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Multiple Logs Analysis for Detecting Zero-Day Backdoor Trojans

Sinchai Caravut
Cleveland State University

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SINCHAI CARAVUT

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King Mongkut's Institute of Technology Ladkrabang

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This thesis has been approved

for the Department of Computer and Information Science

and the College of Graduate Studies by

____

Dr. Chien-Hua (Mike) Lin

____

Department & Date

____

Dr. Barbara A. Benander

____

Department & Date

____

Dr. Victor Matos

____

Department & Date

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SINCHAI CARAVUT

ABSTRACT

Trojan horses commonly known as “Trojans” are the computer threats that have been recently causing trouble on the internet because of their new propagation techniques. Social engineering has become a popular strategy to deceive people to run the attacker’s malicious programs. Trojans use this technique to propagate themselves from a computer or a network to others, thus making them hard to prevent. The only way to keep computers and networks safe from them is by detecting them as soon as possible. Because of their quiet behavior, it’s hard to detect by only IDS (Intrusion Detection System) log analysis; therefore, multiple log analysis is presented for detecting zero-day Trojans. Since there are many kinds of Trojans nowadays, for the first phase we will only concentrate on zero-day backdoor Trojans.

Basically, IDS logs, connection logs, process activity logs and system logs are considered for monitoring user activities and traffic behavior. We make the list of process activities from studying the behavior of many kinds of backdoor Trojans. For example, most backdoor Trojans are downloaded from suspicious websites, which can be revealed from IDS logs and connection logs. Next, process activity logs and system logs can monitor applications' behavior when users try to install backdoor Trojans such as opening unusual ports, hiding processes, modifying the registry for auto-startup, or disabling antivirus services. We look closer at IDS logs if infected machines try to connect to remote IRC servers for sending information every time they start or close or if they generate anomalous traffic such as port scanning or DDos (Distributed Denial of Service) used to attack neighbors. Because of thorough examination, multiple log analysis can create a powerful and accurate alarm for detecting zero-day backdoor Trojans.

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INTRODUCTION

A Trojan horse or Trojan is a program that behaves like a normal program but, behind the scenes, it runs some malicious work. There are many types of Trojans, all of which have differences in behavior and level of severity. One of the most dangerous types of Trojans is the backdoor Trojan because compromised machines will be fully controlled by attackers as if they are administrators of those machines. Moreover, it can raise other harmful activities to neighbors such as unauthorized access, DDoS, and network scanning. When a backdoor Trojan is installed on a machine, it uses some technique to hide itself and opens communication port(s) for attackers who want to remotely access the machine at that time or later.

Trojans have been a danger for a long time and are still present in the Internet world [1]. Social engineering is a popular approach to propagate them on people [1]. Attackers send a backdoor Trojan or a malicious URL to peoples' mailboxes and disguise it as an interesting thing from someone who can be trusted. Once the targeted people run that Trojan or open the given URL, a Trojan will be installed on their machines silently.

Because of this stealthy process, it's a difficult task for administrators to prevent and detect Trojans by only intrusion detection system (IDS) especially zero-day Trojans—Trojans unknown to the public. It implicitly means we don't have their signatures, so signature-based IDS cannot recognize them. Even though we already have anomaly-based IDS, which can detect malicious programs without using signature matching, this kind of IDS highly generates false positive alarms since the nature of network traffic and exploiting traffic are always changed.

In this paper, I present a new approach to detect zero-day backdoor Trojans by using a Multiple Logs Analysis System (MLAS). MLAS considers IDS logs, connection logs, process activity logs, system logs and more for monitoring activities of processes and data traffic generated by these processes. I set the list of process activities for comparing detected activities with backdoor Trojans and give weight for each of them. The list of process activities is set from investigating many backdoor Trojans' behavior such as opening unusual ports, hiding processes and modifying registries. For example, when users access or download software from suspicious websites, the activities are logged into a connection log. Then MLAS checks those websites with online link scanners to see if they are malicious. Further, MLAS looks into machine logs—Windows event log and process activity log-- to find out what processes try to kill antivirus program or other system monitor tools and to detect more as mentioned in the list of process activities. Finally, MLAS look at the network intrusion detection system's logs to check data traffic inside the network. It tries to detect any exploit generated by infected machines

This paper is organized as follows: Section 2 discusses related works and tools, which are used in this work. More information about the Trojan horse is covered in section 3 including backdoor Trojan characteristics. Section 4 introduces MLAS architecture. The list of process activities, weight and event score are specified in section 5. For the next section, MLAS application design and process flow will be technically explained. Implementation, experimental results and result analysis are reported in section 7. Finally, in section 8, we summarize this paper and discuss further work.

