02-Basic Static Analysis

CYS5120 - Malware Analysis

Bahcesehir University

Cyber Security Msc Program

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General Analysis Methods

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Static Analysis

- Signature Search
- Code analysis

Dynamic Analysis

- Behaviour Analysis
- Memory Dump Analysis

Dynamic vs Static

Dynamic Analysis

- Fast and relatively easy
- Only one working path can be seen

Static Analysis

- Further investigation possible
- Slow and difficult

Result

- It is necessary to use two together!

Analysis Process

Analysis Process

- You can start with your choice.
- Recommended process
  - Basic Static
  - Basic Dynamic
  - Advance Static $\Rightarrow$ Advance Dynamic

Key Points for Analysis

Key Points

- Don't focus in details, focus on the goal
- There are multiple ways to reach your analysis goals and multiple tools that can be used. If one does not work, use the other.
- Analysis is a race, *new techniques will be released every day*, be prepared for it.

Oligomorphic Mutation

Oligomorphic Mutation [1]

- One of the first and simplest methods used to obfuscate malware was to encrypt its content
- The malware must be **exposed** in its original form upon execution, and **a decryption key** is used to unlock the malware's original content.
- The algorithm used for decryption is called the **decryptor**, and is in the *simplest case static in each copy of the sample*.
  - *Reverse Engineering* techniques can be applied to find the *decryption key* and the *decryptor*

Definition

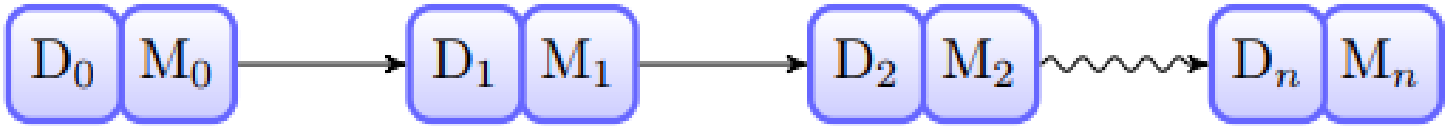
- If the sample is capable of generating a multiple decryptors n, where $n > 1$ but still a *limited* set, it is capable of an *oligomorphic* mutation
- The malware is able to generate different variances of itself upon mutation,and n different signatures must be made to detect it using signature based detection techniques.

[1] https://brage.bibsys.no/xmlui/bitstream/handle/11250/251364/348799_FULLTEXT01.pdf

Polymorphic Mutation

Polymorphic Mutation

- Polymorphic malware can dynamically change the available decryptors to *an extensive number*, making an large amount of actually used decryption methods
- The polymorphic mutation makes it **practically impossible** to *create signatures* for all variances.



(a) Oligomorphic and polymorphic malware mutating itself while spreading. For oligomorpic malware, there are n fixed different decryptors chosen by the malware producer making a set of n different variances of the malware. For polymorphic malware, the amount of decryptors is arbitrary large and generated automatically.

Metamorphic mutation

Metamorphic mutation

- Instead of changing *decryptors* and *encryption methods*, metamorphic malware **mutates its own body**, usually upon propagation.
- In some cases, a metamorphic malware sample can *decompile itself*, change its body in source code form and recompile to generate a completely new variance of itself

(b) Metamorphic malware mutating itself while spreading using a variety of code transformation techniques. The sample m_0 appears completely different from its mutated variance m_1, but the functionality remains untouched.

Malware Analysis Environment Setup

Malware Analysis Environment Setup

- Virtual or Physical Machine
- Internet Connection
- Tools
  - Process Explorer, Process Hacker
  - Process Monitor, CaptureBAT, Regshot
  - WireShark, Network Monitor
  - FakeNet, Honeyd, netcat

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Basic Static Techniques

Basic Static Techniques

- **The first step** in Malware Analysis is to perform a **static analysis** of the malware. Static analysis is necessary for analyzing **the code** or for analyzing **its structure** and for determining **its functionality**.
- The malware **does not run** in the static analysis phase. The stage in which the code is run is **dynamic analysis**.

