Digital Forensics and Incident Response

Christian August Holm Hansen
@UIO 6.3.17

WATCHCOM

/> whoami

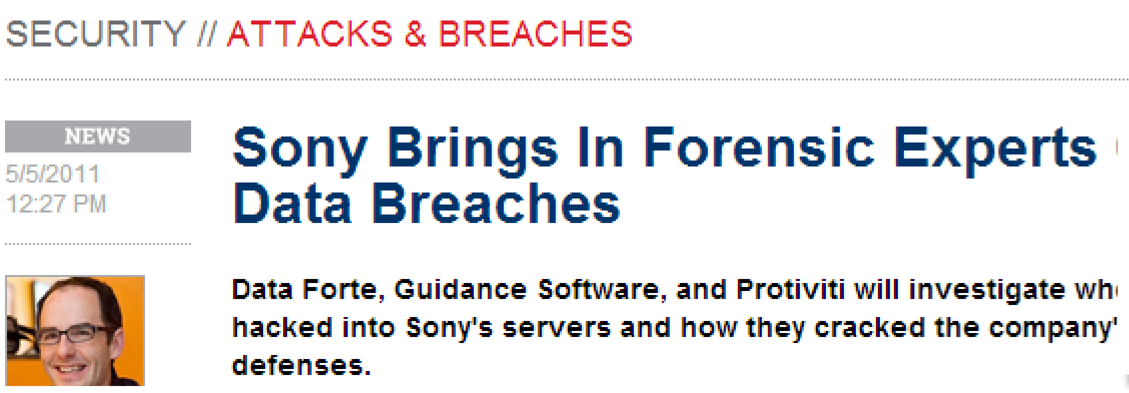
Christian August Holm Hansen:

- M.Sc. NTNU/Eurécom
- Information Security Consultant
  - Pentester, advisor, incident responder
- All opinions in this presentation are my own and all facts are based on open sources

Outline

- Incident Response
- Digital Forensics
- Finding Evidence
- Demos – what do you want to see?

Digital Forensics in Incident Management

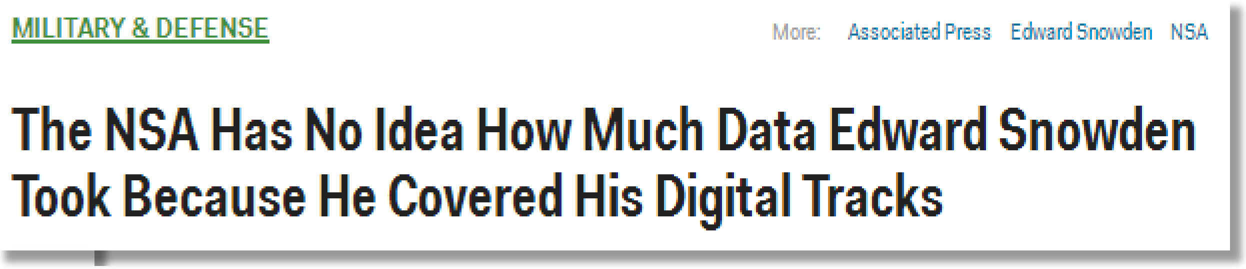


SECURITY // ATTACKS & BREACHES

NEWS
5/5/2011
12:27 PM

Sony Brings In Forensic Experts
Data Breaches

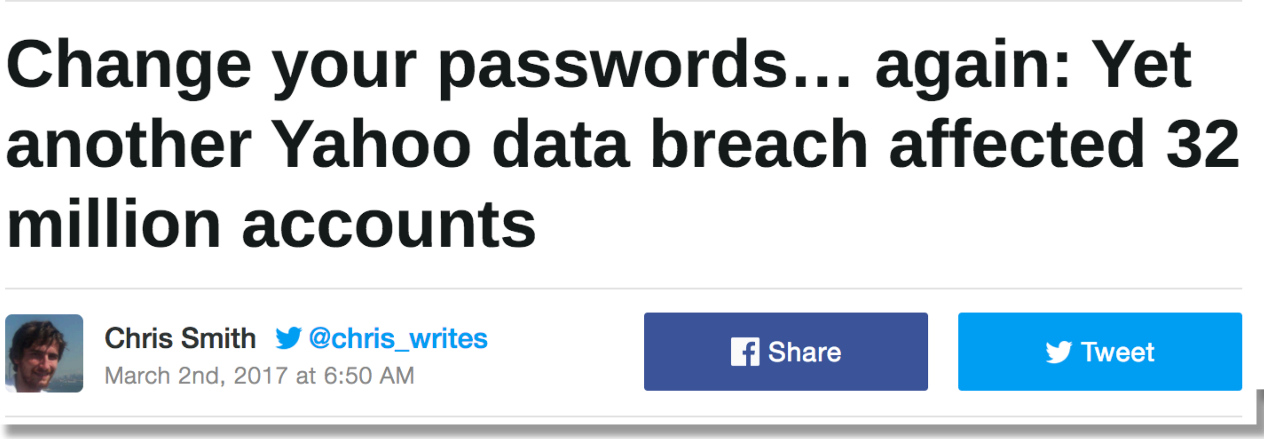
Data Forte, Guidance Software, and Protiviti will investigate wh
hacked into Sony's servers and how they cracked the company'
defenses.



MILITARY & DEFENSE

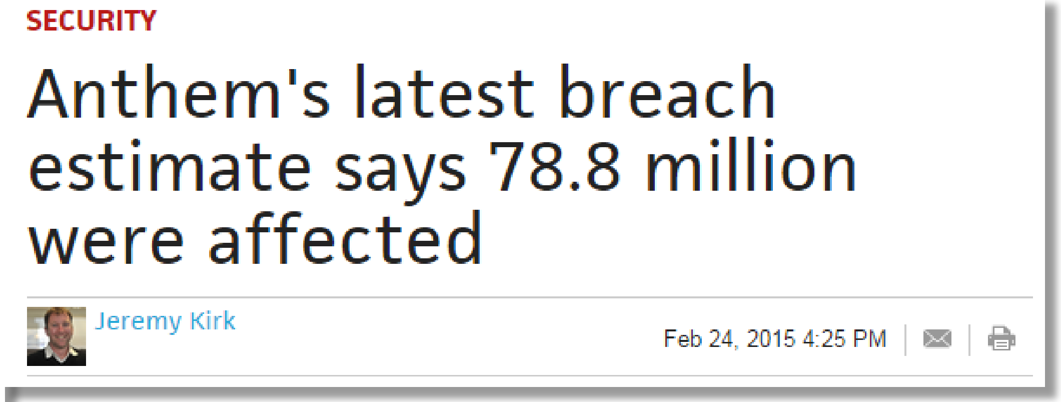
More: Associated Press Edward Snowden NSA

The NSA Has No Idea How Much Data Edward Snowden Took Because He Covered His Digital Tracks



Change your passwords... again: Yet another Yahoo data breach affected 32 million accounts

Chris Smith @chris_writes
March 2nd, 2017 at 6:50 AM



SECURITY

Anthem's latest breach estimate says 78.8 million were affected

Jeremy Kirk
Feb 24, 2015 4:25 PM

Who does this?