CHAPTER II

RELATED WORKS AND TOOLS

LinkScanner Pro [2] is a product of Exploit Prevention Labs, which can analyze the website content and the embedded application behavior of given IP addresses or domain names. It checks not only inside the website but also URLs, to which the page can connect. LinkScanner Pro detects the malicious content, exploit software, social engineer or phishing with an up-to-date malware-definition database. It classifies websites into four categories. Each of them indicate the level of severity. MLAS uses these levels to score an activity in the weighting process.

McAfee SiteAdvisor [3] is another link-check application, which contains the same functionalities as LinkScanner. This application builds an automated robot system to check whether websites contain malicious software, social engineer, phishing or a bad history. This information will be kept in its database and the application will rank them into 3 levels of harmfulness. MLAS converts these levels into a score of an activity. The reasons that MLAS uses more than one link scanner are to assure the information about the severity of website and to have a big malware-definition database.

Snort [4] is a widely used signature-based IDS, which can detect many attacks using pattern matching. It monitors all data traffic passed through a network and compares traffic behavior with signatures. If any traffic behavior matches with any signature inside a signature-definition database, it will generate alarms to administrators. MLAS get information from the alarms and send them into behavior detection processes for comparing process activities and scoring process activities.

Project Lasso [5] is a Windows event log collector. It converts the event log from binary format to text format and sends it across a network via syslog-ng protocol (TCP) to a syslog server. In MLAS, we use only a feature of converting the event log to txt format. This log data will be sent to a database via the MLAS log management system. Project Lasso is an open source application developed by LogLogic Inc.

Port Reporter [11] is an application used to record all connections created by processes on a local machine. The log file contains remote IPs, remote ports, local IPs, local ports and process names, which make a connection. This information is useful for the Behavior Comparing System to compare traffic activities if it meets one in the list of process activities. Also, the remote IPs are sent to the Link Check System for examining the dangers of remote servers.

Sophos Anti-Rootkit [12] is a rootkit scanner. It can detect and clean up hidden processes, hidden registries and hidden files in machines. Some Trojans use rootkit techniques to conceal themselves and Windows cannot see them without using special tool. Sophos Anti-Rootkit was introduced to find these hidden objects and send the object names to MLAS. Sophos Anti-Rootkit is a freeware developed by Sophos Inc.

For a database server, MLAS uses Oracle [13] -- the popular relational database management system product in the market. Oracle provides thin-client JDBC for Java, thus making it easy for Java development. Also, Snort has an interface communicating with Oracle in order to keep log data into the database. The version we used in MLAS is Oracle10gXE database server and client.

System safety monitor (SSM) [14] is a system monitor application. It monitors process activities, inter-process activities, DLL injection, low level access of hardware, etc. SSM allows user to create rules for controlling processes when they try to access resources of other processes, or to start or to terminate processes. MLAS use this application to detect keyloggers, DLL injection and process termination.

These powerful applications provide useful data to MLAS to detect processes run by backdoor Trojans. Port Reporter records all connections created by processes on a local machine and sends remote IPs to LinkScanner Pro and McAfee SiteAdvisor to check their content. Any anomalous network traffic will be captured by Snort. All process activities can be found in Lasso logs and System Safety Monitor logs. For hidden objects, MLAS uses Sophos Anti-Rootkit to find them. Log data and results are kept in an Oracle database. For the next section, I will discuss how processes work together and what the architecture of MLAS is.

CHAPTER III

THE TROJAN HORSE

The word “Trojan horse” came from the story of the Trojan War. The war happened when the Greeks wanted to penetrate through the walls of Troy, which had been surrounded by many troops. The Greeks made a huge horse as a sign of peacefulness and gave this gift to Troy, but inside the horse, there were many Greek troops waiting to attack Troy. Troy accepted the gift and brought it into the city. After the city celebrated their peacefulness and became drunk, the Greek troops inside the horse went outside and opened the gate allowing other troops to take over the city [16].

In the computer security term, we use the name of the Trojan horse to name the malicious programs, which have characteristics like the Greeks’ horse. The Trojan is a malicious application, which pretends to be a legitimate application. When users install the Trojan, the hidden code will be installed as well. The backdoor Trojan is a kind of Trojans but it has some different characteristics, such as opening backdoor ports to the system. Attackers can access the system by creating a remote connection and controlling it to do many things (these kinds of Trojans are also called Remote Access Trojans

(RAT) [17]. For example, the common activities are

- Using the system to be a mail relay and sending spam in order to propagate themselves or something else
- Stealing users' identity or private information such as credit card numbers, account numbers and SSN
- Monitoring users' activities
- Attacking neighbor
- Modifying machines' object such as files, system registries and system log

How do the backdoor Trojans work?

