

Digital Forensics: Essentials and Data Acquisition

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Digital Forensics

- Methods to collect, preserve and analyze *digital evidence*
- Three main phases
 - Acquiring the primary data
 - Analysis and evaluation (establishing the evidence)
 - Reporting
- The first phase is most crucial
 - Must make sure the data is complete, authentic and its integrity can be checked
 - The other phases can be repeated/corrected/scrutinized any time

Examples of investigations

Burst of a ransomware campaign, a self-propagating worm exploiting a zero-day vulnerability in the operating system. After it is executed, the worm blocks access to the data on the disk and asks for ransom.

- Micro Enterprise
 - Can data be recovered?
 - Have data been modified, tempered with?
- Large Organization
 - How the attack is spreading and how to spot it?
 - Have any sensitive data leaked?
- Law Enforcement
 - Is it possible to identify the attacker?
 - Is the determined evidence admissible?

Digital Evidence

- Evidence is based on digital data
- Can be literally anything
 - Files on the storage, memory contents, metadata
 - Computer isn't the only source of data
- Data is digital
 - Potentially hard to get
 - Easy to distort

Today's focus

- We focus on system administrators who want to secure forensically sound data
 - Not aiming at acting in “hostile environment” (like LEA, etc.)
 - The environment is supposed to be known and cooperative (mostly)
 - Architecture details can be (easily) established
 - System passwords and keys are known / available, etc.
- We focus on demonstrating principles using common tools

Data Acquisition

Basic principles

- Common principles
 - The collected data should be:
 - complete (for subsequent analysis)
 - accurate (not altered)
 - “We want to get the most evidence we can with the least amount of alteration”
- The quality of the data and the soundness of the acquisition process determines the utility of the evidence
- Every investigation should be scoped (questions formulated, at least internally)
- Only start the acquisition process if you’re authorized!

Risks of low quality of evidence

- If the evidence is incomplete, it cannot yield relevant outcome
- If the acquisition process doesn't guarantee the integrity and authenticity of the data, results can be disputed
 - Never know when the data will need to be defended, e.g. an internal process with an employee can end up in court
- If you don't know what to do, do not interact with the system at all
 - No commands typed, no programs started, no new logins, ...

Getting data from computer

Machine is switched off

- The off-line approach is straightforward
 - The only evidence is on permanent storage
 - The device can be dismantled and processed outside the computer
 - Works for virtual machines as well
- Or the computer can be booted from a trusted media
 - The computer must never boot other than trusted OS (e.g. USB), esp. the OS installed in the host!

Never boot the machine OS

- Windows 10 changes or creates a lot of system files, e.g.:

/Windows/System32/LogFiles/WMI/NetCore.etl
/Windows/System32/LogFiles/WMI/NtfsLog.etl
/Windows/System32/LogFiles/WMI/Wifi.etl
/Windows/System32/LogFiles/WMI/RtBackup/EtwRTEventLog-Application.etl
/Windows/System32/LogFiles/WMI/LwtNetLog.etl
/Windows/System32/LogFiles/WMI/Microsoft-Windows-Rdp-Graphics-RdpIdd-Trace.etl
/Windows/System32/WDI/LogFiles/WdiContextLog.etl.001
/hiberfil.sys
/pagefile.sys
/swapfile.sys
/Program Files/AMD/atikmdag_dce.log
/Windows/System32/LogFiles/WMI/RtBackup/EtwRTUBPM.etl
/Windows/debug/PASSWD.LOG
/Windows/bootstat.dat
/Windows/System32/SleepStudy/UserNotPresentSession.etl
/Windows/ServiceProfiles/NetworkService/NTUSER.DAT{fd9a35da-49fe-11e9-aa2c-248a07783950}.TxR.blf
/Windows/ServiceProfiles/NetworkService/NTUSER.DAT{fd9a35da-49fe-11e9-aa2c-248a07783950}.TxR.0.regtrans-ms
/ProgramData/Microsoft/Windows Defender/Support/MpWppTracing-20201023-170636-00000003-ffffff.bin
/ProgramData/Microsoft/Windows Defender/Scans/History/Results/Resource/{4862B78F-8B86-4B07-B4CB-254796EFB69D}
/ProgramData/Microsoft/Windows/AppRepository/Packages/Microsoft.Windows.StartMenuExperienceHost_10.0.18362.449_neutral_neutral_cw5n1h2txyewy/ActivationStore.dat
/Windows/System32/winevt/Logs/Microsoft-Windows-LiveId%4Operational.evtx

What if the computer is turned on?

- Never shutdown the computer from the system
 - Files get changed during the process (similarly to the booting process)
- If you want to proceed with off-line approach, pull the power plug
 - But think twice before you do

Why (not) to pull the power plug?