Techniques

- Detection of malware with an antivirus
- Checking the hash values of files
- Obtaining information by examining the **texts**, **functions** and **titles** of the malware

Detection of Malware With an Antivirus

Detection with an Antivirus

- They detect by comparing file signatures with malware software database.
- This can be overcome with **any file signature change** in the malware.
- By using sites such as **VirusTotal**, malware can be scanned in **more than one antivirus engine**.

Checking File Signatures

Checking File Signatures

- **Hashing** is a commonly used method for detecting malware. **MD5** and **SHA1** are some hash algorithms used for malware detection.
- FCIV : File Checksum Integrity Verifier
- Alternative: **WinMD5 GUI**
- It can be searched on the internet for hash values to determine if there is harmful content in the file.

```
$ fciv -md5 -sha1 malware.exe
$ md5sum malware.exe
$ sha1sum malware.exe
```

Review The Text of a File I

Review The Text of a File

- A part of the content of a program consists of **texts**.
  - These texts may be related to a **message**, **URL link**, or **file copy**.
  - Such analyzes also make it easier to understand the function of the program.
- Any text that contains malicious software can be understood when examined.
  - There are programs for examining this type of data, independent of ASCII or Unicode text format.
  - Significant text data can be displayed via these programs.

Review The Text of a File II

Linux OS - strings

- **Linux**: ***strings*** command is used to get text values from executable files.
- **Windows**: *BinText*

```
MacBook-Pro:theHarvester ozgurcatak$ strings \
> /usr/local/mysql-5.7.17-macos10.12-x86_64/lib/plugin/validate_password.so
NSt3__114basic_ifstreamIcNS_11char_traitsIcEEEE
NSt3__113basic_filebufIcNS_11char_traitsIcEEEE
validate
validate_password
Oracle Corporation
check password strength
LOCK_dict_file
Can't retrieve the security context
utf8
user
login user name
priv_user
effective user name
Can't retrieve the %s from thesecurity context
/Volumes/hd2/pb2/build/sb_0-21378219-1480342151.7/mysql-5.7.17/plugin/password_
Dictionary file not specified
Dictionary file not loaded
Dictionary file size exceeded
MAX_DICTIONARY_FILE_LENGTH, not loaded
Exception while reading the dictionary file
%04d-%02d-%02d %02d:%02d:%02d
Effective value of validate_password_length is changed. New value is %d
validate_password_dictionary_file_last_parsed
validate_password_dictionary_file_words_count
length
Password validate length to check for minimum password_length
```

Figure: Example output of *strings* command

Review The Text of a File III

DLLs/URLs

With this command, it is possible to check which DLLs are used in the executable code, whether any URL link is provided.

```
MacBook-Pro:Presentations ozgurcatak$ strings winrar-x64-550.exe |grep dll
COMCTL32.dll
SHLWAPI.dll
USER32.dll
GDI32.dll
ADVAPI32.dll
SHELL32.dll
Fole32.dll
KERNEL32.dll
Delete=rarlng.dll
Delete=rarext.dll
Delete=rarext32.dll
Delete=rarext64.dll
7zxa.dll
RarExt.dll
```

Figure: Example output of *strings* command for DLLs

Review The Text of a File IV

```
C:>strings bp6.ex_
VP3
VW3
t$@
D$4
99.124.22.1 ❹
e-@
GetLayout ❶
GDI32.DLL ❸
SetLayout ❷
M}C
Mail system DLL is invalid.!Send Mail failed to send message. ❺
```