Digital forensics is often part of an incident responder's job

- Law enforcement
- CERTs (Government/industry specific/company specific)
  - In Norway: NorCERT, KraftCert, TelenorCert, FinansCert, UIOCert++
- Company IRTs
  - In Norway: DNB IRT, Statoil CSIRT++
- SysAdmins
- Consultants
  - In Norway: Watchcom Security Group, Mnemonic IRT++
- And others...

Incident Response

WATCHCOM

Incident Management

- Incident Response Policy
- Incident Response Team

Incident Response Policy

Responsibility

- Who makes the decisions?

Asset Priority

- Which systems can be taken offline?
- Which systems can absolutely not be taken offline?

Outside Experts and Agencies

- Who you gonna call?
- At what point is Law Enforcement involved?

Incident Response Policy

As an employee, if I discover an incident, what do I do?

The policy must include information on

- Chain of escalation
- How to prevent further damage
- How to preserve evidence until the Response Team can take over

Incident Response Team

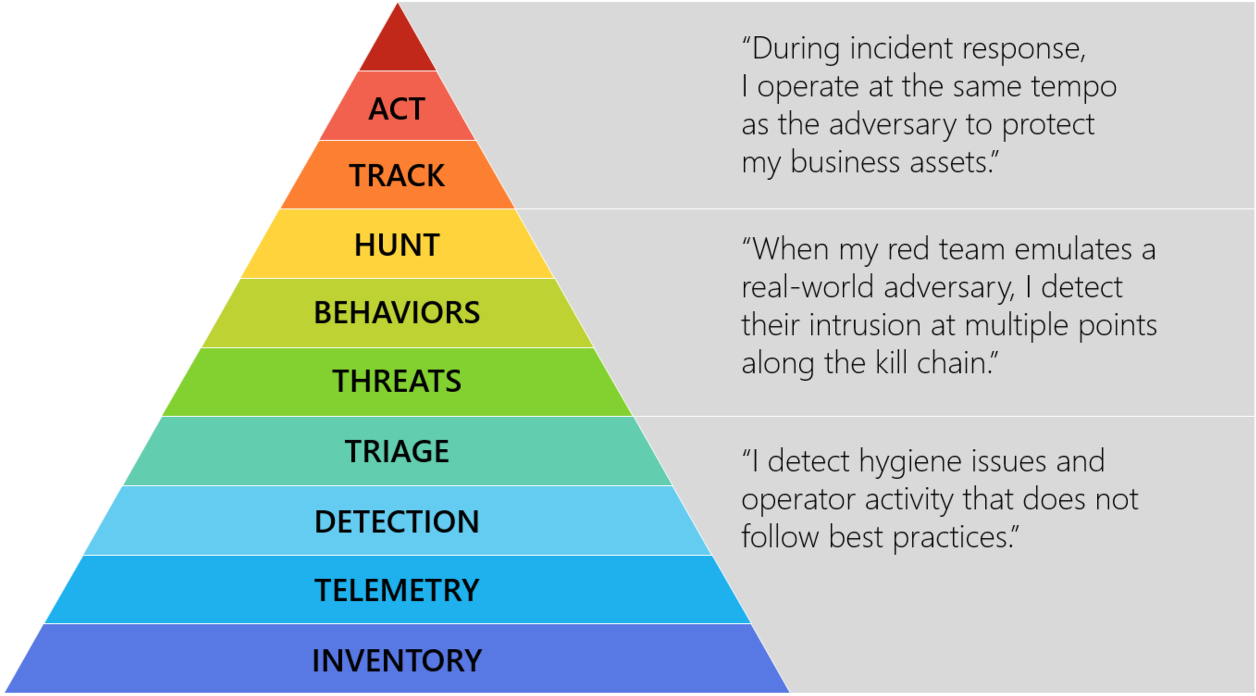
- Many names and definitions – the same principles apply to all of them (IMO)
    - IRT, SIRT, CERT, CSIRT… (Response Team being the key)
- Permanent
- Virtual
- Hybrid

Red Team – Blue Team

- Derived from military wargames
- A simulated attack using security specialists
- The Incident Response Team defends the system from the attack

Incident Response Procedures

- Detect
- Respond
- Recover



ACT

TRACK

HUNT

BEHAVIORS

THREATS

TRIAGE

DETECTION

TELEMETRY

INVENTORY

"During incident response, I operate at the same tempo as the adversary to protect my business assets."

"When my red team emulates a real-world adversary, I detect their intrusion at multiple points along the kill chain."

"I detect hygiene issues and operator activity that does not follow best practices."

Source: Ross McRae, Microsoft (@HollisticInfoSec)

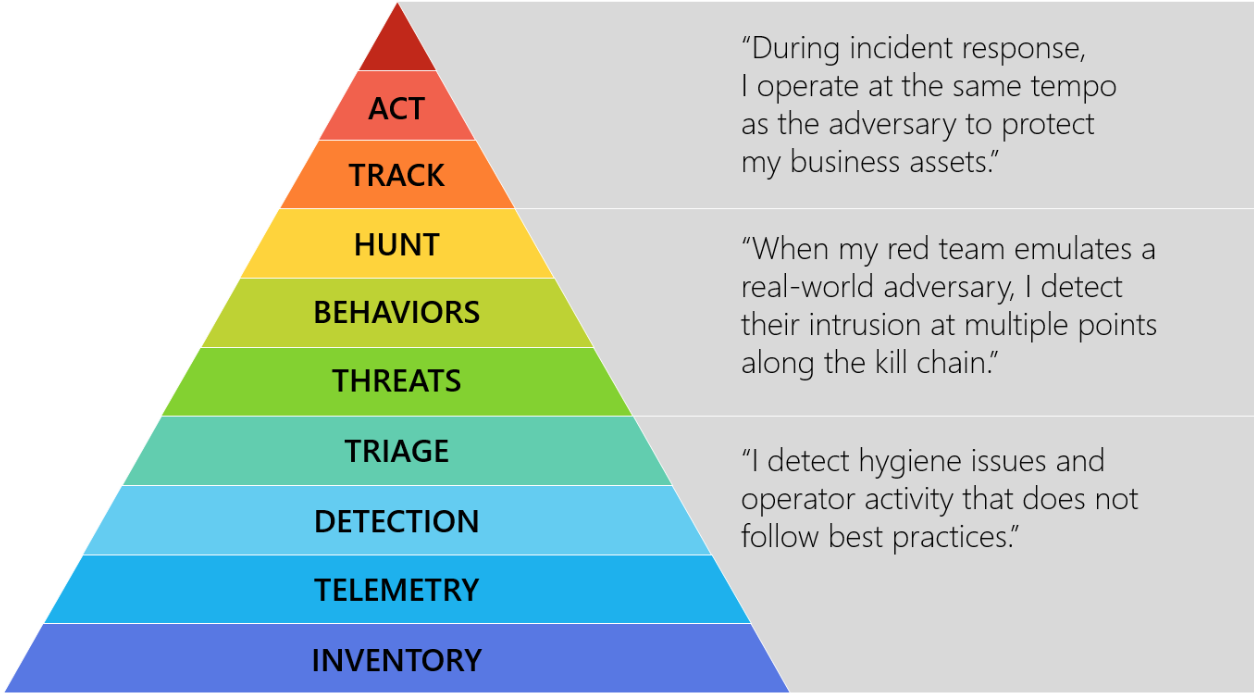
Detect

Know your assets

- If you don't know your assets, you cannot defend them

Triage

- Weed out false positives
- Categorize events
  - Type of incident
  - Source
  - Growth
  - Damange potential



"During incident response, I operate at the same tempo as the adversary to protect my business assets."

