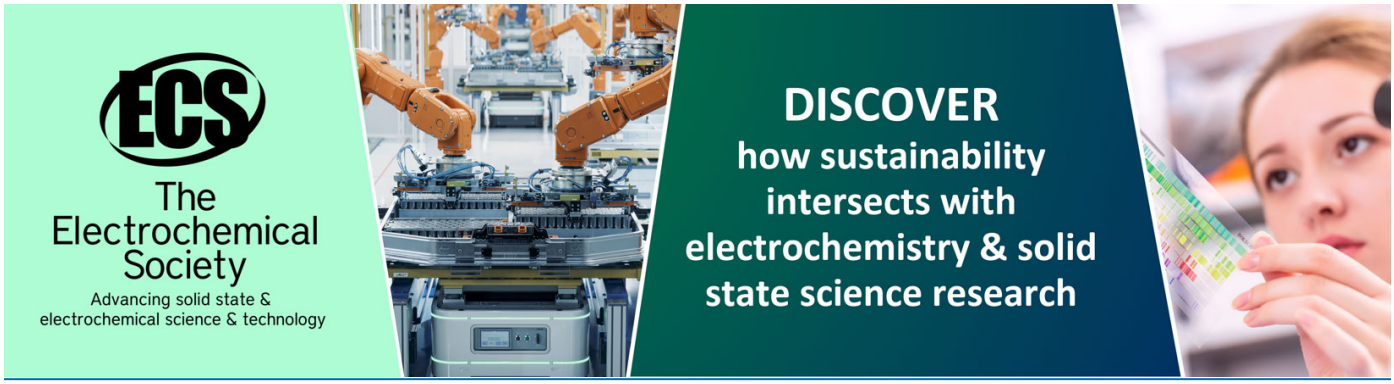
Malware Analysis and Detection Using Reverse Engineering Technique



Malware Analysis and Detection Using Reverse Engineering Technique

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Abstract. The increasing use of internet and technology today cannot be separated from cybercrime that can threaten its users. The cyber threat like malware attempts to infiltrate the computer or mobile device offline or the internet, chat (online) and anyone can be a potential target. Malware, also known as malicious software, is often used by cybercriminals to achieve their goals by tracking internet activity, capturing sensitive information or block computer access. In the past two years, the more malicious software has been created than in the previous ten years combined. Malware has its own defense system and it is possible to hide from antivirus or even infect the antivirus itself. Malware can be handled by knowing how to work when doing an attack into a computer system. This research aims to analyze malware by using malware sample to better understanding how they can infect computers and devices, the level of threats they pose, and how to protect devices against them.

1. Introduction

As time moves forward, everything around us changes. We are almost entirely dependent on technology, and it becomes an important role in modern life. From photo memories to important documents, we store everything on our computers and mobile devices. But, although technology has made our lives convenient, it has also allowed a new form of crime, cyber threat. Even the business processes in the enterprise need the third parties in facing the security threat. The data security services must be specified [1]. Cybercriminals can attack computer by using malware to track internet activities and capturing sensitive information such as username and password from financial websites.

Malware, or malicious software, is any program or file that intentionally designed to harm, infiltrate, or damage a computer, server or computer network. Malware is also commonly defined as malicious code. This software can disable or disrupt the operation of a system, allowing hackers to gain access to confidential and sensitive information and to spy on the computer and the owner of the computer itself. Malware is specifically made to be hidden so that they can remain inside a system for a certain period of time without the knowledge of the system owner. Usually, they disguise themselves into a clean program; even some of the latest

malware has the ability to avoid detection of antivirus. The effect of malicious software is much more dangerous for corporates than for personal users. If malware attacks system's network, they can cause widespread damage and disruption, requiring extensive recovery efforts within the organization.

Malware analysis by using reverse engineering method become one solution that can be used to extract data in a malware to find out how the malware is working when it attacks into the system. Therefore, this study aims to perform malware analysis so as to know the dangers of malware and how to prevent it and protect our devices against it. In this study, a file named best.exe will be used as a malware sample to find out information about malware contained in it.