Figure: Example output of *strings* command for a malware

Review The Text of a File V

```
MacBook-Pro:Presentations ozgurcatak$ strings winrar-x64-550.exe |grep http
  <asmv3:windowsSettings xmlns="http://schemas.microsoft.com/SMI/2005/Windo
http://ocsp.thawte.com0
.http://crl.thawte.com/ThawteTimestampingCA.crl0
http://ts-ocsp.ws.symantec.com07
+http://ts-aia.ws.symantec.com/tss-ca-g2.cer0<
+http://ts-crl.ws.symantec.com/tss-ca-g2.crl0(
https://secure.comodo.net/CPS0C
2http://crl.comodoca.com/COMODORSACodeSigningCA.crl0t
2http://crt.comodoca.com/COMODORSACodeSigningCA.crt0$
http://ocsp.comodoca.com0
;http://crl.comodoca.com/COMODORSACertificationAuthority.crl0q
/http://crt.comodoca.com/COMODORSAAddTrustCA.crt0$
http://ocsp.comodoca.com0
https://secure.comodo.net/CPS0C
2http://crl.comodoca.com/COMODORSACodeSigningCA.crl0t
2http://crt.comodoca.com/COMODORSACodeSigningCA.crt0$
http://ocsp.comodoca.com0
;http://crl.comodoca.com/COMODORSACertificationAuthority.crl0q
/http://crt.comodoca.com/COMODORSAAddTrustCA.crt0$
```

Figure: Example output of *strings* command for URLs

Packed and Obfuscated Malware

Packing or Obfuscation

- Malware writers often use *packing* or *obfuscation* to make their files more difficult to detect or analyze.
- *Obfuscated* programs are ones whose execution the malware author has attempted to hide.
- *Packed* programs are a subset of obfuscated programs in which the malicious program is compressed and cannot be analyzed.
- *Legitimate* programs almost always include many strings.
  - Malware that is packed or obfuscated contains very few strings. If upon searching a program with Strings,
  - you find that it has only a few strings, it is probably either obfuscated or packed,

Packing Files I

Packing Files

- When the packed program is run, a small wrapper program also runs to decompress the packed file and then run the unpacked file.

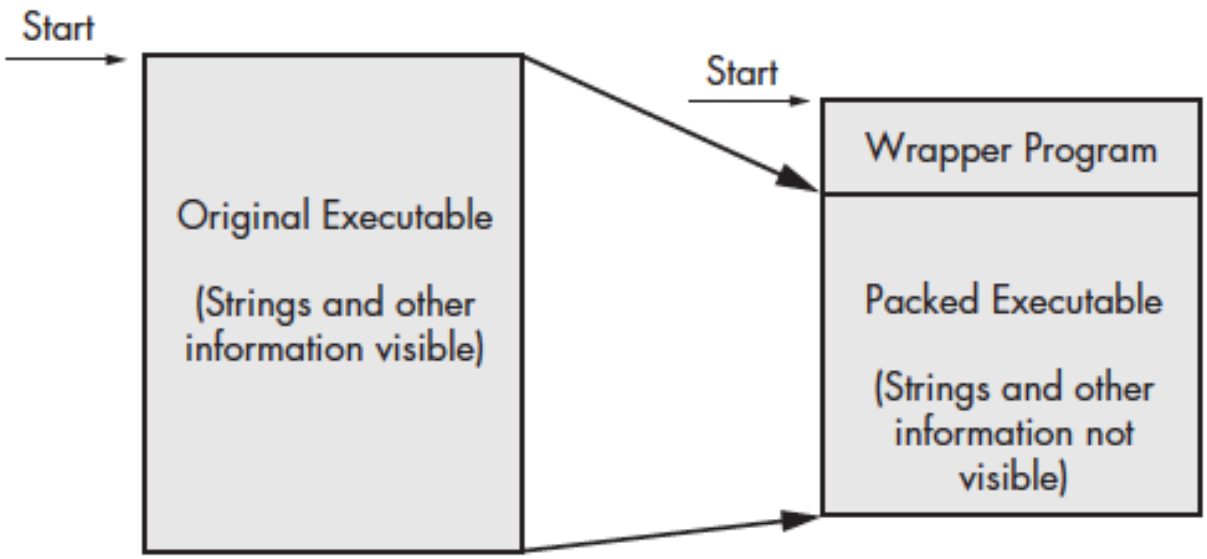
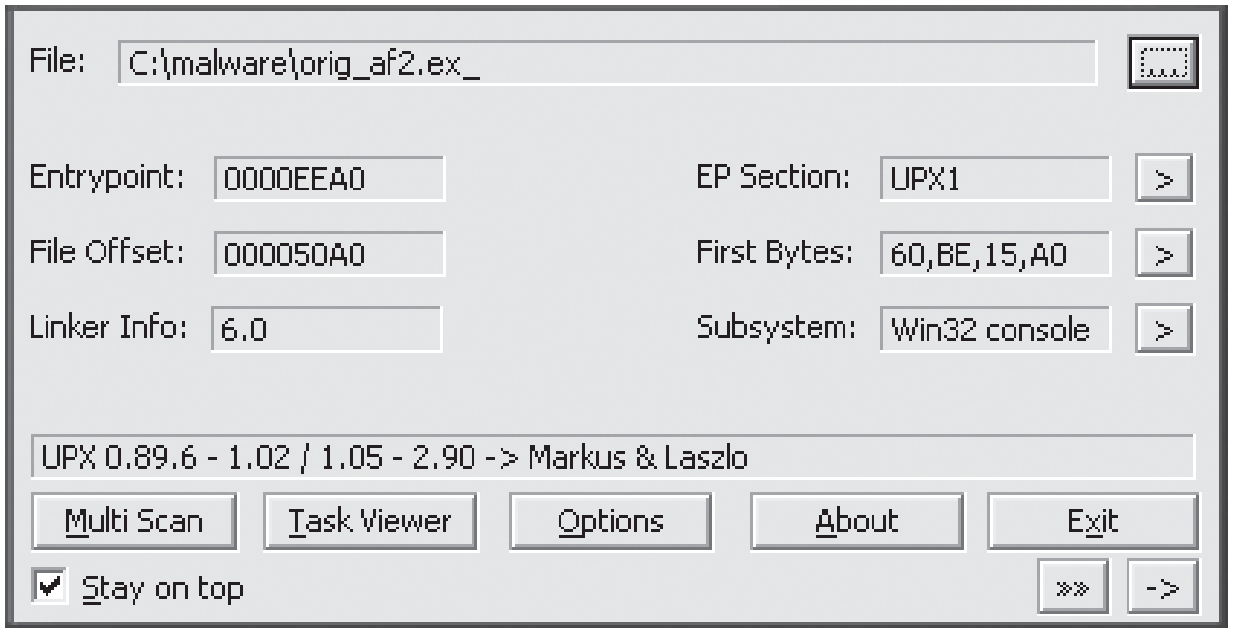


