s.¸..».|
000000D0   8B 4E 02 8B 56 00 CD 13 73 51 4F 74 4E 32 E4 8A   ‹N.‹V.Í.sQOtN2äŠ
000000E0   56 00 CD 13 EB E4 8A 56 00 60 BB AA 55 B4 41 CD   V.Í.ëäŠV.`»ªU´AÍ
000000F0   13 72 36 81 FB 55 AA 75 30 F6 C1 01 74 2B 61 60   .r6.ûUªu0öÁ.t+a`
00000100   6A 00 6A 00 FF 76 0A FF 76 08 6A 00 68 00 7C 6A   j.j.ÿv.ÿv.j.h.|j
00000110   01 6A 10 B4 42 8B F4 CD 13 61 61 73 0E 4F 74 0B   .j.´B‹ôÍ.aas.Ot.
00000120   32 E4 8A 56 00 CD 13 EB D6 61 F9 C3 49 6E 76 61   2äŠV.Í.ëÖaùÃInva
00000130   6C 69 64 20 70 61 72 74 69 74 69 6F 6E 20 74 61   lid partition ta
00000140   62 6C 65 00 45 72 72 6F 72 20 6C 6F 61 64 69 6E   ble.Error loadin
00000150   67 20 6F 70 65 72 61 74 69 6E 67 20 73 79 73 74   g operating syst
00000160   65 6D 00 4D 69 73 73 69 6E 67 20 6F 70 65 72 61   em.Missing opera
00000170   74 69 6E 67 20 73 79 73 74 65 6D 00 00 00 00 00   ting system.....
00000180   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
00000190   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
000001A0   00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
000001B0   00 00 00 00 00 2C 44 63 01 00 00 00 73 20 80 01   .....,Dc....s €.
000001C0   01 00 07 EF FF FF 3F 00 00 00 F1 F9 0D 04 00 00   ...ïÿÿ?...ñù....
000001D0   C1 FF 07 EF FF FF 30 FA 0D 04 60 49 07 04 00 00   Áÿ.ïÿÿ0ú..`I....
000001E0   C1 FF 07 EF FF FF 90 43 15 08 60 49 07 04 00 00   Áÿ.ïÿÿ.C..`I....
000001F0   C1 FF 0F EF FF FF F0 8C 1C 0C A0 BB 1B 2E 55 AA   Áÿ.ïÿÿðŒ.. »..Uª
```

256 Bytes 00 – F0

256 Bytes 00 – FF

ascii

70 = p

Address:
16C
160 xor 00C

Objectives

- To use Linux tools on Windows
- To understand metadata
- To look at Disk Bytes as Hex
- To examine image metadata
- To examine file metadata
- To examine metadata in some documents
- To understand hashing

Data

- What is data?
  - a collection of facts
- Examples
  - Numbers
  - Words
  - Measurements
  - Observations
  - Descriptions
- Presented as
  - Qualitative (description)
  - Quantitative (number)
  - Discrete (limited values)
  - Continuous (a range)
- What is Metadata?
  - Data about the data

Metadata examples

- Images
  - Author, Location, camera type
- Files
  - Dates, author, size, folder path
- Email
  - Source ip, server, dates,
- NTFS Disks
  - Dates, update count
- Phone calls
  - Duration, location

Metadata

- The purpose of Metadata is to support the data
  - Camera metadata helps image editing apps
- Metadata can be physical or electronic
- Metadata can be indexed for searching
  - The book library ISBN
- Metadata can be scrubbed from documents
  - Law firm reports for clients
- Collecting metadata will leave a metadata trace
  - See Locard Week 2

Metadata #2

- Structural metadata describes the data container
  - How the data is structured
  - An example is the Tag:Value pair
- Descriptive metadata describes individual instances
  - the data content of this data sample is “city":"Chatswood"
- Administrative Metadata describes how the data is used
  - Origin, Category, Access rights
- This week we will look at metadata in files
- We will start with graphic files

Objectives

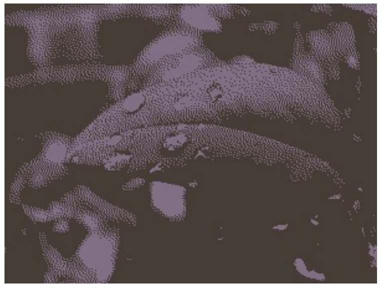
- To look at Disk Bytes as Hex
- To understand metadata
- To examine image metadata
- To examine file metadata
- To examine metadata in some documents
- To understand hashing

Graphic formats

- Pictures (images) can be saved as a file
- There are two ways to do this
- Bitmap – dots (pixels) as a 2D array
- Vector Graphics – define shapes such as lines (length + direction)
- Bitmap editors – MS paint, Photoshop, gimp
- Vector editors – CorelDraw, adobe illustrator
- Bitmap viewers – MS Office
- Vector viewers – pdf-Xchange, Adobe Reader

Graphic files

- Black and White Bitmaps have one bit per pixel.
- A 640x480 pixel image requires 307200 bits = 0.37MB
- Real colour has 24 colour bits for each pixel.
- A real colour 640x480 image needs 7.37 MB
- A vector graphic of a simple image is much smaller than the pixel version.



https://en.wikipedia.org/wiki/Color_depth

Scaling images

- Bitmap files do not scale.
- Increasing the number of bits using an editor does not increase the image quality – the image looks pixelated
- Decreasing the number of bits loses information.
- Vector files scale well.
- You can scale a full stop dot up to fill a page and it still has a perfect round circumference with no pixelation

Graphic compression

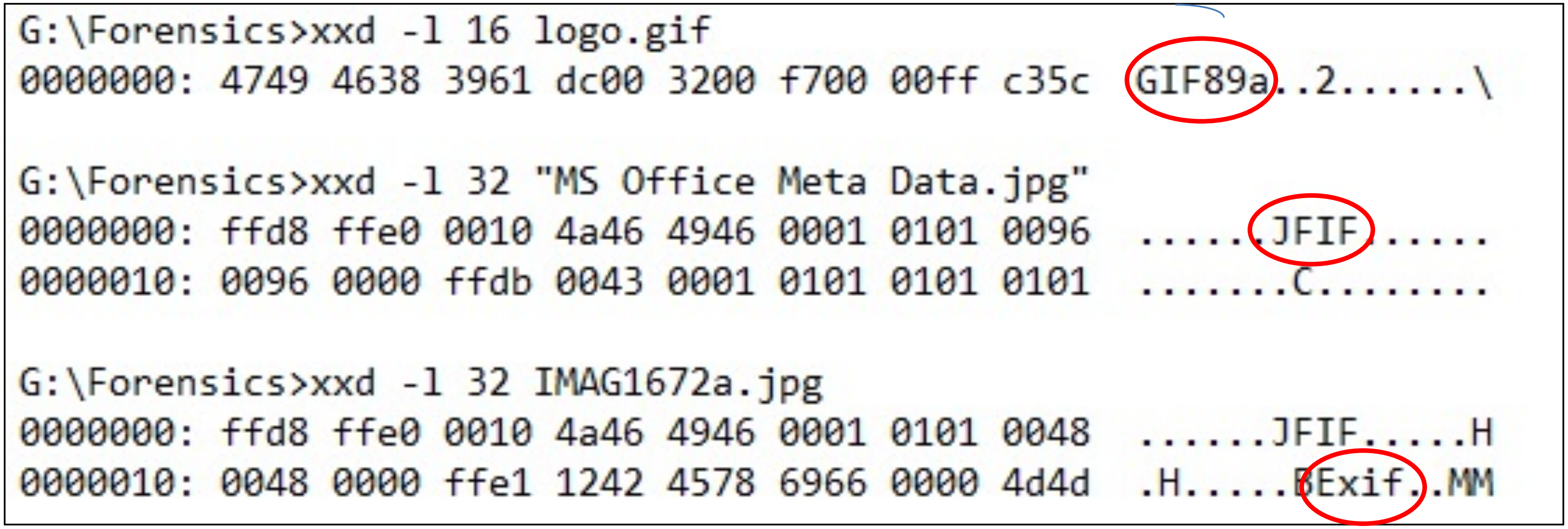
- Graphic compression is like text compression
- Consider a green line of length 100 bits.
- Instead of recording in the file 100 green bits
- we record one green bit and a x 100 instruction
- Some compression is lossless
- Uncompressing retrieves the original
- Some compression is lossy
- Uncompressing retrieves only part of the original.

Graphic file types

- Pixels
  - BMP – no compression, large and lossless, windows
  - TIFF – tagged bitmap, large and lossless
  - GIF , PNG – simple graphics, 8 bit colour
  - JPEG, JPG – small and lossy, used to share photos
  - EXIF – Combines jpeg and tiff for camera metadata
- Vectors
  - SVG – open standard that includes scripting

Graphic File hex signature tags

- A graphic file often has an identifying tag near the start

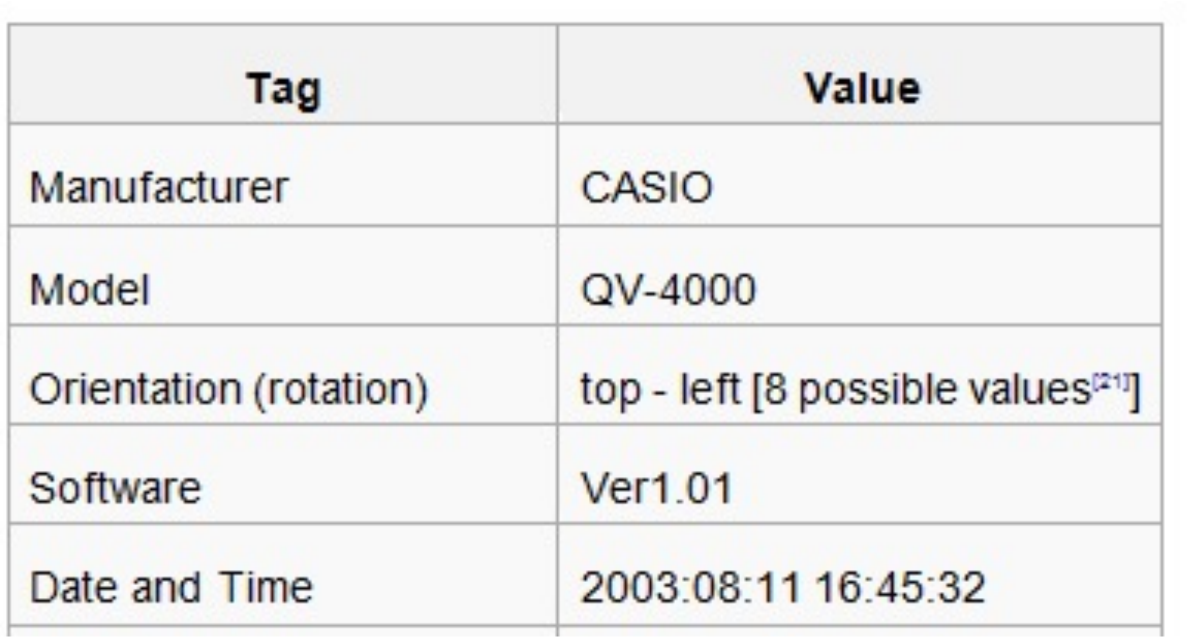