1. Attackers distribute Trojans in many ways such as spam email with an attached backdoor Trojan program

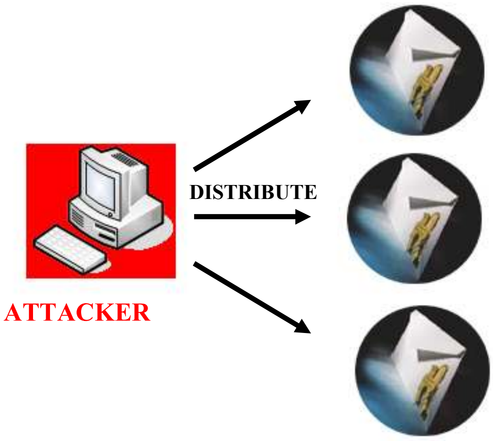


Figure 1 An attacker distributes Trojan emails

2. When users receive email and run the backdoor Trojan program, the Trojan will be installed on users' machine, open backdoor port(s) and notify attacker via IRC, ICQ, MSN or email.

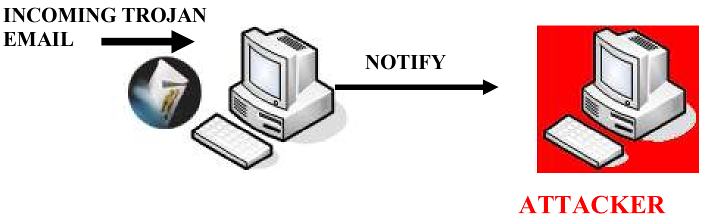


Figure 2 A user receives a Trojan email, runs the Trojan program and notifies to the attacker

3. Attackers can remotely connect to the infected machine and control it

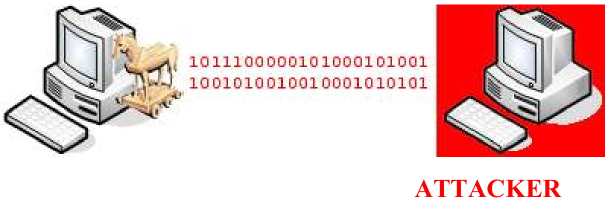


Figure 3 An infected machine opens a backdoor port so that the attacker can remotely connect to it to control it

Backdoor Trojans' characteristics and activities [6], [7], [8], [9]

1. propagates itself by
   - attaching Trojan's executable files in spam emails.
   - sending Trojan's executable files via Internet Relay Chat (IRC), MSN or ICQ.
   - exploiting an existing vulnerability or through an open port such as
     - The Microsoft SQL Server 2000 or MSDE 2000 Audit
     - The Microsoft Windows DCOM RPC Interface Buffer Overrun Vulnerability
     - The Microsoft Windows Local Security Authority Service Remote Buffer Overflow
   - inserting its code in other files or programs.
   - enumerating all the shared drives and attempts to copy itself to the root folder of the shares.
   - downloading code to machines when they visit malicious or compromised web pages.
   - copying itself to the shared folders of some popular file-sharing networks such as Kazaa, Edonkey.
2. consists of a server component and a client component.
3. sends victim's information via SMTP mail, IRC, ICQ pager, ICP Pager, Yahoo Messenger, AOL Instant Messenger, MSN Messenger, and a remote PHP page.
4. contains its own SMTP engine for constructing outgoing messages.
5. injects a companion backdoor dll into a system dll/exe process space such as csrss.exe, svchost.exe, iexplore.exe. This can avoid personal firewall detection.

6. launches the Internet Explorer process and attempt to access malicious web sites
7. hides Trojan’s files and services using a rootkit.
8. hides or unhide files, directories, keys, service names, or process names.
9. sets the file attributes of the dropped files to SHR: System, Hidden and Read only.
10. performs DoS attack.
11. uses the XCP software to hide the copy of the Trojan files and the created registry subkeys.
12. attempts to add the Trojan application as a trusted application into the firewall authorized application list or the Windows Firewall.
13. connects to IRC servers to wait commands.
14. normally distributes as a Win32 PE exe dropper that may be disguised as a JPG or BMP picture.
15. attempts to obtain access to the password cache.
16. a Trojan server process on victim machine make the connection to the client on port 80 using HTTP. In this way, it attempts to avoid personal firewall detection.
17. attempts to SPAM others by searching for email addresses in the Windows Address Book, Internet Explorer's cache folder, and the %Temp% folder in order to spread the Trojan through email.
18. creates a registry run key to load the Trojan processes at Windows startup.
19. kills running processes such as Remote Access Connection Manager, Remote Procedure Call, Remote Procedure Call Service, DCOM.
20. kills or disables firewall, antivirus programs, the windows update service and system monitoring tools.