Figure: The file on the left is the original executable, with all strings, imports, and other information visible. On the right is a packed executable. All of the packed file's strings, imports, and other information are compressed and invisible to most static analysis tools.

Packing Files II

PEiD

- One way to detect packed files is with the PEiD program.
- You can use PEiD to detect the type of packer or compiler employed to build an application, which makes analyzing the packed file much easier.
- As you can see, PEiD has identified the file as being packed with UPX version 0.89.6-1.02 or 1.05-2.90
- When a program is packed, you must unpack it in order to be able to perform any analysis.



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Portable Executable File Format

Definition

- The Portable Executable (PE) file format is used by Windows **executables**, **object code**, and **DLLs**.
- The PE file format is a data structure that contains the information necessary for the Windows OS loader to manage the wrapped executable code.
- **File extensions**: .acm, .ax, .cpl, .dll, .drv, .efi, .exe, .mui, .ocx, .scr, .sys, .tsp

Tools for Windows

Packet Analysis

- LordPE, XPELister
- PEiD
- UPX
- OllyDump, HideOD, OllyAdvanced, OllyScript
- Quick Unpack

System Analysis

- Sys Internals
- RegShot
- MD5sum
- CaptureBAT

Code Analysis

- IDA Pro
- OllyDbg
- BinText
- XORSearch

Conclusion

Conclusion

- Using a suite of relatively simple tools,
  - we can perform static analysis on malware **to gain a certain amount of insight** into its function.
- But **static analysis** is typically only **the first step**, and further analysis is usually necessary.
- The next step is **setting up a safe environment** so you can **run the malware** and perform basic **dynamic analysis**.

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Linux

Tools

- For the Linux operating system, there are fewer malware than Windows.
- **Linux is mostly preferred by software developers** when considering the usage rates of personal computers.
- However, **this number is increasing** day by day with the development of subjects such as **IoT** and **mobile**, and it is also taking place within the **scope of consumer electronics**.
- The number of Linux operating system devices is increasing day by day.