```
G:\Forensics>xxd -l 16 logo.gif
0000000: 4749 4638 3961 dc00 3200 f700 00ff c35c  GIF89a..2......\

G:\Forensics>xxd -l 32 "MS Office Meta Data.jpg"
0000000: ffd8 ffe0 0010 4a46 4946 0001 0101 0096  ......JFIF......
0000010: 0096 0000 ffdb 0043 0001 0101 0101 0101  .......C........

G:\Forensics>xxd -l 32 IMAG1672a.jpg
0000000: ffd8 ffe0 0010 4a46 4946 0001 0101 0048  ......JFIF.....H
0000010: 0048 0000 ffe1 1242 4578 6966 0000 4d4d  .H.....BExif..MM
```

Objectives

- To look at Disk Bytes as Hex
- To understand metadata
- To examine image metadata
- To examine file metadata
- To examine metadata in some documents
- To understand hashing

Metadata sample – Camera image



Tag	Value
Manufacturer	CASIO
Model	QV-4000
Orientation (rotation)	top - left [8 possible values[21]]
Software	Ver1.01
Date and Time	2003:08:11 16:45:32

Forensics and metadata

- How does the metadata get captured?
- Where is it stored?
- What is the data structure?
- Does it have tag = value pairs?
- What are the tag codes?
- What forensic tools are available?
- What are the current forensic issues?

File Analysis

- A three step process
- #1 Recover any hidden/encrypted/deleted files
  - Look for secret disks
  - Look for secret partitions
  - Look for secret files

File Analysis #2

- #2 Recover basic file system information
  - file system type, metadata location, sector size
  - number of partitions, partition size
  - we use the Sleuthkit tools - mmls, fsstat (see later)
- #3 Recover mismatched file information
  - where the file header does not match the file extension
  - we use the file command on each file
  - file requires a magic file; listing all known file types

file extensions

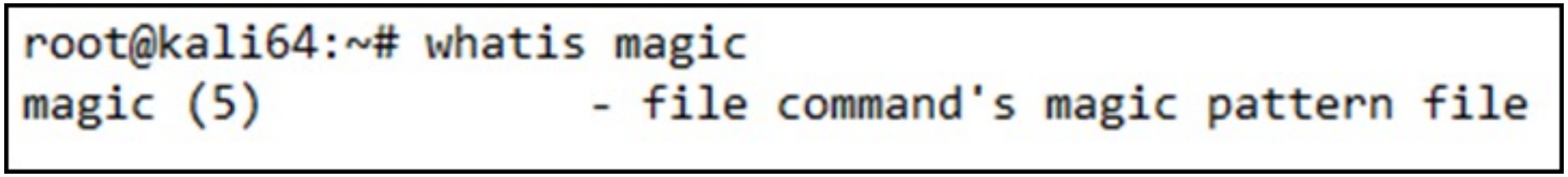
- What happens when you click on Trade_Secrets.txt?
- by magic the notepad program is loaded and handed the file to open
- How does an operating system know which program to associate with a file?
- The file name extension is used (.txt above) kept in the registry
- What if a suspect alters an extension?
  - trojan.exe → cars.txt
- by more magic, forensics can expose this forgery

magic files

- Many file formats have headers with metadata
  - file authoring
  - camera files have camera settings, gps location, etc
- As there are many file types, there are many headers
- To simplify all this, magic numbers evolved
- Originally these were two bytes at the start of the file
- The identifiers are now stored in a separate magic file

- http://en.wikipedia.org/wiki/File_format#Magic_number

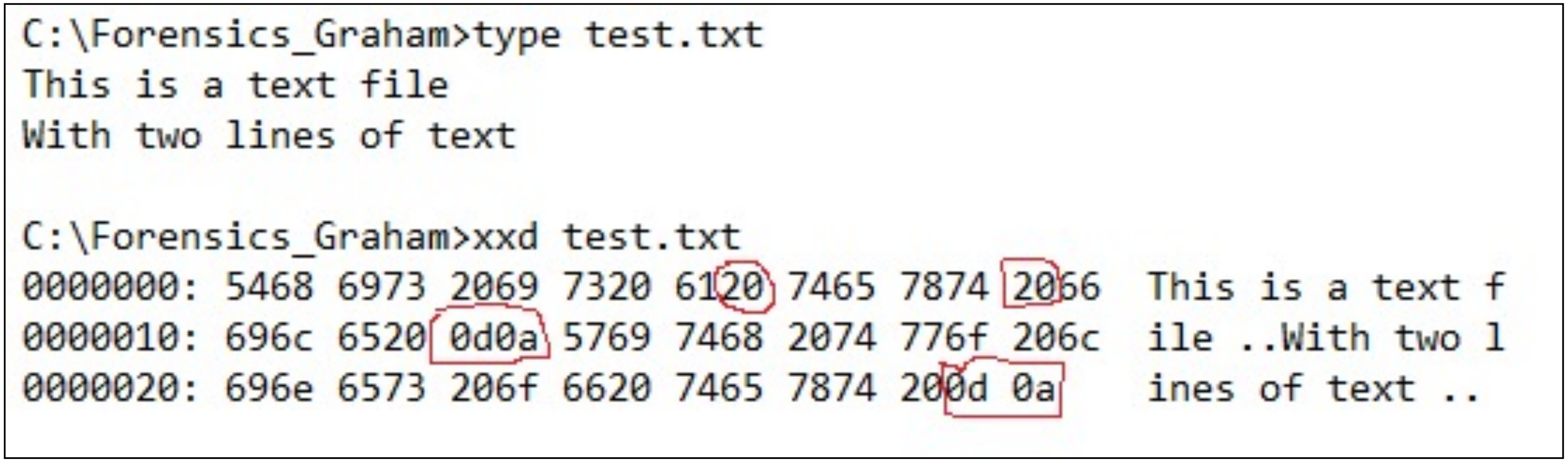
magic files #2



```
root@kali64:~# whatis magic
magic (5)            - file command's magic pattern file
```

- The magic patterns are found in /usr/share/misc/magic
- each file type signature is described as a comment

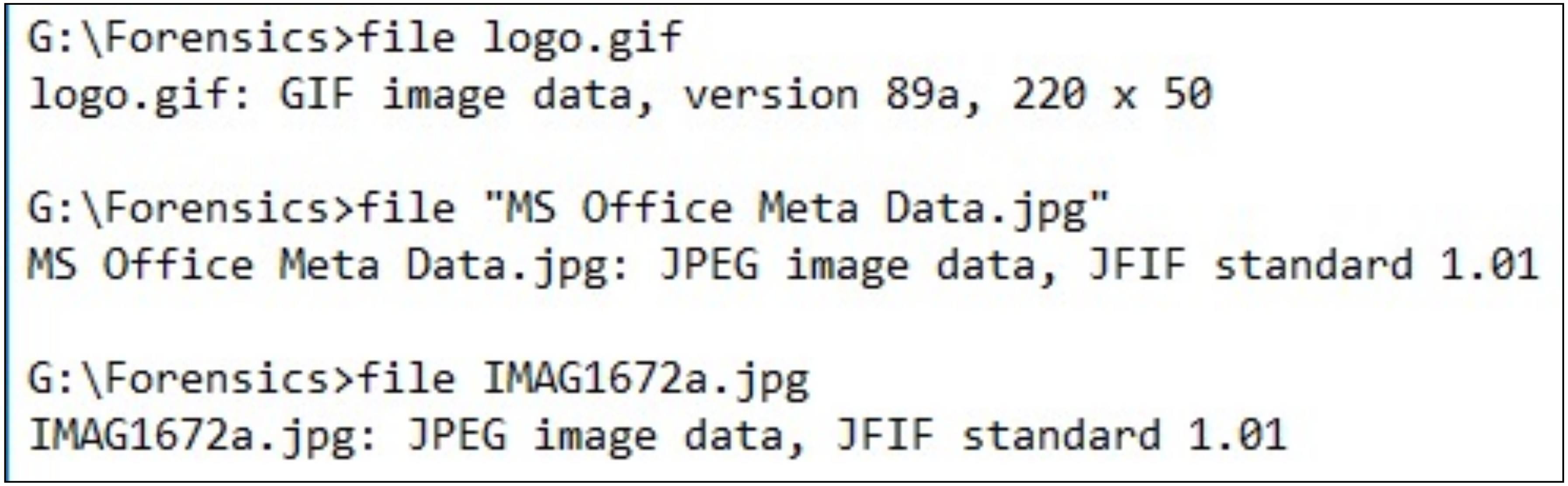
magic file examples – text file