21. decreases the security level.
22. appends the local hosts file (in an attempt to disable updating of many AV products). For example,

    127.0.0.1 www.trendmicro.com

    127.0.0.1 www.symantec.com
23. logs pressed keys when users type.
24. captures browser window titles and keystrokes typed into Windows with the following strings such as bank, cash, login.
25. clears CMOS.
26. views the screen.
27. causes Windows to shut down/reboot/log user off.
28. opens unusual/unexpected ports on machine.
29. manages the local file system.
30. runs system commands via CMD.EXE (command is passed in via HTML form).
31. inserts a script into HTML files on servers to give an individual with unauthorized full access to CMD.EXE.
32. floods others to make networks slow down such as HTTP, ICMP, SYN, Ping, and UDP floods.
33. redirects attempts to access spoofed web pages.
34. adds new accounts.
35. serves as a HTTP proxy or an SMTP relay.
36. attempts to delete files generated by Trojans.

37. The following registry entry is added to install a BHO (Browser Helper Object) for generating extra pop-up ads, monitoring page navigation explorer
38. turns on the victim's Webcam.
39. adds configurable entry to the "load=" and "run=" lines in Win.ini, and "shell=" line of System.ini.
40. schedules tasks to run Trojan’s processes.
41. monitors the Internet Explorer for data submitted in web forms and log this information.

CHAPTER IV

THE MLAS ARCHITECTURE

The MLAS Architecture

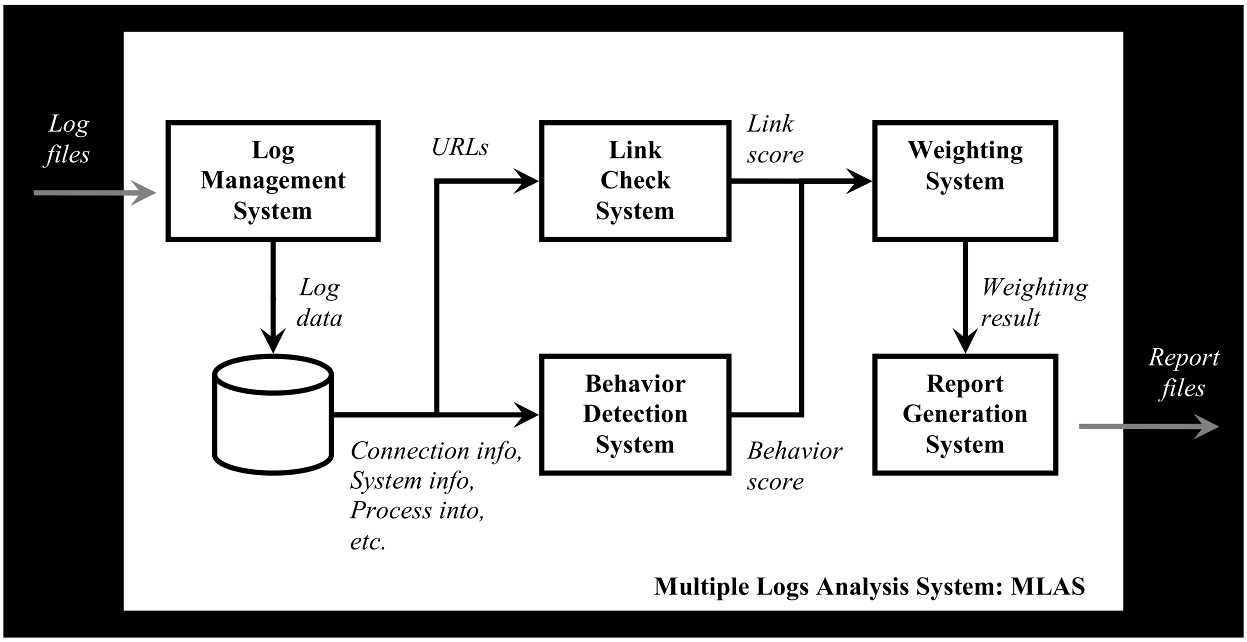


Figure 4 MLAS architecture

Log Management System (LMS)

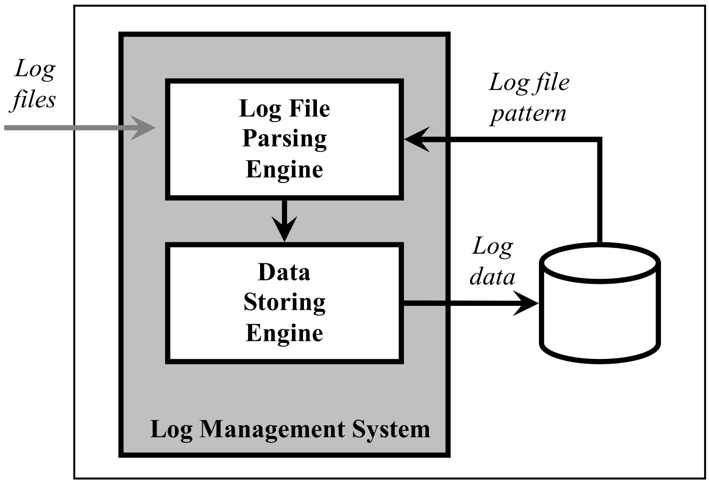


Figure 5 Log Management System

The LMS manages log files received from many applications. The Log File Parsing Engine parses log files following a log file pattern. Then, the Data Storing Engine keeps this data in the database.