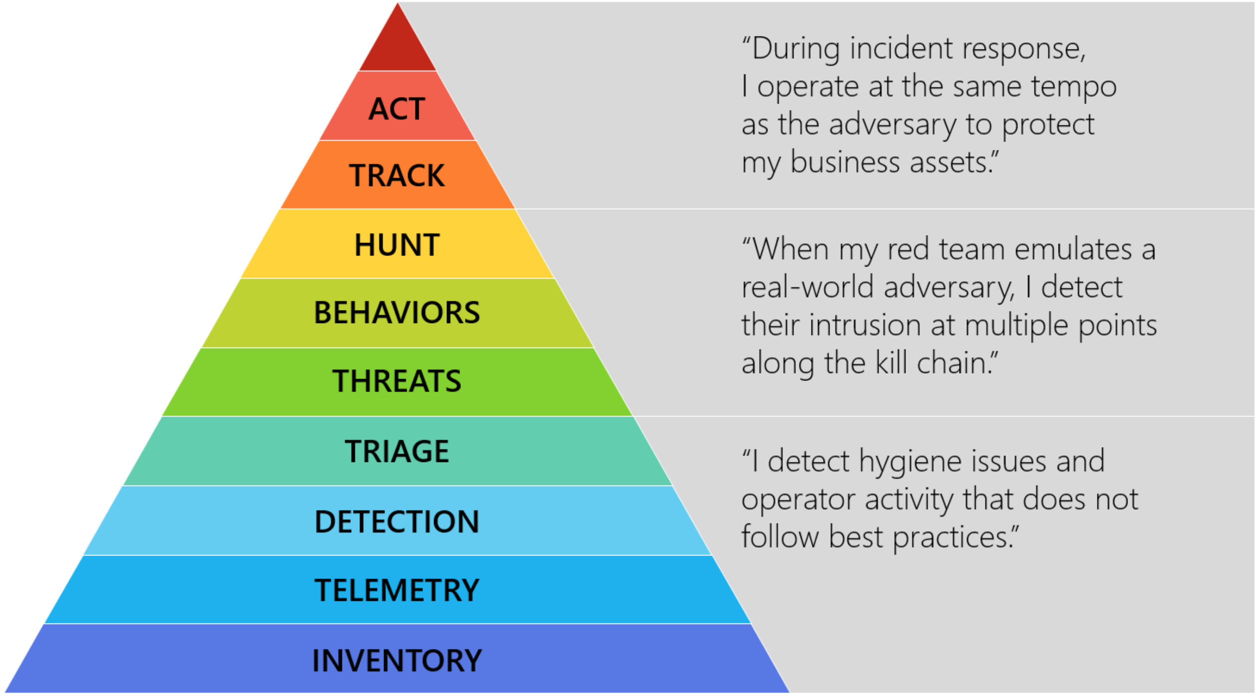
"When my red team emulates a real-world adversary, I detect their intrusion at multiple points along the kill chain."

"I detect hygiene issues and operator activity that does not follow best practices."

Source: Ross McRae, Microsoft (@HollisticInfoSec)

Respond

- Collect data
- Mitigate damage
- Isolate systems



"During incident response, I operate at the same tempo as the adversary to protect my business assets."

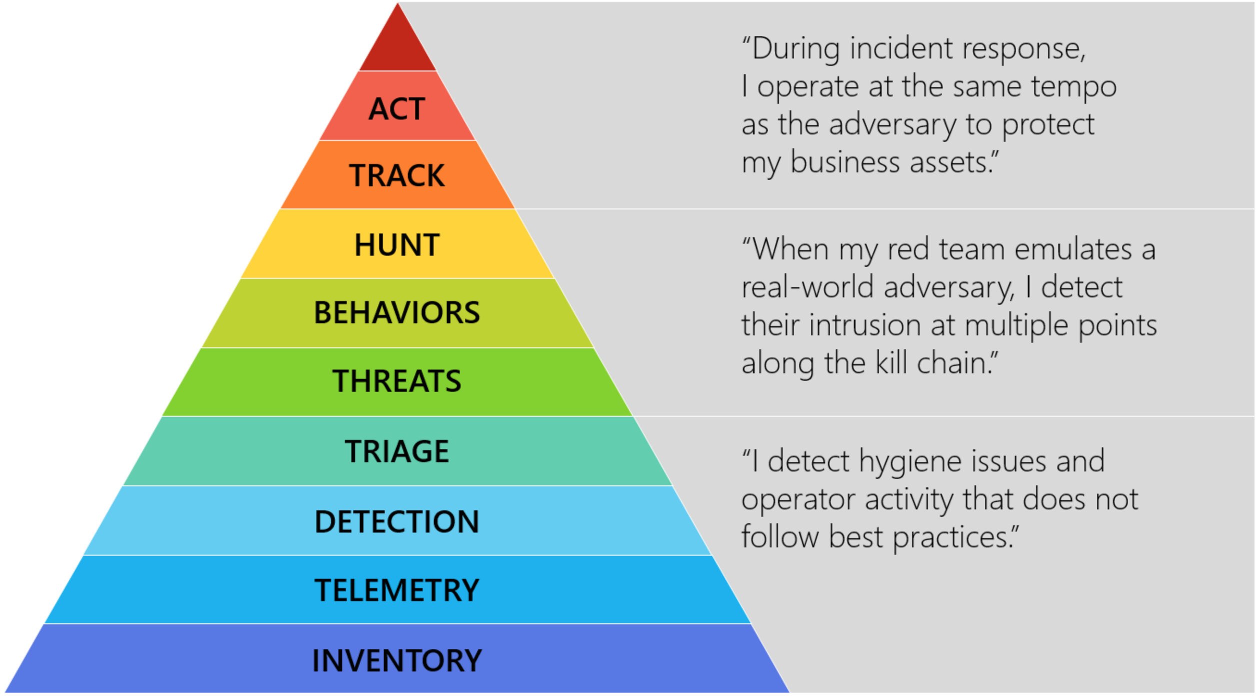
"When my red team emulates a real-world adversary, I detect their intrusion at multiple points along the kill chain."

"I detect hygiene issues and operator activity that does not follow best practices."

Source: Ross McRae, Microsoft (@HollisticInfoSec)

Respond (2)

- Analyze and track adversary
  - What is the root cause of the incident?
  - Who, how, when, why
- Law enforcement
  - Is it necessary?



"During incident response, I operate at the same tempo as the adversary to protect my business assets."