```
C:\Forensics_Graham>type test.txt
This is a text file
With two lines of text

C:\Forensics_Graham>xxd test.txt
0000000: 5468 6973 2069 7320 6120 7465 7874 2066  This is a text f
0000010: 696c 6520 0d0a 5769 7468 2074 776f 206c  ile ..With two l
0000020: 696e 6573 206f 6620 7465 7874 200d 0a    ines of text ..
```

- 20 = space
- 0D= Carriage Return (CR), 0A = Line Feed (LF) / new line
- The End of Line marker (EOL) is 0D0A in Windows
- This text file ends with a single EOL

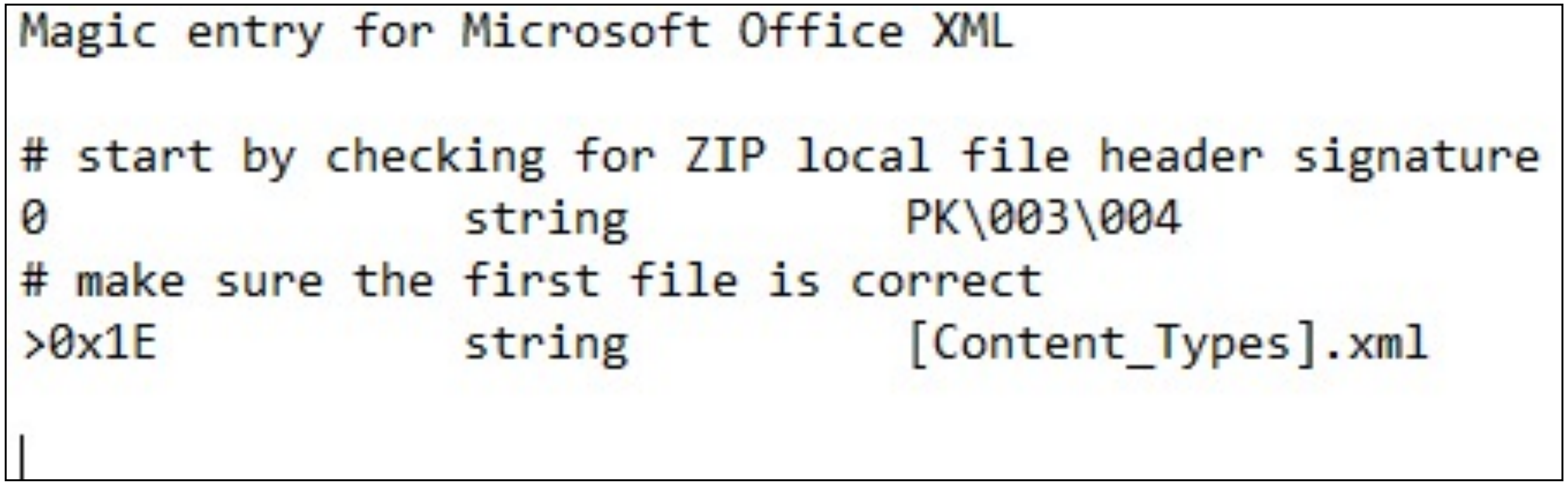
magic file examples – graphic files



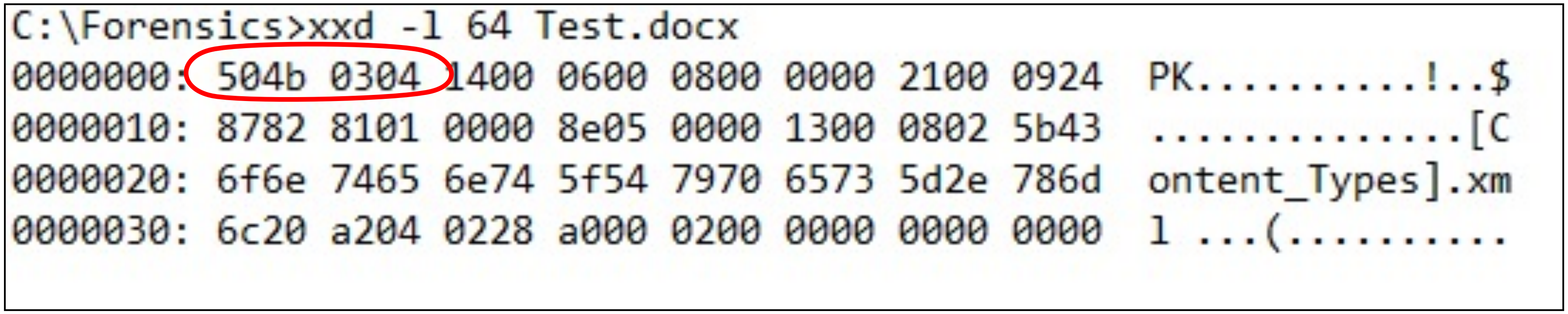
```
G:\Forensics>file logo.gif
logo.gif: GIF image data, version 89a, 220 x 50

G:\Forensics>file "MS Office Meta Data.jpg"
MS Office Meta Data.jpg: JPEG image data, JFIF standard 1.01

G:\Forensics>file IMAG1672a.jpg
IMAG1672a.jpg: JPEG image data, JFIF standard 1.01
```

- the exif in the last file is not shown

magic file example – MS Word

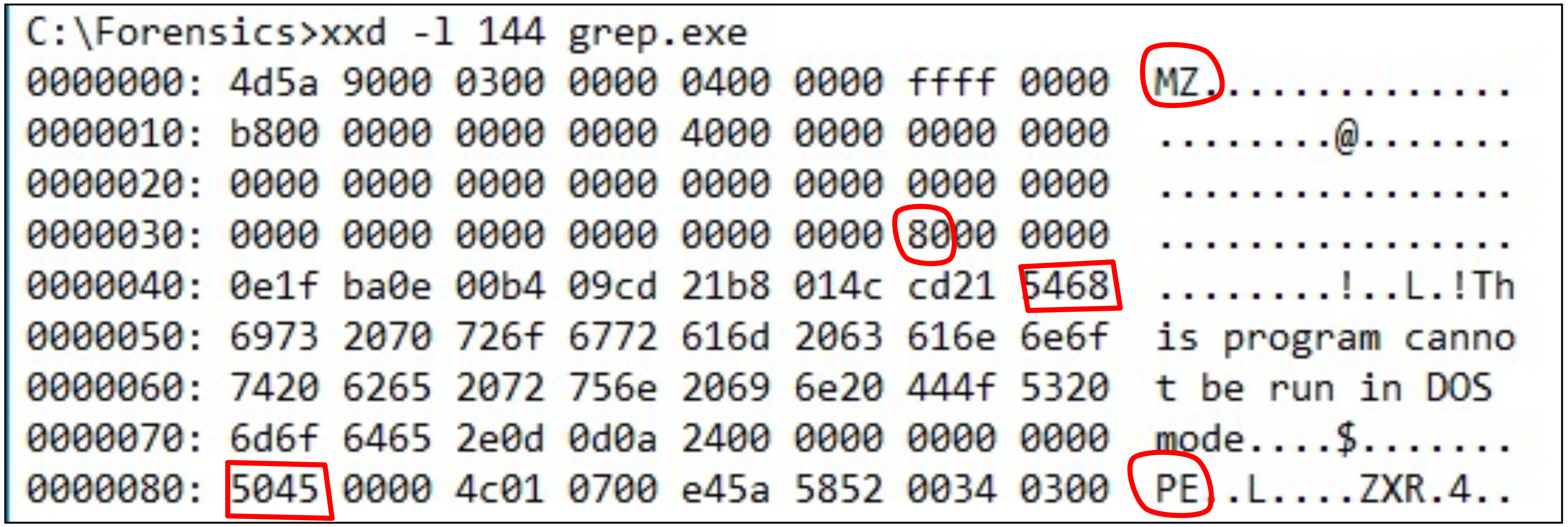


```
Magic entry for Microsoft Office XML

# start by checking for ZIP local file header signature
0               string          PK\003\004
# make sure the first file is correct
>0x1E           string          [Content_Types].xml
```



```
C:\Forensics>xxd -l 64 Test.docx
0000000: 504b 0304 1400 0600 0800 0000 2100 0924  PK..........!..$
0000010: 8782 8101 0000 8e05 0000 1300 0802 5b43  ..............[C
0000020: 6f6e 7465 6e74 5f54 7970 6573 5d2e 786d  ontent_Types].xm
0000030: 6c20 a204 0228 a000 0200 0000 0000 0000  l ...(..........
```

magic file example – Windows Executable

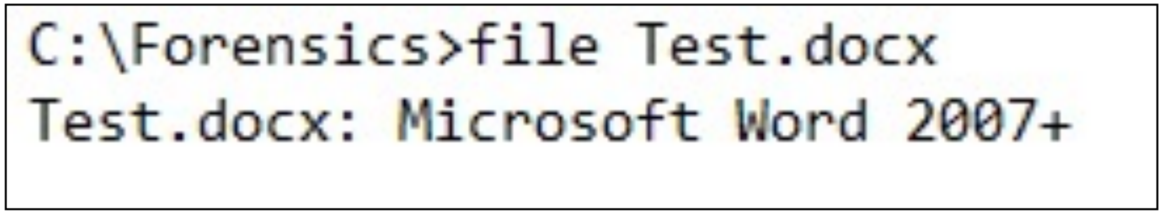