Link Check System (LCS)

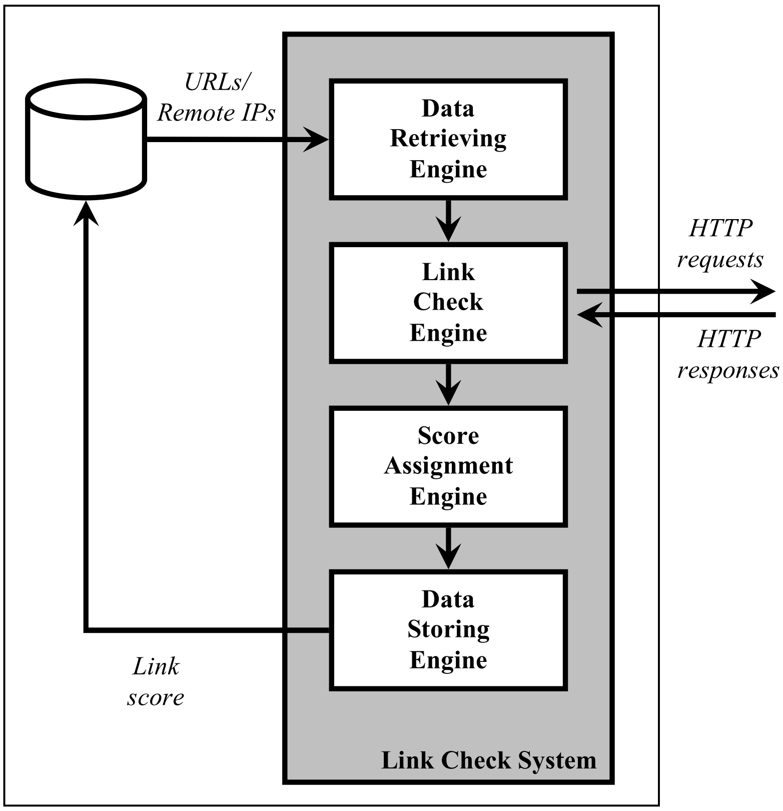


Figure 6 Link Check System

The LCS checks URLs that user on target machine visited with link scanner agents outside MLAS. The Data Retrieving Engine retrieves URLs or remote IPs in the database. The Link Check Engine sends HTTP requests with parameter URLs to link scanner agents in order to check the level of harmfulness. When it receives responses, it sends this result to the Score Assignment Engine to assign score for each of URLs. Assigned scores will be stored in the database to be an input of the Weighting System.

Behavior Detection System (BDS)

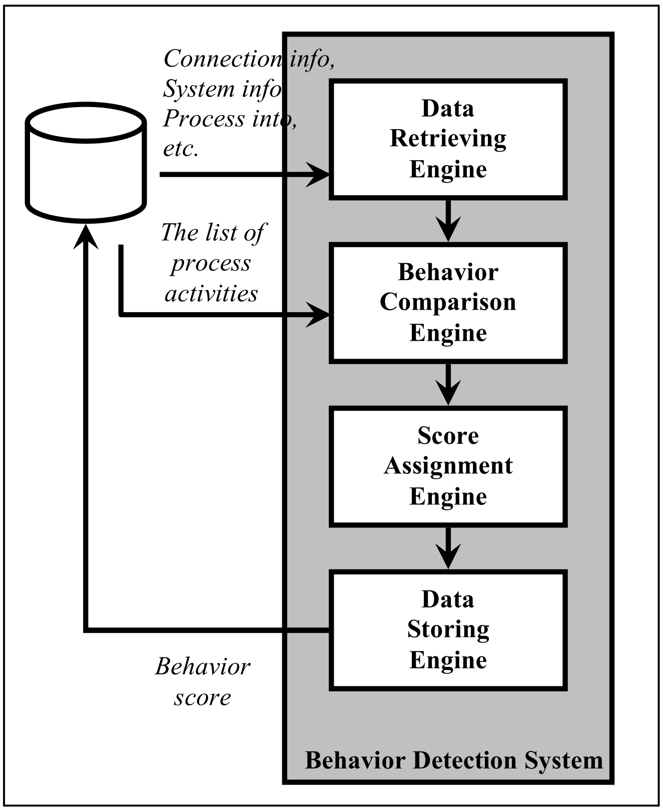


Figure 7 Behavior Detection System

The BDS detects behavior of processes, which run on the target machine, to match with process activities in the list. Connection logs, system logs, process activity logs and others are retrieved by the Data Retrieving Engine. The Behavior Comparison Engine compares this information with process activities in the list and scores for each of the activities. Then, it sends the result to the Weighting System. The scores of the activities are assigned by the Score Assignment Engine. Results from this system will be stored in the database.