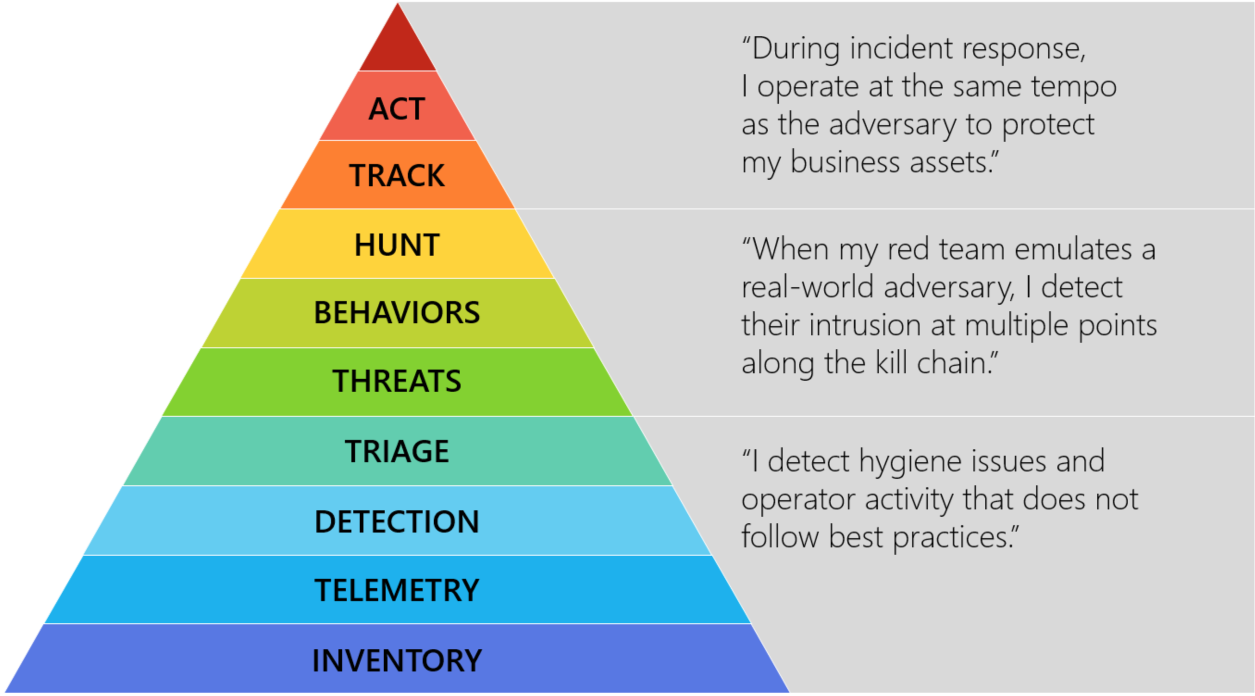
"When my red team emulates a real-world adversary, I detect their intrusion at multiple points along the kill chain."

"I detect hygiene issues and operator activity that does not follow best practices."

Source: Ross McRae, Microsoft (@HollisticInfoSec)

Recover

- Fix the problem
- Improve Incident Response Policy
- Disclosure



"During incident response, I operate at the same tempo as the adversary to protect my business assets."

"When my red team emulates a real-world adversary, I detect their intrusion at multiple points along the kill chain."

"I detect hygiene issues and operator activity that does not follow best practices."

Source: Ross McRae, Microsoft (@HollisticInfoSec)

Digital Forensics

Digital Forensics in Court

The BTK Killer

- Metadata in Word file led to arrest after 30 years

Krenar Lusha

- Search of laptop led to discovery of bomb-making equipment

Matt Baker

- Suicide of wife ruled murder after incriminating google searches is discovered 4 years later

Sharon Lopatka

- Emails on her computer led to her killer

Corcoran Group

- Evidence that data had been deleted led to conviction

Digital Forensics

It's all the same…

- Digital forensics, computer forensics, network forensics, electronic data discovery, cyberforensics, forensic computing…

Big difference in the handing of evidence

- Law enforcement
- Corporate incidents
- … but it shouldn't be

What is digital evidence?

“Any digital data that contains reliable information that supports or refutes a hypothesis about an incident”

Forensic Investigation Process

- Identification
- Preservation
- Collection
- Examination
- Analysis
- Presentation

At the Crime Scene

Document the crime scene

- Document who has access
- Document any contamination

Photograph everything

- Especially the screen

Locate the media

- Follow cables
- All digital devices may contain digital evidence

If the computer is running, dump the RAM

The Digital Forensics Toolkit

- Screwdrivers
- Evidence bags
- Labels
- Forensic software
- Write Blocker
- Camera
- Notebook with numbered pages
- Storage – Large HDDs

Basic Scientific Principles

1. Best evidence
2. Minimal Intrusion
3. Minimal Force
4. Minimal Interruption
5. Transparency
6. Chain of Custody
7. Primacy of the Mission
8. Impartiality
9. Documentation

Evidence Location

- Network analysis
- Media analysis
- Software analysis
- Hardware analysis

Dealing with Evidence

R-OCITE

- **R**eturn

Or sieze...

- **O**riginal
- **C**lone
- **I**mage
- **T**argeted copy
- **E**xtensive copy

Admissible Evidence

- How was it gathered?
- How was it treated?
- Who handled it?
- How reliable is it?
- Is the Chain of Custody complete?

Evidence Categories

Conclusive Evidence

- This is fact

Best Evidence

- This is it

Secondary Evidence

- This how it looks

Direct Evidence

- This is what I saw

Evidence Categories

Corroborative Evidence

- That happened, because of this

Circumstantial Evidence

- That could have happened, because of this

Opinion Evidence

- I'm an expert, this is what happened

Hearsay Evidence

- I heard this about that

Digital evidence is considered hearsay unless an expert vouces for it

Finding Evidence

WATCHCOM

Finding Evidence

- Many ways to hide
- Many ways to find

Hidden Files

- Setting the “hidden” flag on the file
    - Different for Windows and *nix
- Inconspicuous folder names

Locating Hidden Files

- The “hidden” flag is ignored by default
- Forensic software can be set to show the drive as a "flat" drive
  - Ignoring folder hierarchy

Changing File Extensions

- When opening the file, the system returns an error message
- “Oh, I guess it is corrupted. Too bad.”