REMnux I

REMnux

- A distribution called **REMnux** is used to perform malware analysis on the Linux platform.
- This distribution will be used for the analysis of malware in Linux environment.

REMnux II

Statically Examine Files

- Inspect file properties using pescanner, pestr, pyew, readpe, pedump, peframe, signsrch, readpe.py.
- Investigate binary files in-depth using bokken, vivbin, udcli, RATDecoders, radare2, yara, wxHexEditor.
- Deobfuscate contents with xorsearch, unxor.py, Balbuzard, NoMoreXOR.py, brxor.py, xortool.
- Examine memory snapshots using Rekall, Volatility.
- Assess packed files using densityscout, bytehist, packerid, upx.
- Extract and carve file contents using hachoir-subfile, bulk_extractor, scalpel, foremost.
- Scan files for malware signatures using clamscan after refreshing signatures with freshclam.
- Examine and track multiple malware samples with mas, viper, maltrieve, Ragpicker.
- Work with file hashes using nsrllookup, Automater, hash_id, ssdeep, totalhash, virustotal-search, vt.
- Define signatures with yaraGenerator.py, autorule.py, IOCextractor.py, rule-editor.

REMnux III

Handle Network Interactions

- Analyze network traffic with wireshark, ngrep, tcpick, tcpxtract, tcpflow, tcpdump.
- Intercept all laboratory traffic destined for IP addresses using accept-all-ips.
- Analyze web traffic with burpsuite, mitmproxy, CapTipper, NetworkMiner.
- Implement common network services using fakedns, fakesmtp, inetsim, "ircd start", "httpd start".

Examine Browser Malware

- Deobfuscate JavaScript with SpiderMonkey (js), d8, rhino-debugger and Firebug.
- Define JavaScript objects for SpiderMonkey using /usr/share/remnux/objects.js.
- Clean up JavaScript with js-beautify.
- Retrieve web pages with wget and curl.
- Examine malicious Flash files with swfdump, flare, RABCDAsm, xxxswf.py, extract_swf.
- Analyze Java malware using idx_parser.py, cfr, jad, jd-gui, Javassist.
- Inspect malicious websites and domains using thug, Automater, pdnstool.py, passive.py.

Examine Document Files

- Analyze suspicious Microsoft Office documents with officeparser.py, oletools, libolecf, oledump.py.
- Examine PDFs using pdfid, pdfwalker, pdf-parser, pdfdecompress, pdfxray_lite, pyew, peepdf.
- Extract JavaScript or SWFs from PDFs using pdfextract, pdfwalker, pdf-parser, swf_mastah.
- Examine shellcode using shellcode2exe.py, sctest, dism-this, unicode2hex-escaped, m2elf, dism-this.py.

REMnux IV

Investigate Linux Malware

- Disassemble and debug binaries using bokken, vivbin, edb, gdb, udcli, radare2, objdump.
- Examine the system during behavioral analysis with sysdig, unhide, strace, ltrace.
- Examine memory snapshots using Rekall, Volatility.
- Decode Android malware using Androwarn, AndroGuard.

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Lab I

Windows

- Lab 1: Malware hash value
  - Malware: com.parental.control.v4_1.0.apk
  - Hash algorithm: md5
  - Tool: fciv.exe
- Lab 2: Malware string search
  - Malware: candy_corn
  - Tool: Bintext
- Lab 3: Getting Information from PE head
  - Malware: defref.exe
  - CFF Explorer
- Lab 4: Packer detection with PEID
  - Malware: tnnbtib.exe
    - Pack with **upx**
  - Tool: PEid

Lab II

Linux

- Lab 1: Malware hash value
  - Malware: Linux-lady.zip
  - Hash algorithm: md5
  - Tool: md5sum
- Lab 2: Malware string search
  - Malware: Backdoor.Linux.CGI.a
  - Tool: string
- Lab 3: Packer detection and Getting Information from PE head
  - Malware: tnnbtib.exe
  - Tools: pescanner, pyew