```
C:\Forensics>xxd -l 144 grep.exe
0000000: 4d5a 9000 0300 0000 0400 0000 ffff 0000  MZ..............
0000010: b800 0000 0000 0000 4000 0000 0000 0000  ........@.......
0000020: 0000 0000 0000 0000 0000 0000 0000 0000  ................
0000030: 0000 0000 0000 0000 0000 0000 8000 0000  ................
0000040: 0e1f ba0e 00b4 09cd 21b8 014c cd21 5468  ........!..L.!Th
0000050: 6973 2070 726f 6772 616d 2063 616e 6e6f  is program canno
0000060: 7420 6265 2072 756e 2069 6e20 444f 5320  t be run in DOS
0000070: 6d6f 6465 2e0d 0d0a 2400 0000 0000 0000  mode....$.......
0000080: 5045 0000 4c01 0700 e45a 5852 0034 0300  PE..L....ZXR.4..
```

- MZ at 00
- Jump to (80) at 3C (compiler dependant)
- DOS ascii text message at 4D
- PE (Portable Executable) at or after 80 (compiler dep)

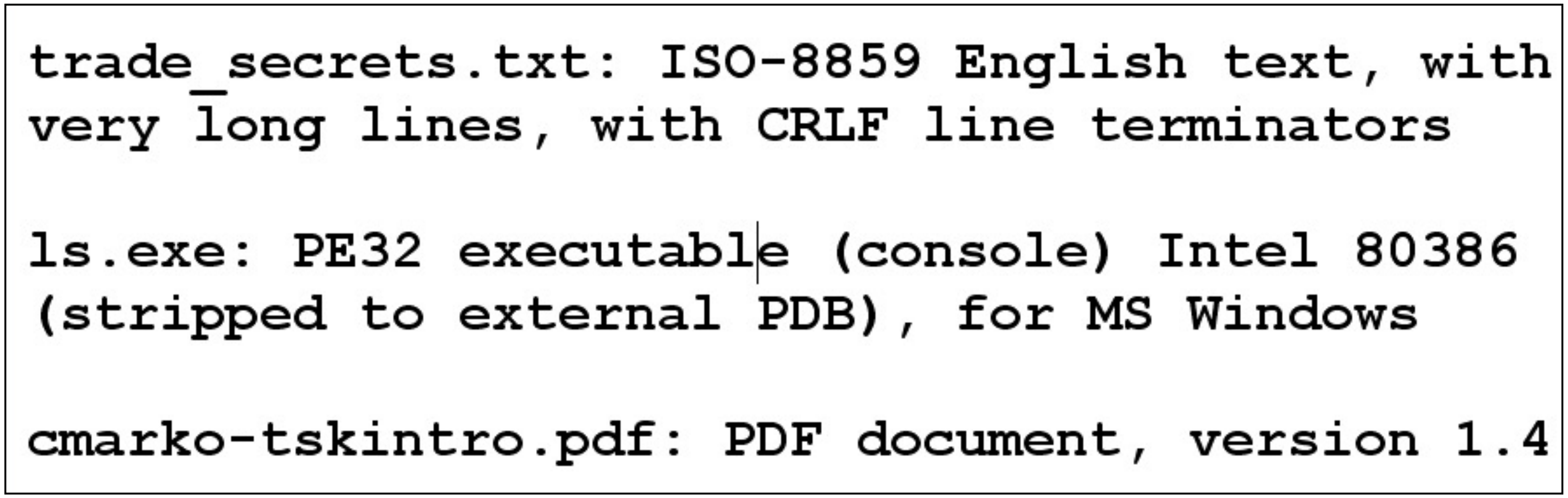
The file file

- In Linux, the magic file is accessed using file



```
C:\Forensics>file Test.docx
Test.docx: Microsoft Word 2007+
```

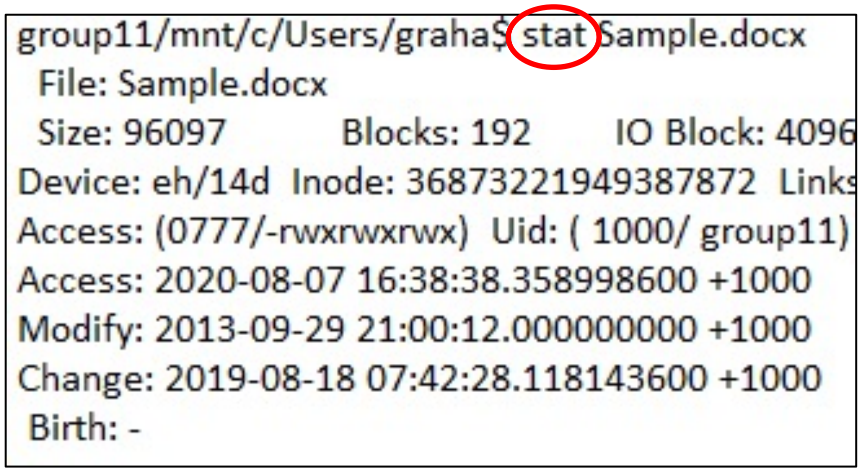
- file *   # list all files



```
trade_secrets.txt: ISO-8859 English text, with
very long lines, with CRLF line terminators

ls.exe: PE32 executable (console) Intel 80386
(stripped to external PDB), for MS Windows

cmarko-tskintro.pdf: PDF document, version 1.4
```

File Date/Time

- In Linux you can stat a file to see the three date/time stamps