2. Related Works

Analyzed malware sample using a static and dynamic method has been researched [2]. The results of the use method can provide complete information on TT.exe malware, but it takes a long process of time. The first thing to do is to identify a suspected malware program, then detect techniques packaged/disguised by malware, and find the malware. The method used to provide information that can actually be used malware, network connections made by malware against servers, and malware processes in the system. This malware can shut down windows systems like antivirus, firewall, and recovery system. Then the study to analyzed malware and proves that using Reverse Engineering technique has a high success rate in analyzing malware. However, it causes high complexity [3]. Malware can be handled if knowledge of the malware movement when attacking a system is revealed.

Malware is malicious software that is currently increasing at an alarming rate [4]. Meanwhile, another research discussed developments in the detection of android malware, which uses static analysis techniques, dynamic analysis, and hybrid. The main problem in evaluating approaches to malware attacks is due to the absence of more complete malware datasets [5]. Another research combines two methods of static analysis and dynamic analysis that can be used as an indicator to analyze Trojan based on its behavior. Therefore, how the behavior of Trojan when infected windows operating system can be depicted [6].

3. Malware Analysis

Malware analysis is done to provide the necessary information to deal with malware attacks by knowing what's going on in the system, the location of the infected file, detecting how the malware works, and which types of malware it belongs to. Malware can be categorized into several types, and to perform malware analysis [4,7,8]. Precise technique and method are required so the purpose of analysis can be achieved.

3.1 Types of Malware

The following are some common types of malware:

1. Adware
   An adware is a type of malware that automatically delivers advertisements and displays ads on your computer. Adware is the most lucrative malware and the least dangerous.
2. Spyware
   A spyware is designed to monitor, tracking internet activities, and other activities. Spyware just like adware often sends activities to advertisers. Spyware can violate privacy and has the potential to be abused this becomes controversial.
3. Virus
   A virus is malicious software that cybercriminals program to reproduce. Viruses can be used to create botnets, steal information, steal money, harm host computers and network and more. The virus most often is spread by files between computers or sharing software.
4. Worm
   A worm like a virus, a program that replicates itself and worms, are infectious. Worm destroys files on the computer and data. They spread over computer networks by exploiting operating system vulnerabilities. Type of computer virus can be classified as computer worms, and worms often spread by sending mass emails with infected attachments to users contact.
5. Trojan
   A trojan is a type of malware that trick users into downloading and installing malware by disguise. Trojan is the most dangerous malware. Trojans are used for discovering your financial information, steal data (logins, electronic money), modify files, taking over your computer's system resources, and more.
6. Rootkit
   A rootkit is a type of malicious software that gives an unauthorized user privileged access to a computer and designed to remotely access a computer without being detected by security programs or users. It is the hardest of all malware to detect and therefore to remove.
7. Backdoors
   A backdoor provides a network connection for other malware to enter or for viruses or spam to be sent or hackers.
8. Keyloggers
   The keylogger records everything entry made on your computer without the permission of the user in order to glean your login passwords, names, and other sensitive information.
9. Ransomware
   Ransomware is the software finds all your files and encrypts them and then leaves messages for you. To regain access to data, then we have to pay a ransom. Ransomware often spreads like a normal computer worm through some other vulnerability in a

network service or downloaded file. Ransomware encrypts data on the computer and used an encryption key that only attackers know. If the ransom is not paid, often the data is permanently deleted.

3.2 Malware Analysis Method

When performing malware analysis, the malware sample used is an executable file format, which won't be human-readable. Therefore, some methods are used to extract the file so that it can get information from malware. There are two main malware analysis approaches, namely static analysis and dynamic analysis; both methods are subsequently categorized as basic or advanced [9] as seen in Figure 1.

Figure 1. Malware analysis method

From Figure 1, we can describe the methods as follow:

1. Basic Static Analysis
   Programs that are suspected of being malware will be tested with scanning using antivirus, then hashing and detection packed or obfuscated in the program. To detect the packer program used so that we can unload the malware file is PEiD. The portable executable structure of the program will be analyzed.
2. Advanced Static Analysis
   Advanced static analysis stage includes disassembly or debugging to analyze strings, libraries, and functions linked by using IDA disassembler.
3. Basic Dynamic Analysis
   The basic method in dynamic analysis, in observing the work of a system or behavior of malware, a virtual machine is used. So, if the executed malware is damaging the system then the main system is not damaged due to malware that is running.
4. Advanced Dynamic Analysis
   In advanced dynamic analysis methods, an analysis of the Windows operating system and registrialware analysis monitoring process and data analysis packages created by malware.
5. Malware Analysis Report
   Reports of malware analysis results obtained are based on static analysis and dynamic analysis. Therefore, the report information about the characteristics of malware is obtained.