- If you pull the plug
 - you don't risk any change of the evidence
 - you immediately stop any malicious activities
- There is a big disadvantage, though
 - information may be lost immediately by virtue of the volatility of digital data
 - The contents of RAM is lost when power is off, couldn't be recovered
 - Examples:
 - Data is lost – a mail being composed
 - Crucial information that never hits disk (encryption keys, passwords)
 - System structures – list of running processes, open connections

Live capture

- Accessing a live, running system and collecting volatile information
- Data capture should follow the order of volatility
 - Data is volatile (either frequently changing and/or available only for a limited time)
 - There are different levels
 - Most volatile data needs to be captured first
 - e.g., list of open connections is more volatile than disk contents

Things to remember during live capture

- Minimize all activities on the system
 - (every action leaves/modifies traces)
- A running system persistently modifies itself even without investigation activities
 - keeps producing logs, performing SW updates, ...
- Remember the capturing is always mediated by the system that is being investigated
 - Don't trust the programs on the system
 - Be prepared the collected information might be distorted/hidden
 - Imagine a kernel rootkit hiding certain processes or connections

Perils of live acquisition

- Inherently a thin line between investigation and acquisition
 - The system needs to be investigated to establish potential sources of evidence
- It's important to document the process
 - E.g., using video/image records, a log of performed actions, etc.
 - In serious investigations work in a pair (investigating + documenting steps)

Handling primary data

Managing captured data

- Integrity protection and authenticity is necessary
 - Cryptographic hashes with them
- Store primary data as read-only and perform analysis on copies of the data
 - Data might be large, you'll need a double space (to store and analyse)
- After the analysis is done, data needs to be archived

```
analysis$ cd /storage/investigations/egi
analysis$
analysis$ mkdir rt12345
analysis$ mkdir rt12345/primary_data rt12345/work
analysis$ chmod 700 rt12345
analysis$ █
```

Acquiring evidence from storage systems

Strategies

- Byte-stream copies
 - Source is a whole disk or a volume
 - Target is either image file or another disk
 - Copies are exact (byte) replicas of the original
- Logical (sparse) acquisition
 - Capturing only specific files
 - Takes less time and space
 - Omits some information
- Acquisition of contents metadata
 - Quick, with minimal space requirements
 - Reasonable notion of the whole system
 - Inherently misses information from content

Acquisition in virtual environment

- No need to manipulate with HW devices
 - Snapshots or disk copies can be obtained easily
- It can be obtained from a device or can be retrieved from a storage “manager”
 - Virtualization, containers
 - Different formats are used
 - Must be converted to be usable by common tools

Performing full byte-stream copy

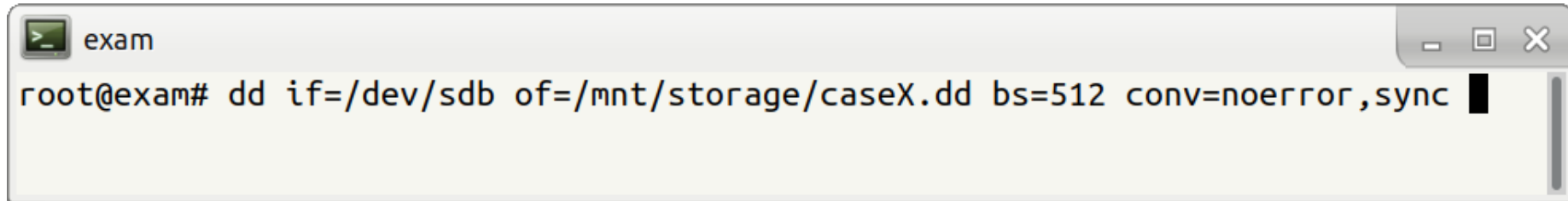
Full byte copy

- The image is exact copy of the source
 - It is a continuous byte stream stored in a single file
- Error handling
 - The source might fail to read some parts of the media
 - The acquisition tool has to handle errors properly, e.g. to fill in failing sectors with zeros (and report the problem)
 - If a sector is skipped, the addresses would change, making it difficult to reconstruct partitions, file systems data etc.

Mirroring

- Connect the source media to a computer and mirror the device directly
 - Where write blocker cannot/should not be used
 - Also usable for other media (USB sticks, memory cards, non-removable storage)
- You can consider to use the existing computer but make sure it boots a trusted OS
- Decide whether to image a whole disk or a particular partition
 - Depends on the goals of investigation and expected sources of evidence

Imaging using dd

A terminal window titled 'exam' with a standard Linux window control bar (minimize, maximize, close). The terminal text shows a root user at the 'exam' prompt executing the command: `dd if=/dev/sdb of=/mnt/storage/caseX.dd bs=512 conv=noerror,sync`.

```
exam  
root@exam# dd if=/dev/sdb of=/mnt/storage/caseX.dd bs=512 conv=noerror,sync
```

- `dd` is a common tool to transfer data between two endpoints (files)
- `if` refers to the source device (`/dev/sdb`)
- `of` refers to the target (external device)
- `bs` block size (the amount of data to read at once)
- `conv=noerror,sync` makes sure the processing doesn't stop error and failing blocks are filled with 0's

```
forensics# █
```