```
group11/mnt/c/Users/graha$ stat Sample.docx
  File: Sample.docx
  Size: 96097          Blocks: 192        IO Block: 4096
Device: eh/14d  Inode: 3687322194938787 2  Links
Access: (0777/-rwxrwxrwx)  Uid: ( 1000/ group11)
Access: 2020-08-07 16:38:38.358998600 +1000
Modify: 2013-09-29 21:00:12.000000000 +1000
Change: 2019-08-18 07:42:28.118143600 +1000
 Birth: -
```

- However in Linux a suspect can touch a file to change one or more of these date/time stamps
- However the file header may also contain another date/time stamp as metadata
  - this may be missed by the suspect using touch

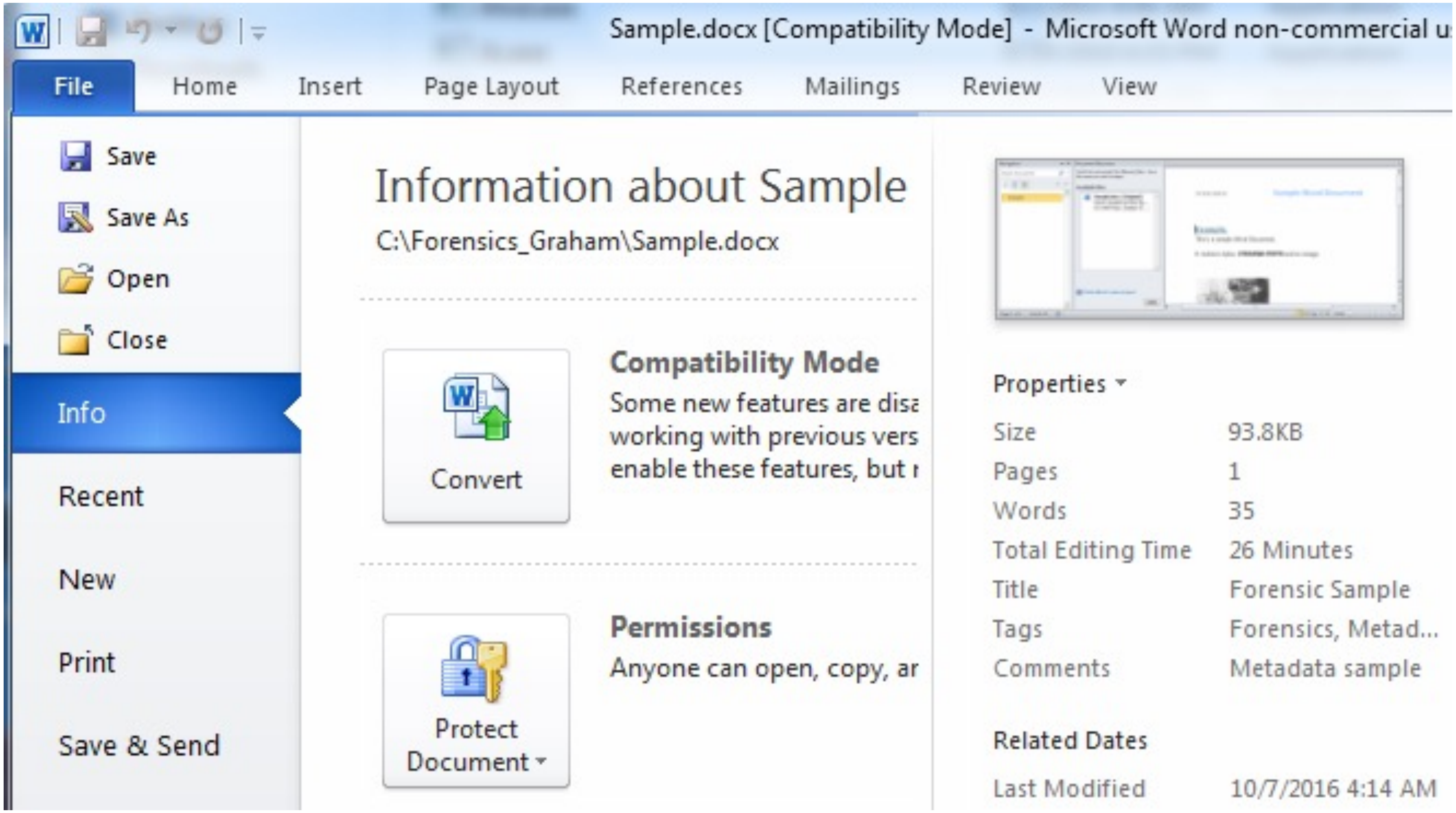
Objectives

- To look at Disk Bytes as Hex
- To understand metadata
- To examine file metadata
- To examine metadata in some documents
- To understand hashing

MS Office Files

- MS Office files are three xml zipped files
  - examine with the 7-zip tool.
- app.xml
  - application properties, such as page count
- core.xml
  - author, date altered, print date
- word/media
  - contains any images
- See Readings

docx metadata in MS Word



Information about Sample

C:\Forensics_Graham\Sample.docx

Compatibility Mode

Some new features are disa
working with previous vers
enable these features, but r

Permissions

Anyone can open, copy, ar

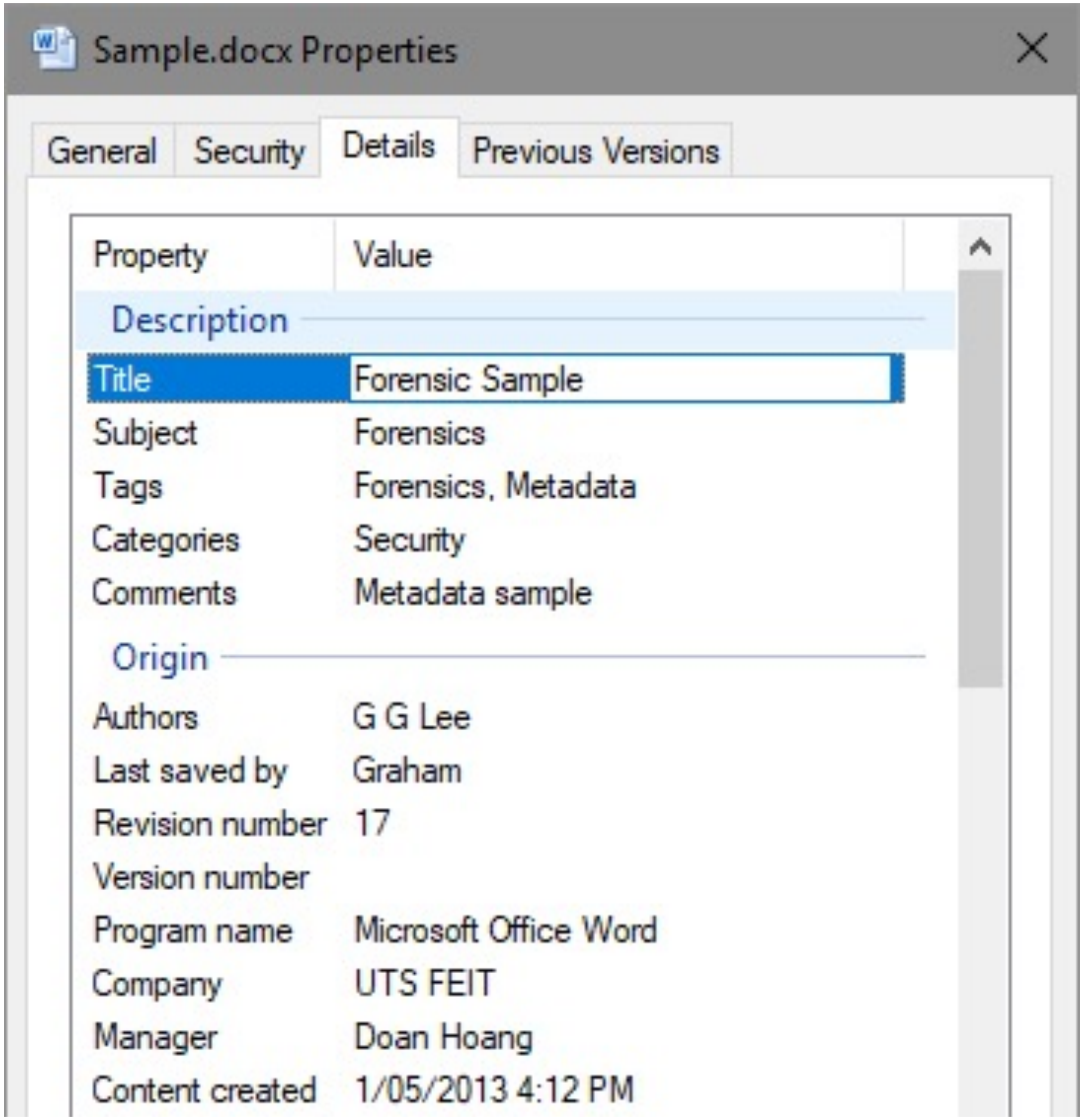
Properties

Size	93.8KB
Pages	1
Words	35
Total Editing Time	26 Minutes
Title	Forensic Sample
Tags	Forensics, Metad...
Comments	Metadata sample

Related Dates

Last Modified	10/7/2016 4:14 AM

docx metadata in Win 10



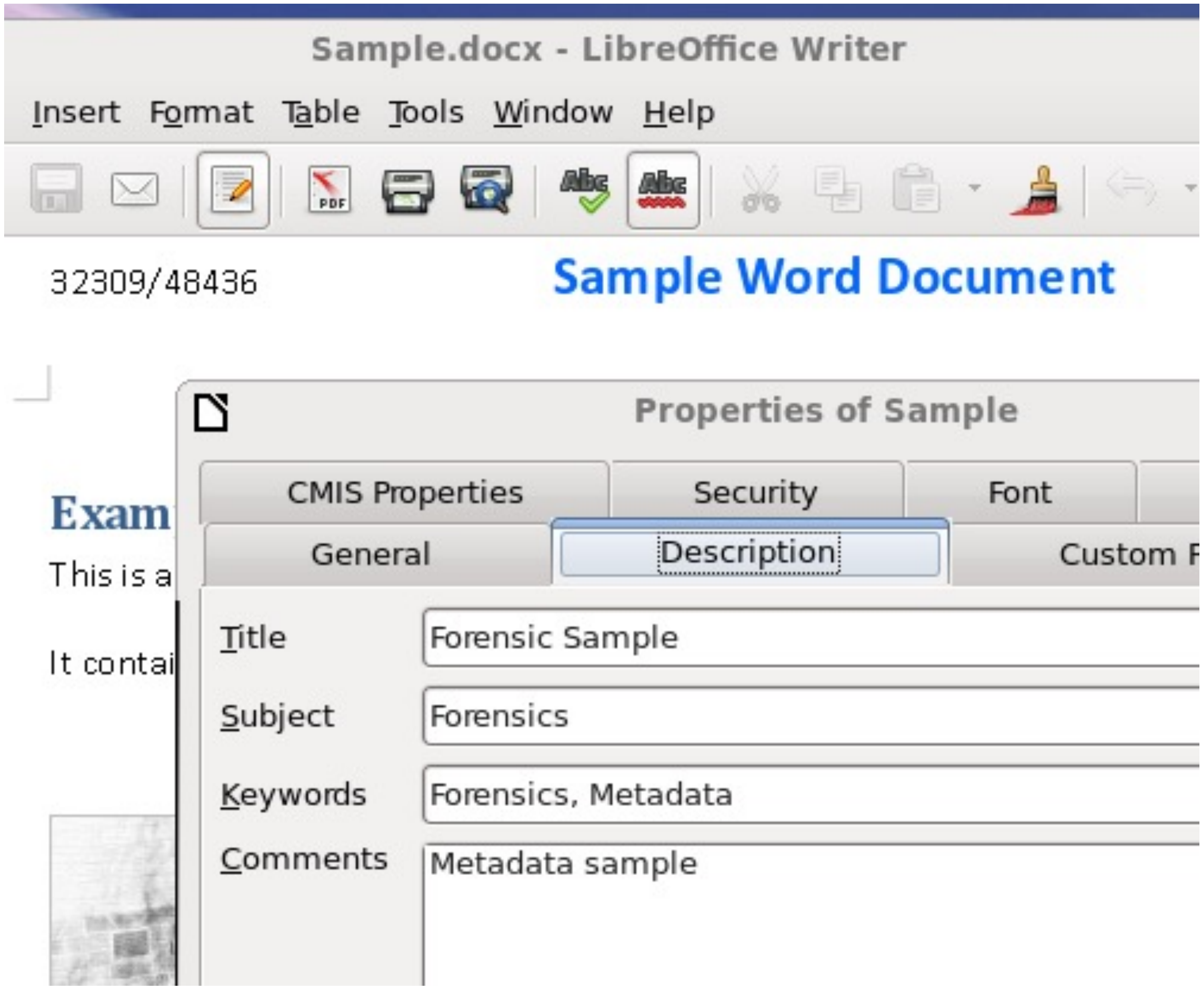
Sample.docx Properties

General | Security | Details | Previous Versions

Property	Value
Description	
Title	Forensic Sample
Subject	Forensics
Tags	Forensics, Metadata
Categories	Security
Comments	Metadata sample
Origin	
Authors	G G Lee
Last saved by	Graham
Revision number	17
Version number	
Program name	Microsoft Office Word
Company	UTS FEIT
Manager	Doan Hoang
Content created	1/05/2013 4:12 PM

docx metadata in LibreOffice

- Select File, Properties, Description



Title: Forensic Sample

Subject: Forensics

Keywords: Forensics, Metadata

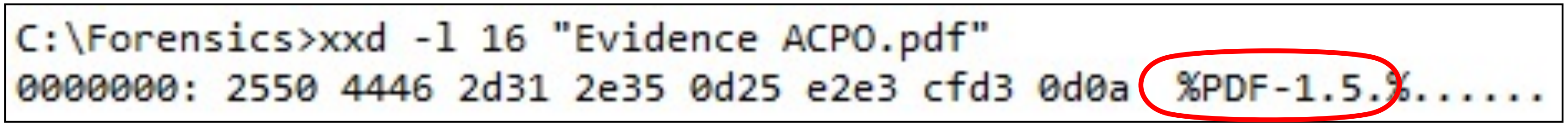
Comments: Metadata sample

PDF Files

- The PDF structure is complex
- Header, objects and a trailer
- Uses internal scripting commands
- /Launch will launch a program
- /JavaScript will launch JavaScript
- /OpenAction will run a script on open
- http://en.wikipedia.org/wiki/Portable_Document_Format
- See Readings

PDF Headers

- The PDF Header starts with %PDF-1.x

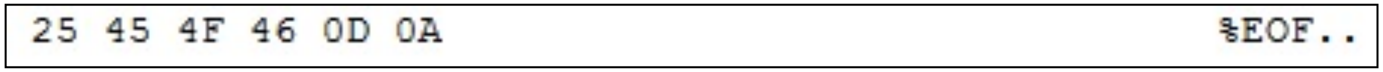