3.3 Reverse Engineering Technique

According to [10], the reverse engineering process in software or application can be implemented with the steps:

1. Assembly
   Assembly language is used for microprocessors and other programmable devices which any low-level programming language. An assembly language is not just a single language but rather a group of languages and the most basic programming language available for any processor. Assembly language cannot recognize high-level languages like Java and Pascal.
2. Disassembly
   Disassembly is used for transforming assembly language into machine code. Disassembly is a reverse assembly process [2].
3. Debugging
   Debugging is a method which developers can implement to search bugs, subtract bugs, and isolate the source of the problem. Debugging is used for executing testing from each core process in malware [11].
4. X86 Architecture
   The X86 architecture is a design of complex instruction set computer with varying instruction length. Basically, on the internal; of most modern computer architectures including x86 follow the Von Neumann architecture. In the design of the reconfigurable system, the interoperability could also be an issue in the architecture [12].
5. Instruction
   Instruction is construction from assembly program. An assembly of x86 instruction consists of mnemonic and zero or operands.
6. Hashing
   The hash process is executed for verification before and after the malware analysis process. Verification is executed to determine the absence of hash changes in the sample malware after the analysis process.
7. String analysis
   Strings in a program are values that will be loaded from malware sample when executed. Reverse engineering process must be done for string analysis to get strong evidence from malware sample.

4. Conclusion

In this research, we use best.exe as a malware sample and perform some experiments by executing it to observe how the malware works. To prevent other systems from getting infected by malware sample, the virtual machine was used for the analysis. On the laptops, VMWare Workstation was installed with Windows 7 as guest OS. With VMWare Workstation, the system can go back to a non-infected system without reinstalling the guest OS using snapshot.

The following tools were used for help malware analysis which is categorized by malware analysis methods. Static method tools can be seen in Table I, and dynamic tools in Table II.

Table 1. Static Tools

Basic Static Analysis	
Tools	***Description***
CFF explorer	is used for analyzing portable .exe file without affecting the internal structure
PEview	is used for displaying the structure and content of the .exe file
Virustotal.com	is a website for checking malware against a program
Advanced Static Analysis	
Tools	***Description***
IDA	The Interactive Disassembler (IDA) is used for disassembling binary code
Dependency Walker	is used for analyzing the dependencies used by the malware sample

Table 2. Dynamic Tools

Basic Dynamic Analysis	
Tools	***Description***
VM Ware Workstation	is used as a virtual machine to run the malware sample
Process	is used for monitoring and displaying all activities

Basic Dynamic Analysis	
Tools	***Description***
Monitor	within the system in real-time
Process Explorer	is used for monitoring the processes that are currently running in a system path
Wireshark	is used for capturing and analyzing network traffic
Advanced Dynamic Analysis	
Tools	***Description***
Olly Dbg	is used for debugging binary code

There are many tools that can be used to perform malware analysis. We can choose these tools according to our needs. Some of these tools can be downloaded for free through their official website, and some of them require us to pay the full version of the software.

4.1 Static Analysis

After choosing the tools, malware analysis began with static analysis by using static analysis tools to get the information that can be retrieved by looking at the .exe file's PE header information. Information that will be obtained such as whether the file is really malware or not, what kind of malware it is, what programming language it contains. For the first step, we use CFF Explorer to open the malware sample. This tool can give us the information related to the malware that we want to investigate. The process of this step can be seen in the figures 2.