Discovering Changed File Extensions

- Some forensic software will point out files with mismatched extensions
- File signatures tells us what kind of file it is
  - Also called “Magic Numbers”

File Signatures

A hexadecimal code in the file, also called file “headers” and “footers”

Examples:

25 50 44 46	= %PDF	= PDF
49 44 33	= ID3	= MP3
FF D8 FF	= ÿØÿà	= JPEG
42 4D = BM	= BMP	
4D 5A = MZ	= EXE, COM, DLL	

Obscure File Names

- Hiding files by giving them inconspicuous file names
- “Blueprints_iPhone8.jpeg” becomes “Florida vacation 001.jpeg”

File Names not an Issue

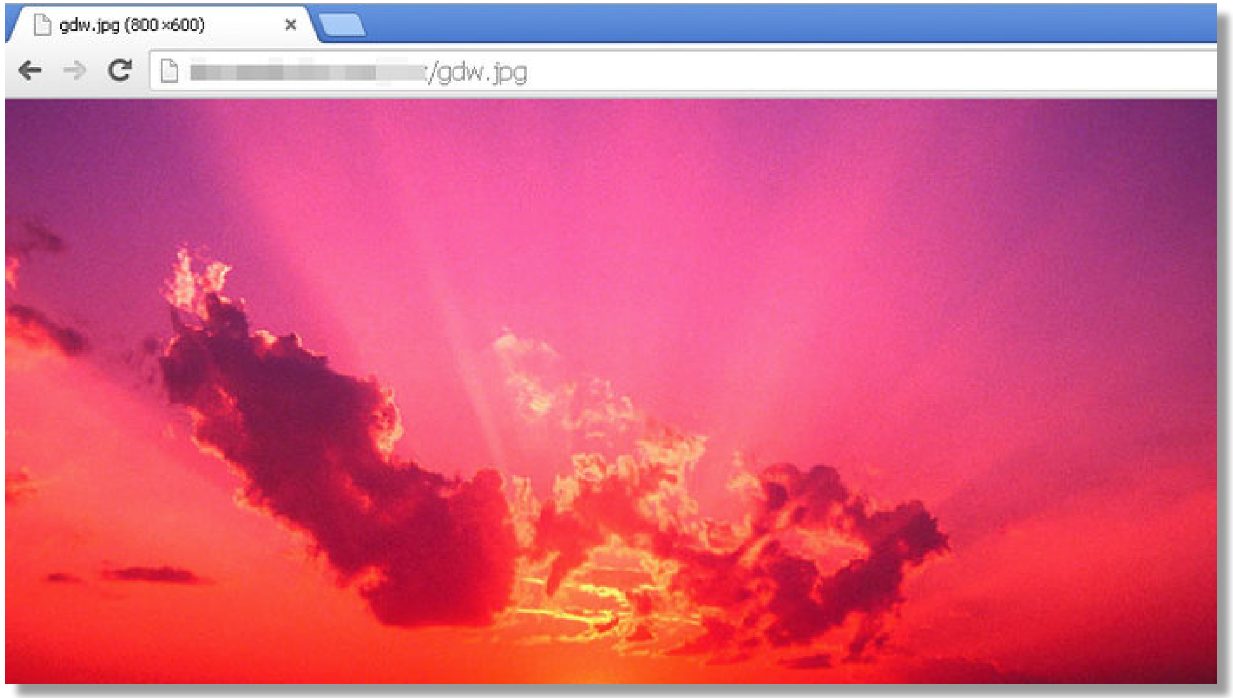
- Hash functions to look for known files
  - Lists of hash sums recognize known illicit files
  - Lists of hash sums recognize known "good" files
  - We can create our own lists

Steganography

- Hiding a file inside another file
- Hiding “Nuclear Launch Codes.txt” inside “Adorable Cat.jpeg”

Steganography Example

- Command & Control traffic in images
  - Known sites - imgur, Dropbox, Instagram etc.
- ZeusVM botnet malware used image files to hide configuration files



Discovering Steganography

- Hard to determine unless you are looking for it
- Steganography software on suspect's computer a strong indicator
- File type signatures to the rescue
  - Linux tools: binwalk, file