```
C:\Forensics>xxd -l 16 "Evidence ACPO.pdf"
0000000: 2550 4446 2d31 2e35 0d25 e2e3 cfd3 0d0a  %PDF-1.5.%......
```

- Adobe versions also contain 25 e2 e3 cf d3

Google this

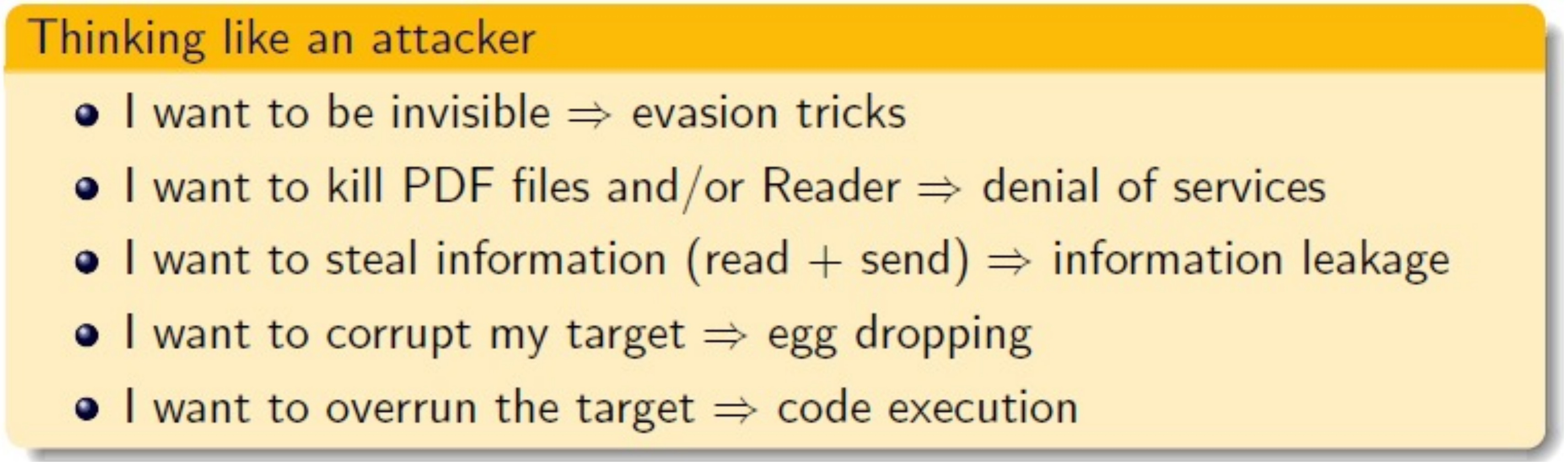
- The Trailer contains an End of File marker



```
25 45 4F 46 0D 0A                                   %EOF..
```

Malicious PDFs

- Malware can:
  - embed an exe into the pdf
  - embed malicious JavaScript in the pdf


Thinking like an attacker

- I want to be invisible ⇒ evasion tricks
- I want to kill PDF files and/or Reader ⇒ denial of services
- I want to steal information (read + send) ⇒ information leakage
- I want to corrupt my target ⇒ egg dropping
- I want to overrun the target ⇒ code execution

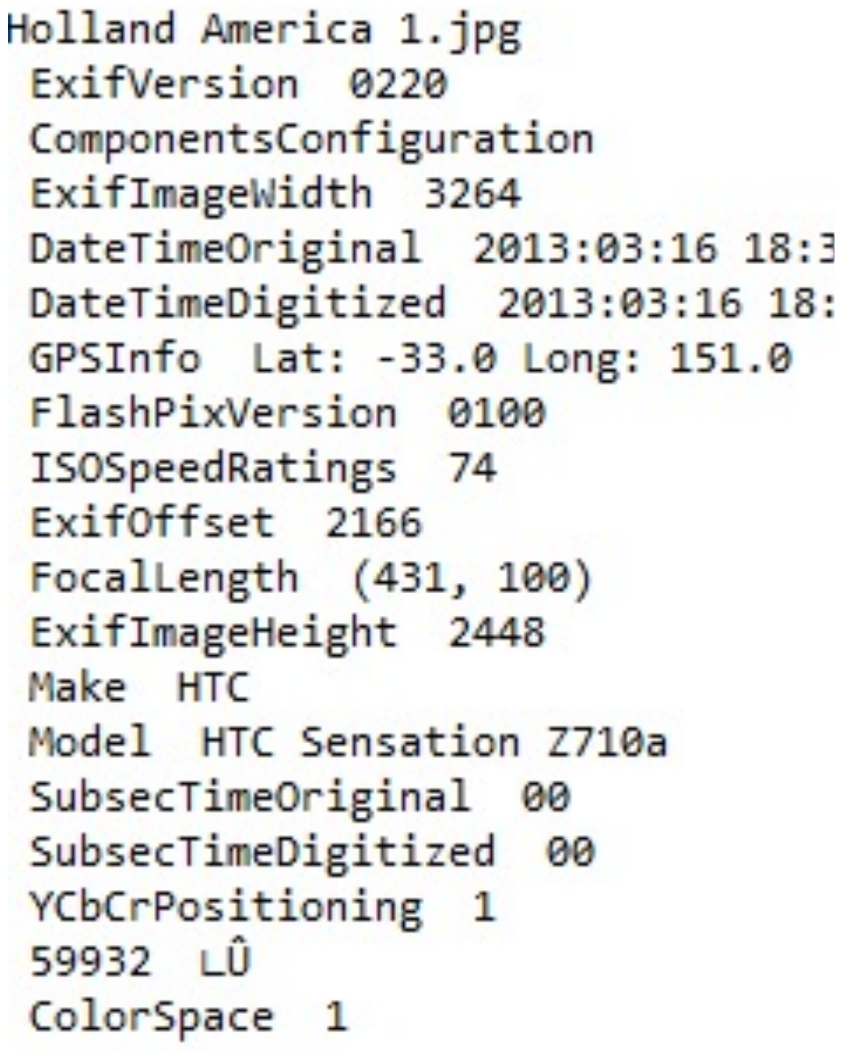
- https://doi.org/10.1007/s11416-009-0128-2

Camera Files

- Exchangeable image file format (exif)
- Used by cameras, Smartphones and scanners
- Developed from JPEG and TIFF
- Includes Geolocation
- Camera files are exif files, but save as jpegs
- The exif standard has many shortcomings
- Many cameras use their own format instead
- https://en.wikipedia.org/wiki/Exchangeable_image_file_format

Exif Files

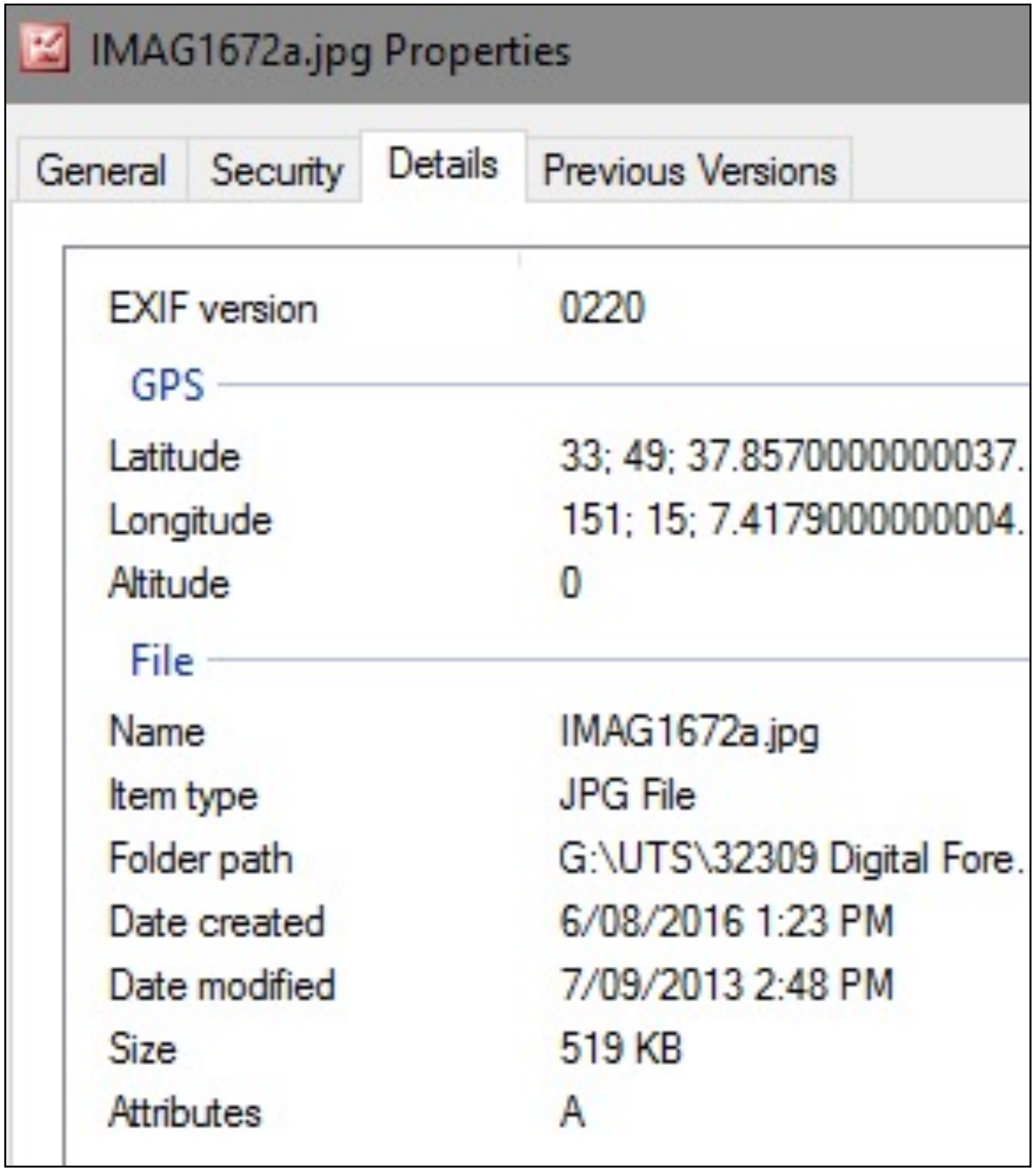
- file thinks this is a jpg
- The stat date/times can be altered
- exif reveals the metadata date