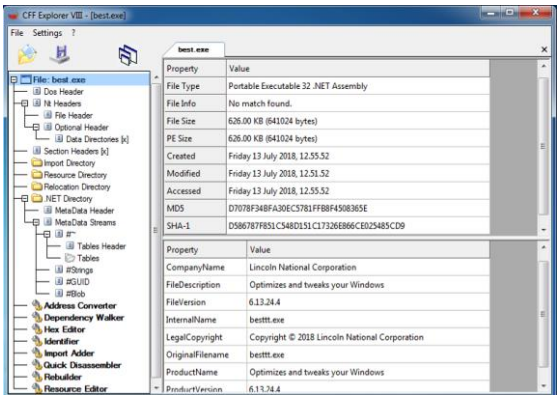

Figure 2. Malware static analysis using CFF Explorer

Figure 2 shows information about the identity of the best.exe file. From the analysis obtained information about the file size which is 626 KB / 641024 bytes, with 32.NET assembly Portable Executable (PE) file type, and the manufacturer is Lincoln National Corporation. The file has the original name of best.exe with file version 6.13.24.4 (see Figure 3).

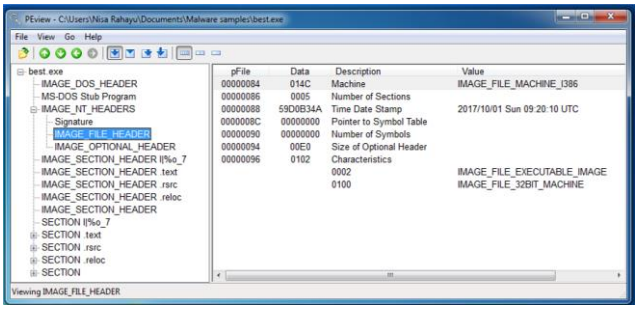

Figure 3. Analyzing PE structure with Preview

In Figure 3, it is shown that the best.exe file has a file structure consisting of several sections. The analysis using PEview above also obtained the date of the file made. The file is made on Sunday, 01/10/2017 at 09:20 UTC. Details of each section can be seen in the table III.

In addition to using software, this paper also uses a website that is virustotal.com to analyze malware samples so it can find out whether the file best.exe really is a malware and includes which type of malware the file as shown in Figure 4.

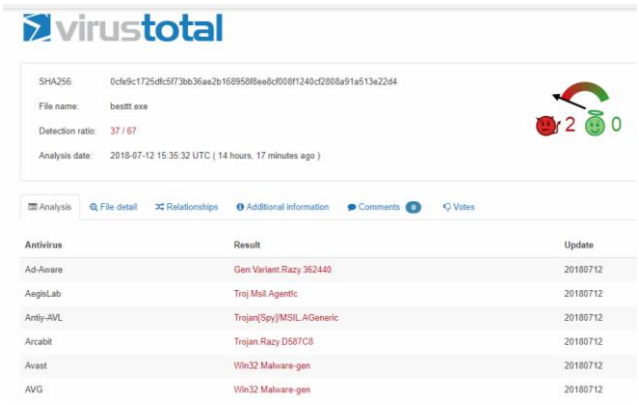

Figure 4. Malware static analysis using virustotal.com

Based on the scanning of some antivirus on virustotal.com site, we obtained some information that the best.exe file is a malware that is included in Trojan type with the code SHA256 of 0cfe9c1725dfc5f73bb36ae2b168958f8ee8cf008f1240cf2 808a91a513e22d4.¬ The next step is to disassemble the malware sample to find out the commands used by the malware. IDA software is used to perform disassembly processes resulting in assembly language source code from machine-execution code. In this study, IDA software used is IDA freeware. Example of disassembling binary code can be seen in Figure 5.

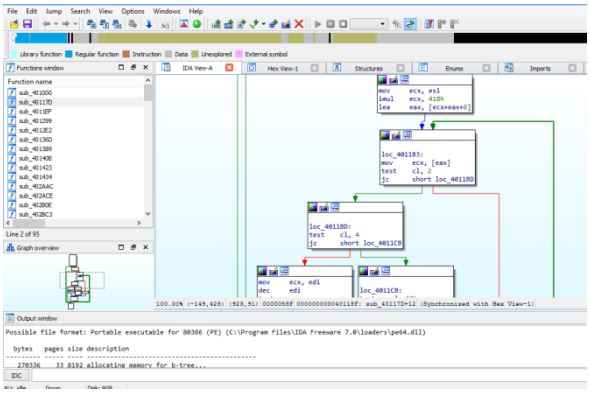

Figure 5. Example of disassembling binary code with IDA

4.2 Dynamic Analysis

The first step in the dynamic analysis is to record all malware activity when running the sample. To do so, Process Monitor and Wireshark are run first before running the sample. So that as soon as the sample is executed, the process the monitor shows all disk and registry activity of the currently running sample as shown in Figure 6 and 7 respectively.