Weighting System (WS)

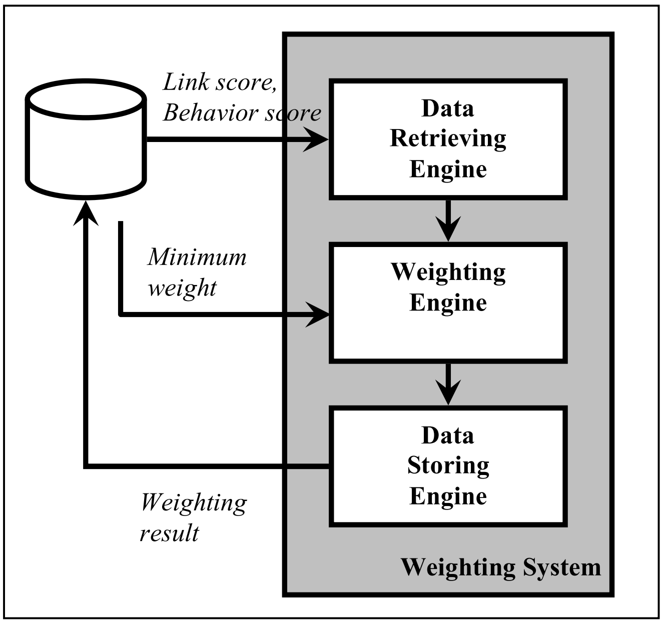


Figure 8 Weighting System

The WS makes the decision whether activities generated from the target machine are suspicious in that they might be infected by backdoor Trojans. The Weighting Engine receives the score from LCS and BDS and calculates weight of these data. If the total weight is more than the minimum weight that we set from experiments in the laboratory, MLAS assumes this machine is suspicious in that it might be infected by a backdoor Trojan; otherwise, it is not suspicious. Information about a suspicious machine is sent to the Report Generation System.

Report Generation System (RGS)

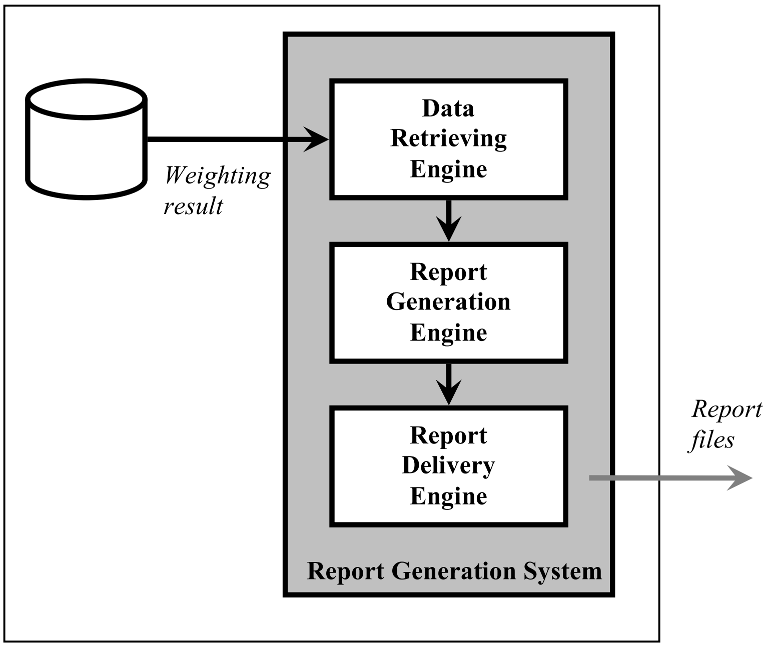


Figure 9 Report Generation System

The RGS generates reports to administrators. The Report Generation Engine receives information from WS and creates reports. The reports contain the total weight of every process run on the target machine and detail of process activities, which are met with process activities in the list. These reports will be sent to administrators by the Report Delivery Engine.

CHAPTER V

PROCESS ACTIVITIES, WEIGHT AND EVENT SCORE

Process activities and weight

From the backdoor Trojans' characteristics and activities, I chose the important events to create the list of process activities. Each process activity was assigned weight by level of severity, which can harm a system or a network. The first time, I assigned weight following an assumption on how dangerous these process activities can be. After many testing, the weight of some process activities was changed as mentioned in the result analysis (chapter VII). Finally, the process activities and their weight ended up following the table process activities and weight.