```
Holland America 1.jpg
 ExifVersion  0220
 ComponentsConfiguration
 ExifImageWidth  3264
 DateTimeOriginal  2013:03:16 18:3
 DateTimeDigitized  2013:03:16 18:
 GPSInfo  Lat: -33.0 Long: 151.0
 FlashPixVersion  0100
 ISOSpeedRatings  74
 ExifOffset  2166
 FocalLength  (431, 100)
 ExifImageHeight  2448
 Make  HTC
 Model  HTC Sensation Z710a
 SubsecTimeOriginal  00
 SubsecTimeDigitized  00
 YCbCrPositioning  1
 59932  LÛ
 ColorSpace  1
```

Exif Files #2

- Windows 10 includes a built-in exif viewer under file properties.



EXIF version	0220
GPS	
Latitude	33; 49; 37.857000000037.
Longitude	151; 15; 7.4179000000004.
Altitude	0
File	
Name	IMAG1672a.jpg
Item type	JPG File
Folder path	G:\UTS\32309 Digital Fore.
Date created	6/08/2016 1:23 PM
Date modified	7/09/2013 2:48 PM
Size	519 KB
Attributes	A

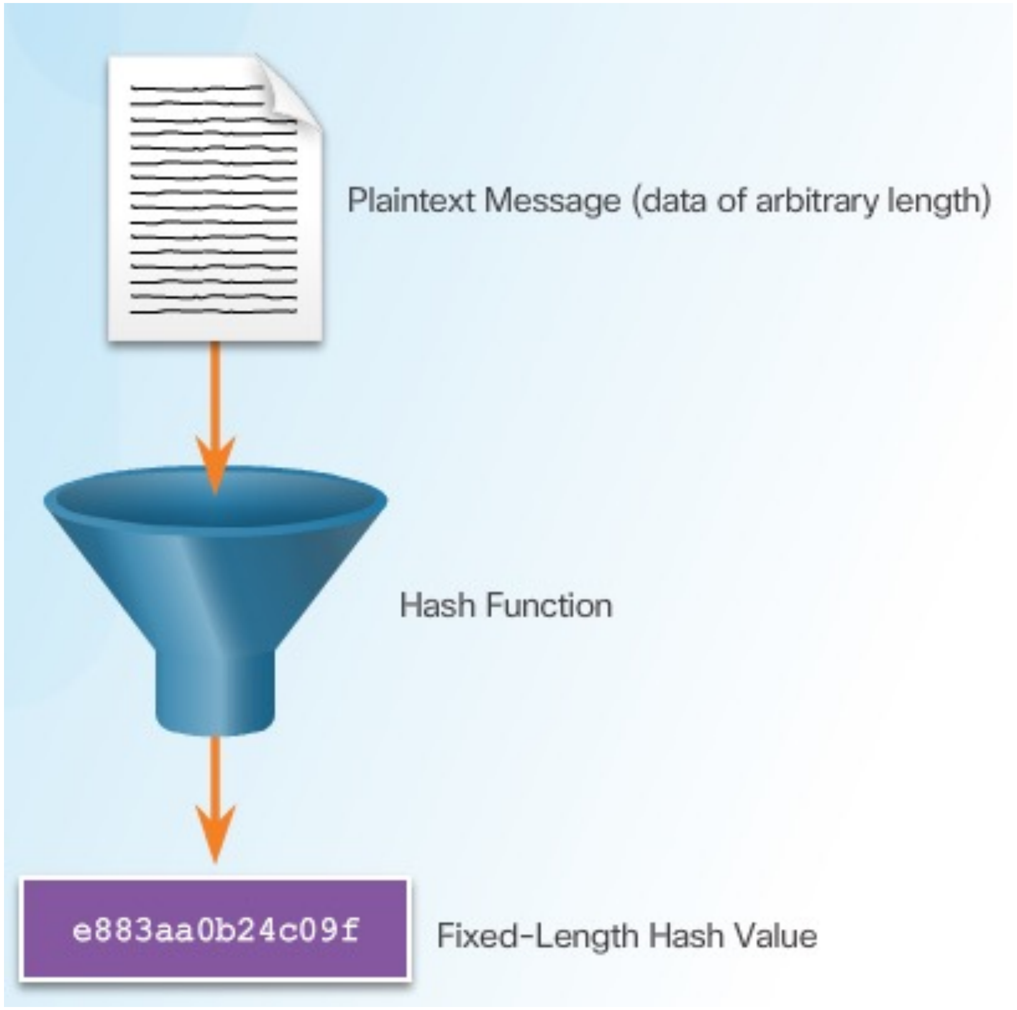
Email metadata

- Email *.EML files can be found on the client.
- Emails contain headers that can contain useful information
  - the mail server ip used to send the email
  - IP address of the person receiving the email
  - IP addresses that the email was passed to
  - email authentication.

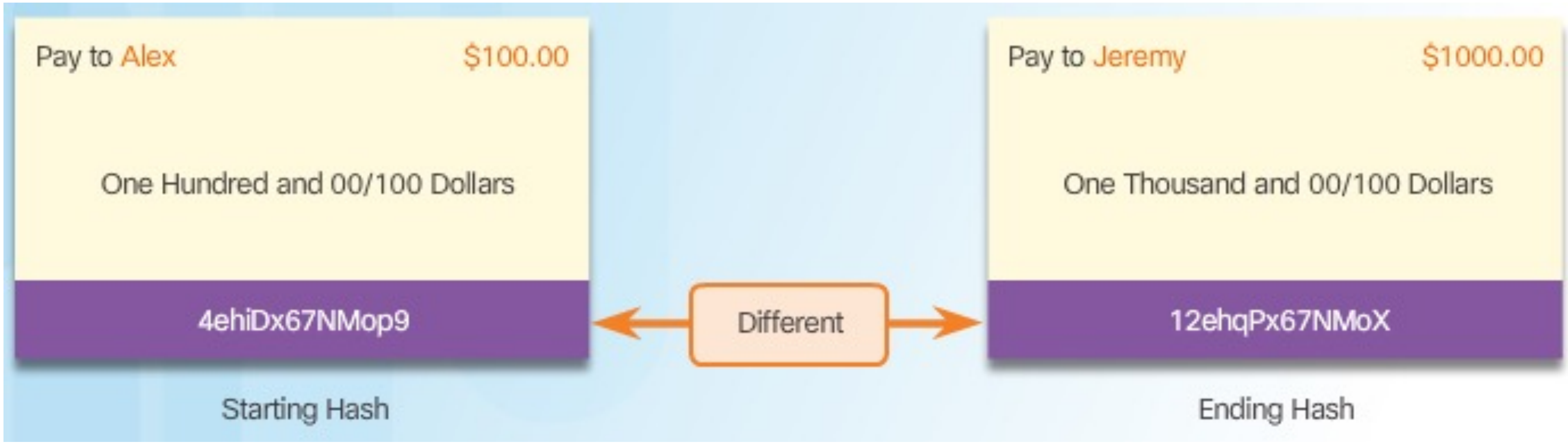
Objectives

- To look at Disk Bytes as Hex
- To understand metadata
- To examine file metadata
- To examine metadata in some documents
- To understand hashing

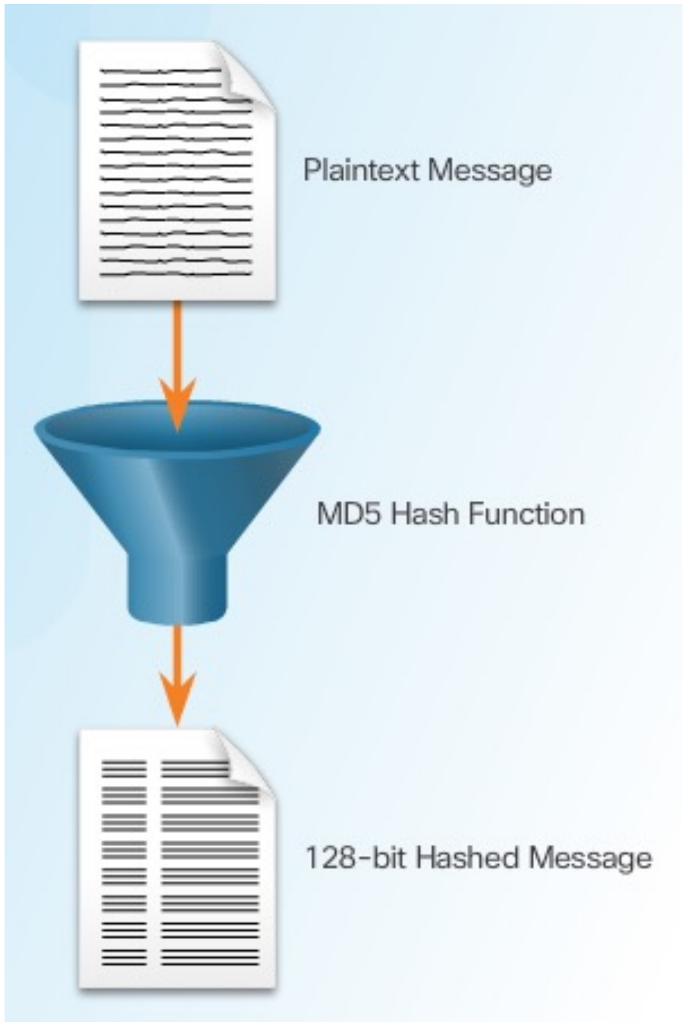
Cryptographic Hash Function



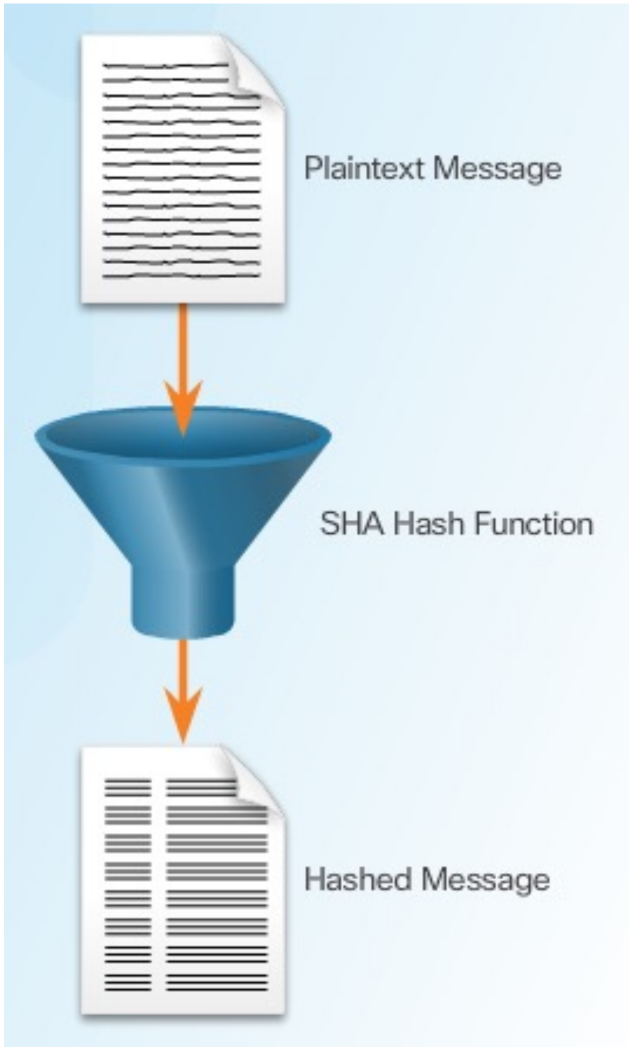
Using a hash protects integrity



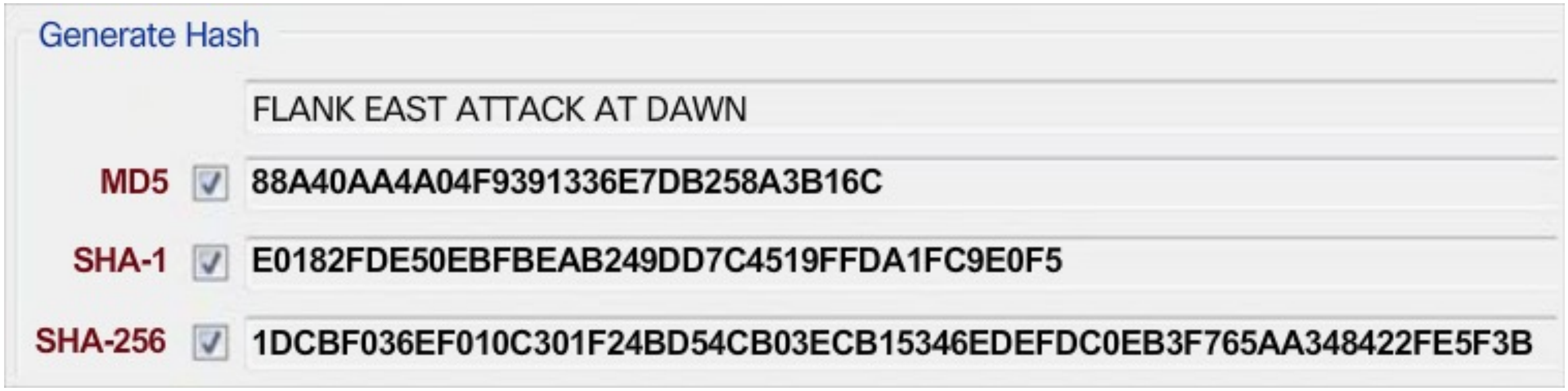
Message Digest 5 Algorithm



Secure Hash Algorithm



MD5 Versus SHA



Generate Hash

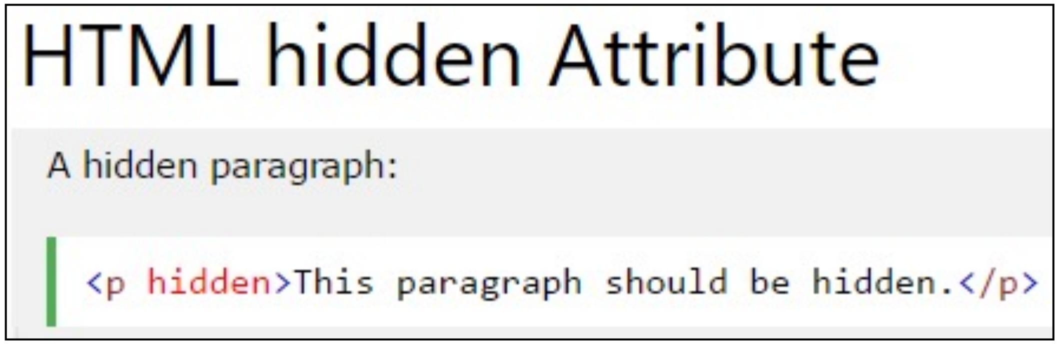
		FLANK EAST ATTACK AT DAWN