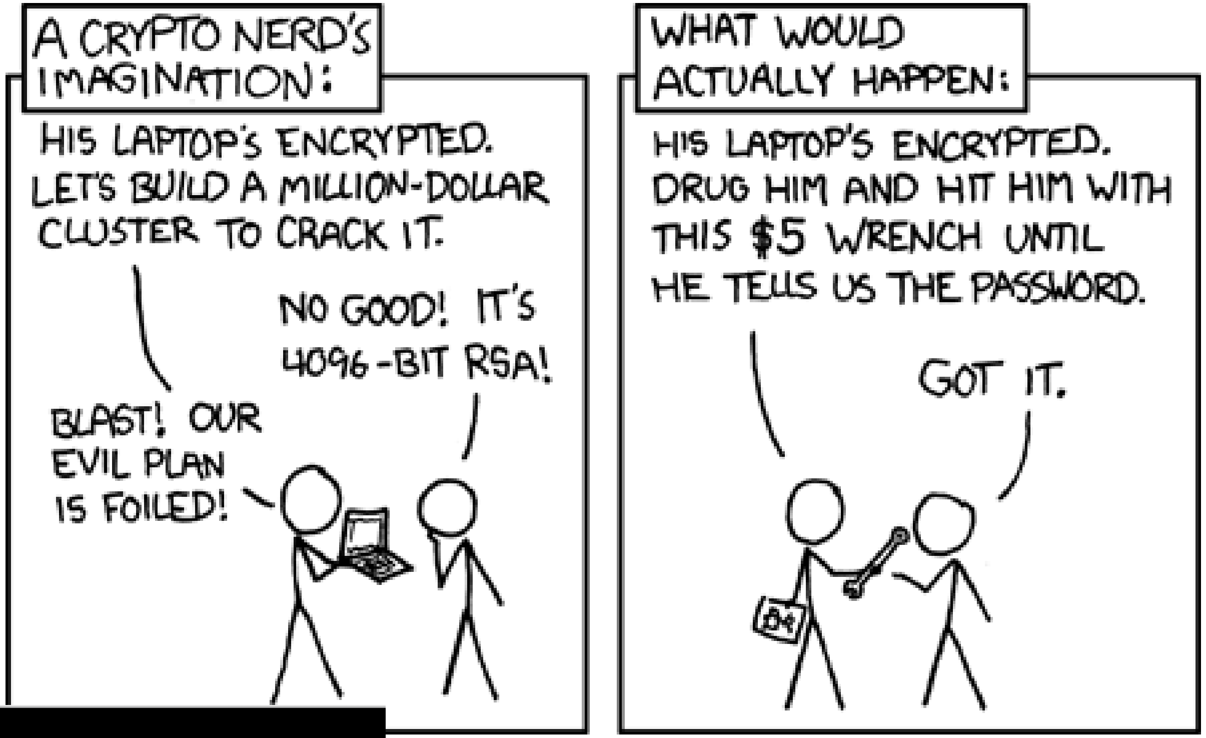
Encrypted Files

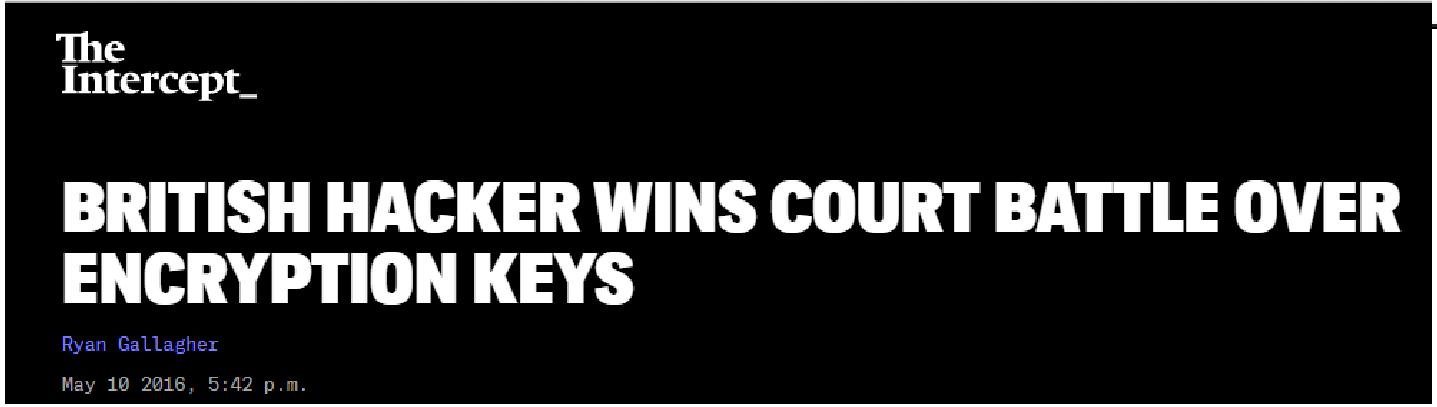
- This is where the problems start for the investigator
- Strong encryption algorithms almost impossible to break
- “Sorry, I’ve forgotten my 50 character long password.”

“Breaking” Encryption

- Recovering key from RAM
- Brute force
- Exploiting weaknesses in the software or the algorithm used (Cryptanalysis)
- Some countries have laws that compel the suspect to give up keys
- Less ethical methods
  - Rubber-hose cryptanalysis
  - Black-bag cryptanalysis

“Breaking” Encryption


A CRYPTO NERD'S IMAGINATION:
HIS LAPTOP'S ENCRYPTED. LET'S BUILD A MILLION-DOLLAR CLUSTER TO CRACK IT.
NO GOOD! IT'S 4096-BIT RSA!
BLAST! OUR EVIL PLAN IS FOILED!
WHAT WOULD ACTUALLY HAPPEN:
HIS LAPTOP'S ENCRYPTED. DRUG HIM AND HIT HIM WITH THIS $5 WRENCH UNTIL HE TELLS US THE PASSWORD.
GOT IT.



The Intercept_

BRITISH HACKER WINS COURT BATTLE OVER ENCRYPTION KEYS

Ryan Gallagher

May 10 2016, 5:42 p.m.

Deleting Files

- Deleting the files from the computer before law enforcement claims it
- “You can’t prove anything, there is nothing there.”

How does the System Delete Files?

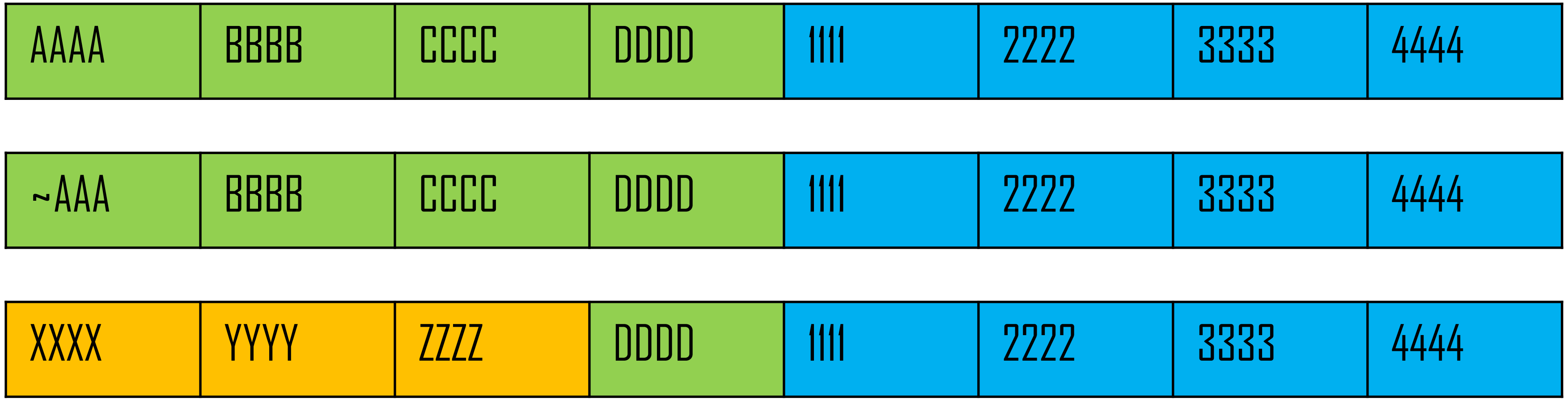
- Deleting a file does not actually remove it
- In Windows, the file is renamed
  - CorporateSecrets.txt
  - ~orporateSecrets.txt
- This tells the system that the space is available to be overwritten in the future

Reclaiming Deleted Files

- Data carving
    - Ignore file system – extract file directly from the media
- Renaming the file

Reclaiming Overwritten Files

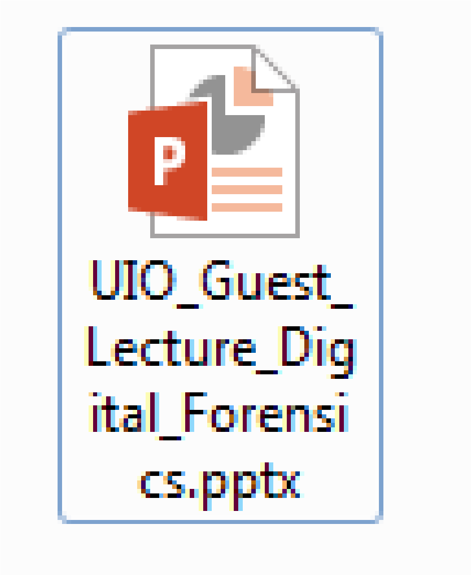
- Pieces of data can be recovered from "slack space"
- File slack, RAM slack, drive slack
- Forensics software can often recover files or parts of files from slack space

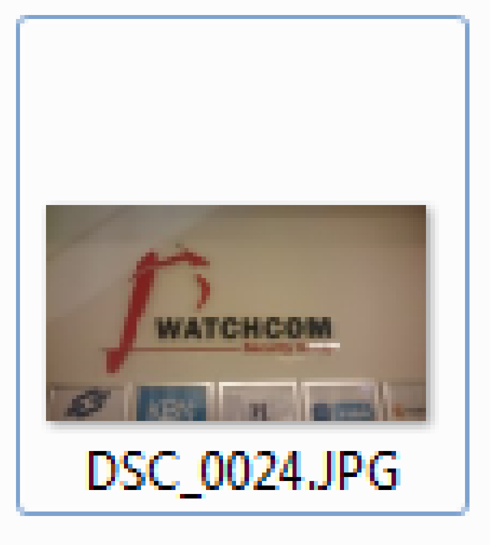


AAAA	BBBB	CCCC	DDDD	1111	2222	3333	4444
~AAA	BBBB	CCCC	DDDD	1111	2222	3333	4444
XXXX	YYYY	ZZZZ	DDDD	1111	2222	3333	4444

Metadata

- What if we only have a file, and not the source media?