The weights ranged from 1 to 3. The higher value is the higher level of severity.

Table I Weight and meaning

Weight	Meaning
1	a general activity that is a part of backdoor behavior.
2	a general activity that is a part of backdoor behavior and can generate serious situations to machines.
3	a backdoor Trojan behavior.

Score

A score will be assigned to measure how close a detected event matches to a process activity in the list. The range of score is from 0 to 10. The maximum score value determines that the detected event is very close to the process activity in the list. Events that have the score 0 will be ignored and not be recoded.

Table II Process activities and weight

	Event	Weight
1	An application saves its files into %WinDir% or %SysDir% rather than %Program Files% ***Detection :*** Windows Event Log> security log	2
2	An application adds its process into registry in part of automatic startup to run itself every time Windows start or copies the process into startup folder ***More detail:*** *[Appendix A: 1. Startup registry keys and startup folder]* ***Detection :*** *Windows Event Log> security log*	1
3	An application tries to change the configuration of Windows monitor tools or a Windows update component in the registry. ***More detail:*** *[Appendix A: 2. Windows monitor tools' configuration registry keys]* ***Detection :*** *Windows Event Log> security log*	2
4	An application add some value into this registry to generate extra pop-up ads or monitor the navigation explorer page: • HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\Browser Helper Objects ***More Detail:*** *[appendix A: 3. Browser Helper Object]* ***Detection :*** *Windows Event Log> security log*	2
5	An application tries to send machine's information via SMTP mail, IRC, ICQ pager, ICP Pager, Yahoo Messenger, AOL Instant Messenger, MSN Messenger, and a remote PHP page.	2

	More Detail: *[appendix A: 4. Ports and login servers for sending machine's information]* ***Detection:*** *The Port reporter application's log* *Snort's log*	
6	An application tries to inject DLLs into system DLLs/processes, such as csrss.exe, svchost.exe, iexplore.exe ***More Detail:*** *[appendix A: 5. DLL injection]* ***Detection :*** *Windows Event Log> security log*	2
7	An application attempts to access malicious web sites while it's installing or after installing ***Detection:*** *The Port reporter application's log*	3
8	An application hides its files, directories, service names, or process names using rootkit ***More Detail:*** *[appendix A: 6. Rootkit]* ***Detection :*** *The Sophos Anti-Rootkit application's log*	2
9	An application performs attacks to neighbors such as DoS attack, protocol floods, port scan. ***Detection:*** *Snort's log*	3
10	An application connects to an IRC server for waiting command from an attacker. ***Detection:*** *The Port reporter application's log*	3
11	An application attempts to access the password cache or any location where password information is contained. ***Detection :*** *Windows Event Log> security log*	3
12	An application creates SMTP connection and sends many emails in order to spread itself through spam emails by searching for email addresses in Outlook's Address Book.	3

	Detection : *Windows Event Log-> security log* *The Port reporter application's log*	
13	An application tries to kill running system processes such as Remote Access Connection Manager, Remote Procedure Call, Remote Procedure Call Service, DCOM ***Detection :*** *Windows Event Log> security log*	2
14	An application kills or disables system monitoring tools such as the Windows firewall, the Windows update service and antivirus programs, or it decreases the security level of that machine. ***Detection :*** *The System safety monitor's log*	3
15	An application appends the local hosts file with any security websites to loop to a localhost ip. For example, it appends this line "127.0.0.1 www.symantec.com" ***Detection :*** *Windows Event Log> security log*	2
16	An application logs keystrokes that a user typed into Windows. ***More Detail:*** *[appendix A: 7. Keylogger]* ***Detection :*** *System safety monitor's log*	3
17	An application captures the screen ***Detection :*** -	2
18	An application opens unusual/unexpected ports on the machine. ***More detail:*** *Considering ports as unusual ports is upon environment of a network. For example, in a web server farm network, port number 80 is a usual port. On the other hand, this port can be considered as an unusual port if it appears in a user network group.* *In this work, MLAS will be implemented on a user network group, so server ports such as http, ftp, SMTP, etc. will be considered as unusual ports.* ***Detection :*** *Windows Event log ->security log* *The Port Reporter's log*	2

19	An application adds new accounts. ***Detection :*** *Windows Event Log> security log*	3
20	An application serves as a server such as an HTTP proxy or a SMTP relay. ***Detection:*** *Windows Event log>security log*	3
21	An application adds entries to • the file Win.ini in the lines containing keywords "load=" and "run=" • the file System.ini in the lines containing a keyword "shell=" ***Detection :*** *Windows Event Log> security log*	2
22	An application reads Windows system's information ***Detection :*** *Windows Event Log> security log*	1