MD5	✓	88A40AA4A04F9391336E7DB258A3B16C
SHA-1	✓	E0182FDE50EBFBEAB249DD7C4519FFDA1FC9E0F5
SHA-256	✓	1DCBF036EF010C301F24BD54CB03ECB15346EDEFDC0EB3F765AA348422FE5F3B

Forensic hashing

- We can use hashing to ensure the integrity of evidence
- We can pickup changes made to images for instance by a suspect or a virus
- However if we hash all of a live disk, a second hash will be different.
  - Because a live disk is always changing.
- We use forensic hashing to hash many parts of a disk and keep the results in a table of hashes.

Steganography

- “Hiding in plain sight”
- We insert data into an image file.
- It is invisible to the naked eye
- Two methods: Insertion and substitution
- Insertion - html has a hidden attribute
- The data inside the tag is hidden


HTML hidden Attribute

A hidden paragraph:

```
<p hidden>This paragraph should be hidden.</p>
```

Substitution Steganography

- Replaces least significant bits (lsb) in a bitmap image with data
- Can also embed data in mp3 audio files.
  - Mp3 has metadata using the ID3 format
- Other methods adjust spacing characters in text files.
- Common steno programs are password protected
- It is often hard to detect steno using an IDS

Watermarking

- Commercial programs such as Photoshop can watermark an image to detect a copyright infringement
- Watermarks can record:
- the copyright owner
- the distributor
- the distribution chain
- the purchaser of the document, game or music

DRM

- Digital Rights Management (DRM) supply an encryption key for paid downloads such as pdf courseware.
- The document will not open on any other device
- This technique is also used for Gaming

FIN

- Sayōnara