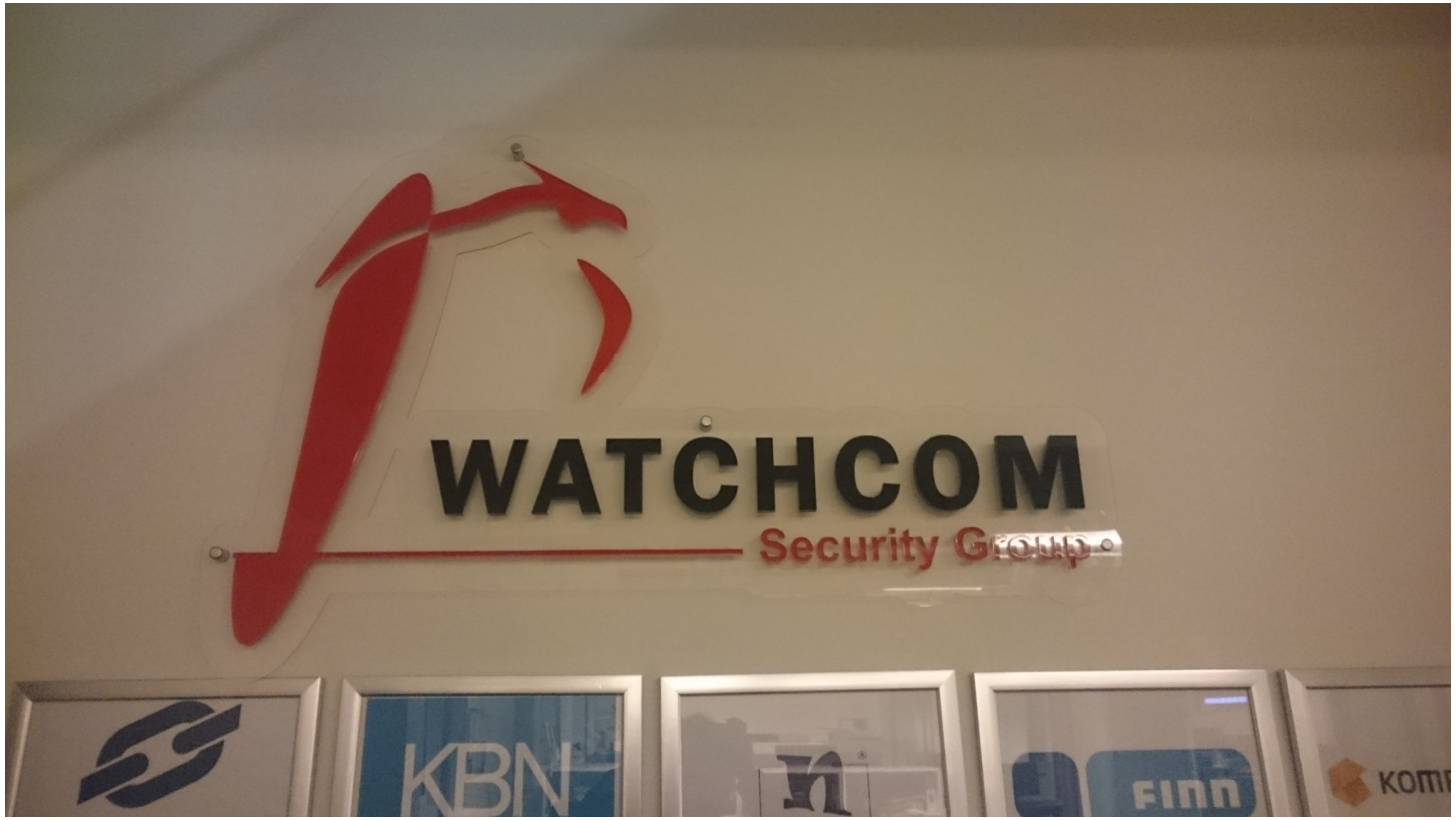




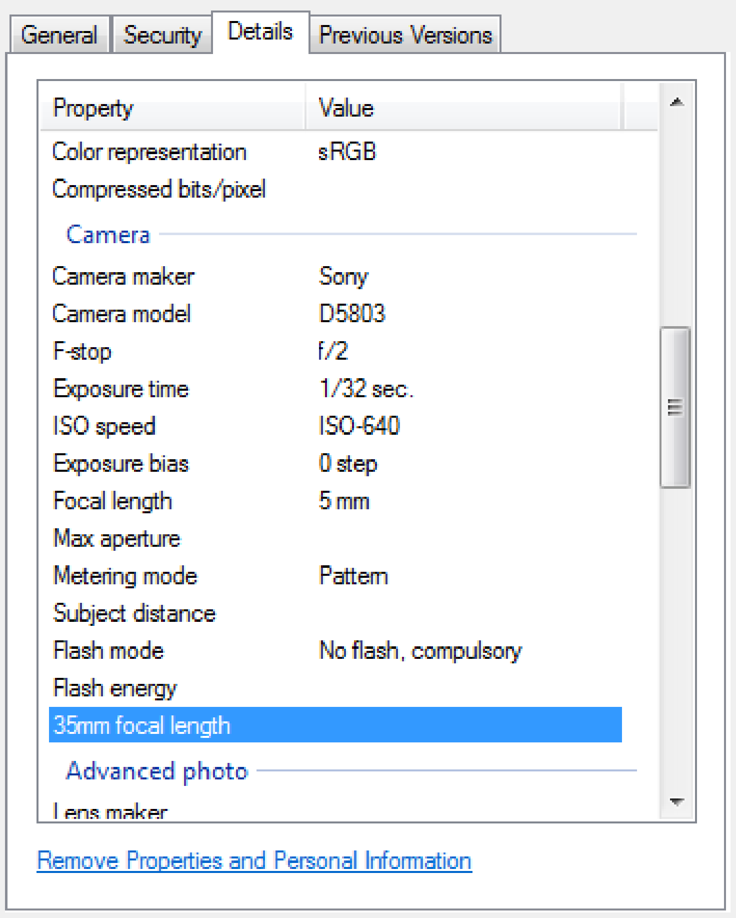
Using Metadata

- Data about the file
  - When was the file last used?
  - When was the file created?
  - Who opened it?
  - Where was it created?
- Can prove who had access to the file