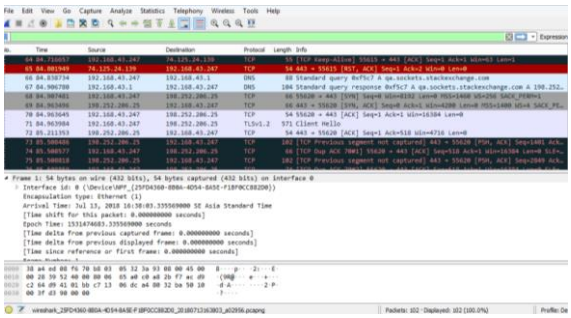

Figure 6. Analyzing malware network traffic with Wireshark

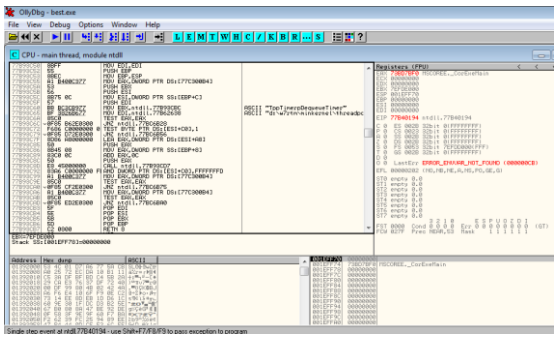

Figure 7. Debugging malware sample with Ollydbg

5. Result Analysis

Malware analysis that has been done with the best.exe file as malware sample using some malware analysis tools got a result that file of the best.exe is a malware which is virus Gen:Variant.Razy with the file size of 626 KB. Virus Gen:Variant.Razy is a virus that can be detected by some anti-virus and anti-malware because the virus is attacking computer systems with Windows OS. Some capabilities of the virus Gen:Variant.Razy according to the results of the analysis are as follows:

1. Can hide traces after download

   The code is used:
   `"<Input Sample>" opened`
   `"C:\best.exe:Zone.Identifier"` (with delete access)
2. Know the computer name that is active
   The code is used:
   `"<Input Sample>" (Path: "HKLM\SYSTEM\CONTROLSET001\CONTROL\COMPUTERNAME\ACTIVECOMPUTERNAME"; Key: "COMPUTER NAME")`
3. Make the computer sleep mode with a long

   The code is used:
   `"<Input Sample>" sleeping for "1566804069" milliseconds`
4. Create the new processes/tasks

   The code is used:

   ```
   "<Input Sample>" is creating a new process (Name:
   "C:\best.exe", Handle: 800)

   "<Input Sample>" is creating a new process (Name:
   "%WINDIR%\SysWOW64\wscript.exe", Handle: 612)

   "wscript.exe" is creating a new process (Name:
   "%WINDIR%\SysWOW64 \cmd.exe", Handle: 772)

   "cmd.exe" is creating a new process (Name:
   "%APPDATA%\remcos\remcos.exe", Handle: 124)
   ```

5. Can send information about infected computer to hacker
6. Record browsing history

This virus can be downloaded while searching the internet. Most of the users are unaware of how the virus has been installed in their computer until the antivirus software detects any

malware or virus threats. Based on the analysis that has been done, some common symptoms that occur when the computer has been infected with the virus Gen: Variant.Razy include:

1. High and abnormal CPU and VGA usage
2. Windows slows down
3. All programs work slower than before
4. Appears browser popups that recommend fake updates

To overcome these viruses, they can be checked using antivirus software and by resetting the browser to default settings.

6. Conclusion

Based on the analysis of malware using reverse engineering techniques that have been done in this study, the following conclusions are obtained:

1. Reverse engineering is an appropriate technique for use in analyzing malware
2. Static analysis and dynamic analysis methods each have advantages in the process of analyzing malware, then by combining the two methods will be able to provide more accurate results.
3. Each type of malware has its own way of working and threats, therefore malware analysis is an important thing to do in order to find the right steps to overcome and prevent malware attacks.

7. Reference

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