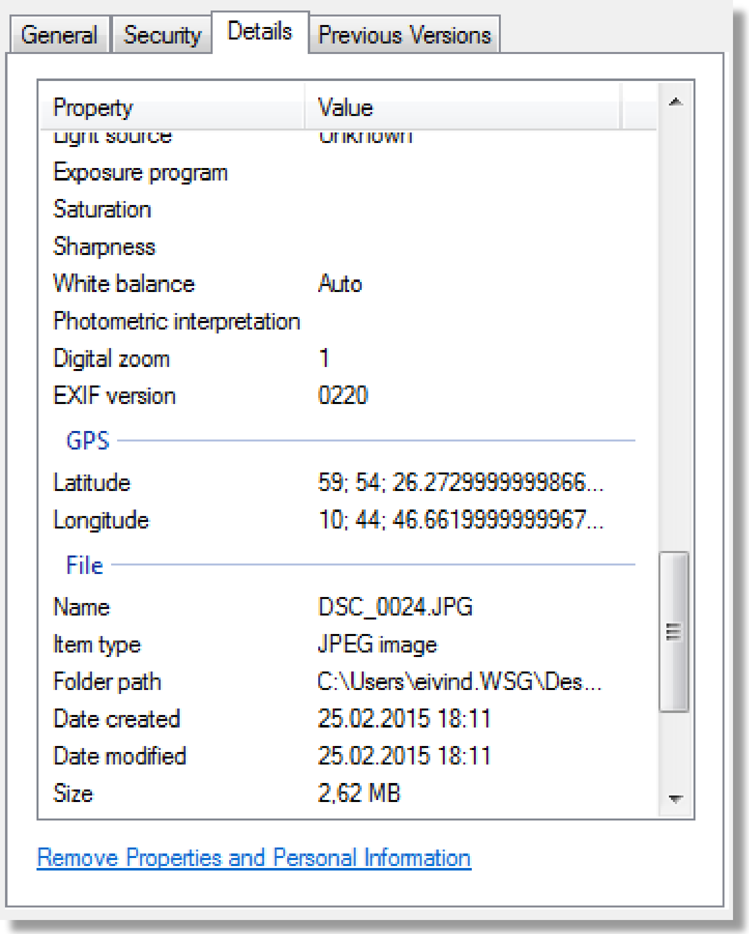
Metadata Example



Metadata Example

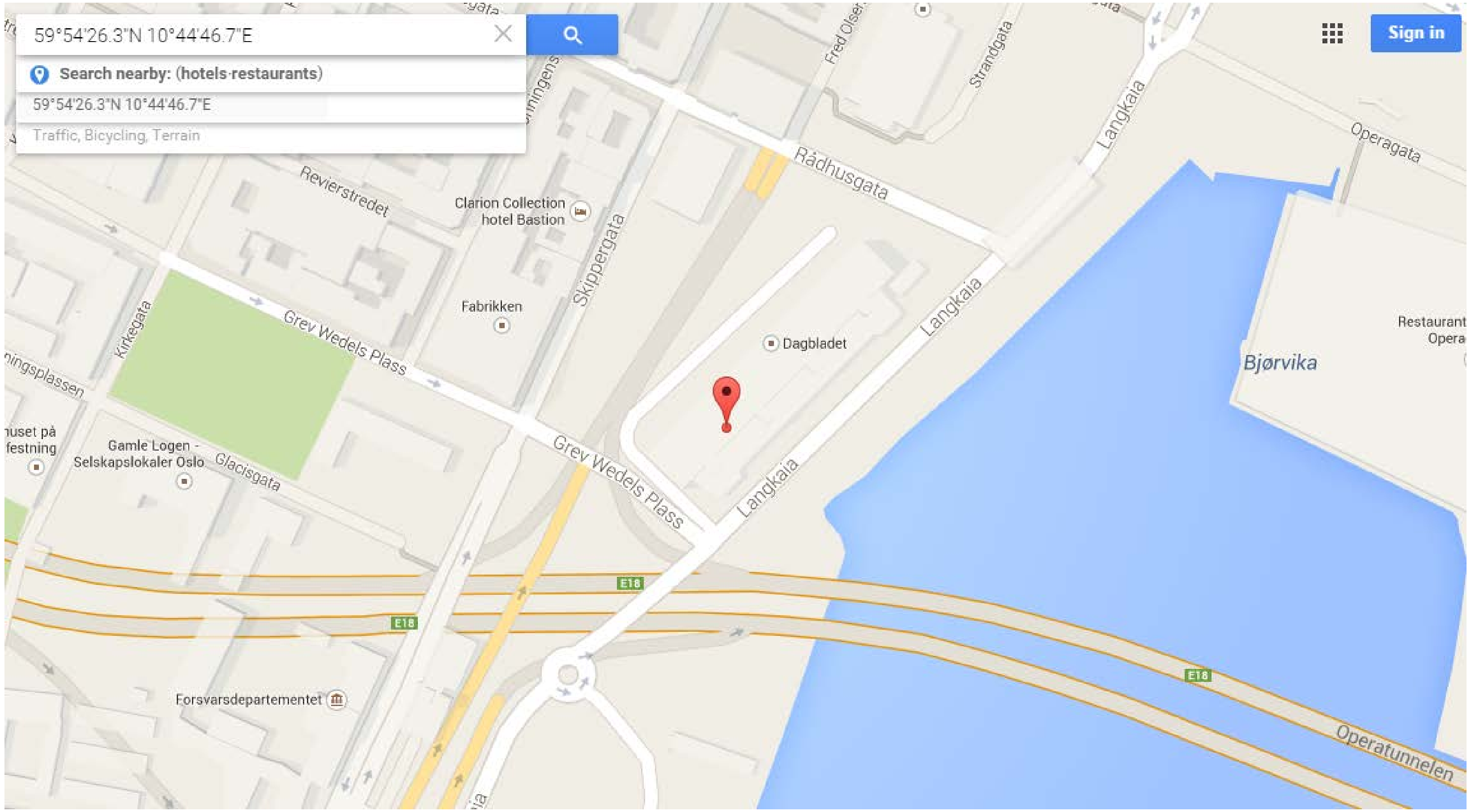


Property	Value
Color representation	sRGB
Compressed bits/pixel	
Camera	
Camera maker	Sony
Camera model	D5803
F-stop	f/2
Exposure time	1/32 sec.
ISO speed	ISO-640
Exposure bias	0 step
Focal length	5 mm
Max aperture	
Metering mode	Pattern
Subject distance	
Flash mode	No flash, compulsory
Flash energy	
35mm focal length	
Advanced photo	
Lens maker	



Property	Value
Light source	Unknown
Exposure program	
Saturation	
Sharpness	
White balance	Auto
Photometric interpretation	
Digital zoom	1
EXIF version	0220
GPS	
Latitude	59; 54; 26.2729999999866...
Longitude	10; 44; 46.6619999999967...
File	
Name	DSC_0024.JPG
Item type	JPEG image
Folder path	C:\Users\eivind.WSG\Des...
Date created	25.02.2015 18:11
Date modified	25.02.2015 18:11
Size	2,62 MB

Metadata Example



59°54'26.3"N 10°44'46.7"E

Search nearby: (hotels·restaurants)

59°54'26.3"N 10°44'46.7"E

Traffic, Bicycling, Terrain

Metadata Example 2

- Red Star OS – Appends unique system identifier to all media files

It's not all theory – if you want to learn more…

CTFs

Forums (/r/forensics, /r/netsec)

Virtual machines, tools & wargames

- Sans DBIR
- Redline
- Volatility
- Sandboxed malware (be careful…)

- Books

Courses (e.g. SANS SEC504)

- Course contents are public. Use Google to learn the goals!

- Conferences (DEFCON, Black Hat, CCC, Paranoia)
  - Videos are often published online, freely available
  - Paranoia is held in Oslo Spektrum on the 10th and 11th of May
- Books

Questions?

christian.hansen@watchcom.no

Demo time!

What do you want to see?

- Red Star OS
- Redline Live Forensics
- Steganography/data carving with *nix tools
- Gaudox Botnet
- I want to go home