CHAPTER VI

MLAS APPLICATION DESIGN

Log file format

Event report

File name format

MLAS_EVENT_REPORT[date].HTM

Report format

```
[IP1]
    [detected event1]
    [event1 detail]
    [detected event2]
    [event2 detail]
    [more events]
[IP2]
    [detected event1]
    [event1 detail]
    [detected event2]
    [event2 detail]
     [more events]
[more IPs]
```

Summary Report

File name format

MLAS_SUMMARY_REPORT[date].HTM

Report format

```
[IP1]
    [process1]
    [process1’s total weight]
    [process2]
    [process2’s total weight]
     [more processes]
[IP2]
    [process1]
    [process1’s total weight]
    [process2]
    [process2’s total weight]
     [more processes]
[more IPs]
```

Process flow

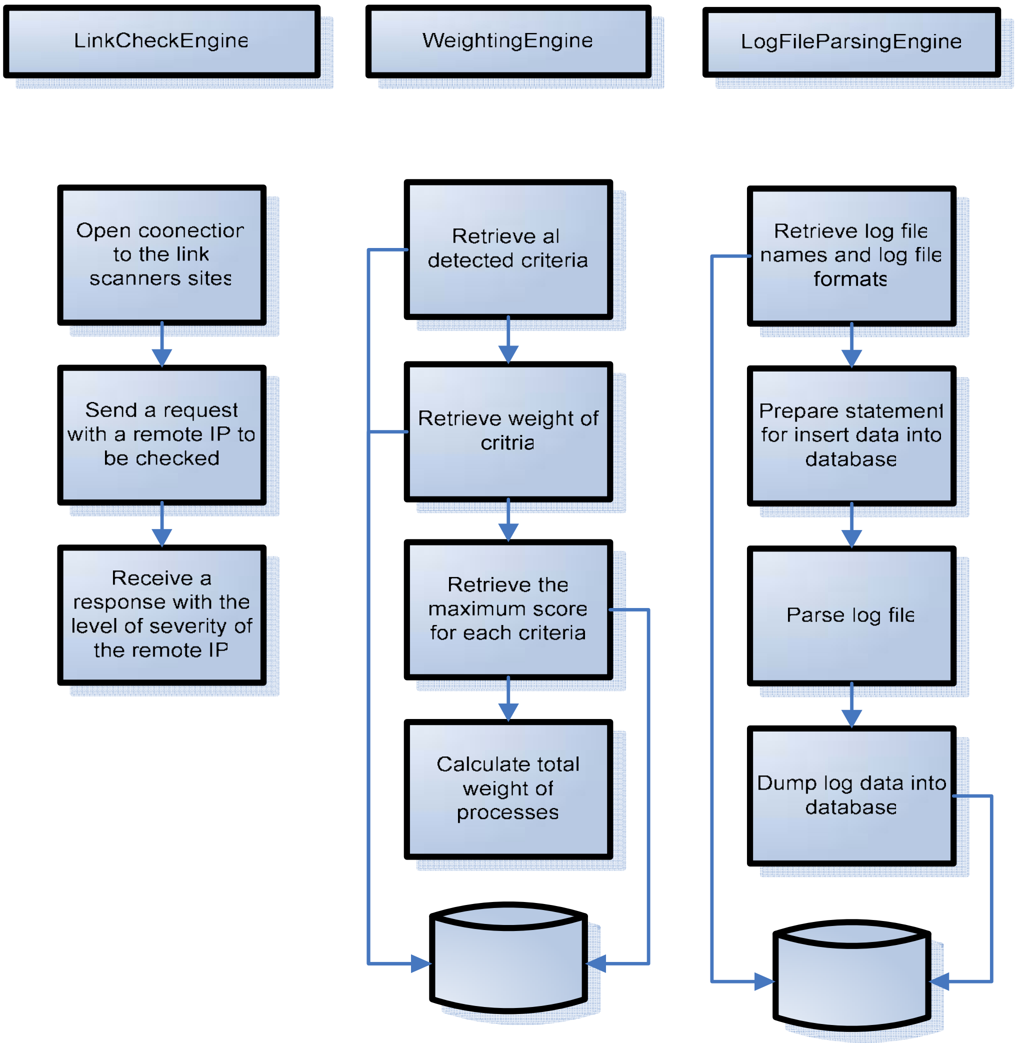

LinkCheckEngine
WeightingEngine
LogFileParsingEngine
Open coonectior to the link scanners sites
Send a request with a remote IP to be checked
Receive a response with the level of severity of the remote IP
Retrieve al detected criteria
Retrieve weight of critria
Retrieve the maximum score for each criteria
Calculate total weight of processes
Retrieve log file names and log file formats
Prepare statement for insert data into database
Parse log file
Dump log data into database

Figure 10 Process flow of LinkCheckEngine, WeightingEngine, and LogFileParsingEngine

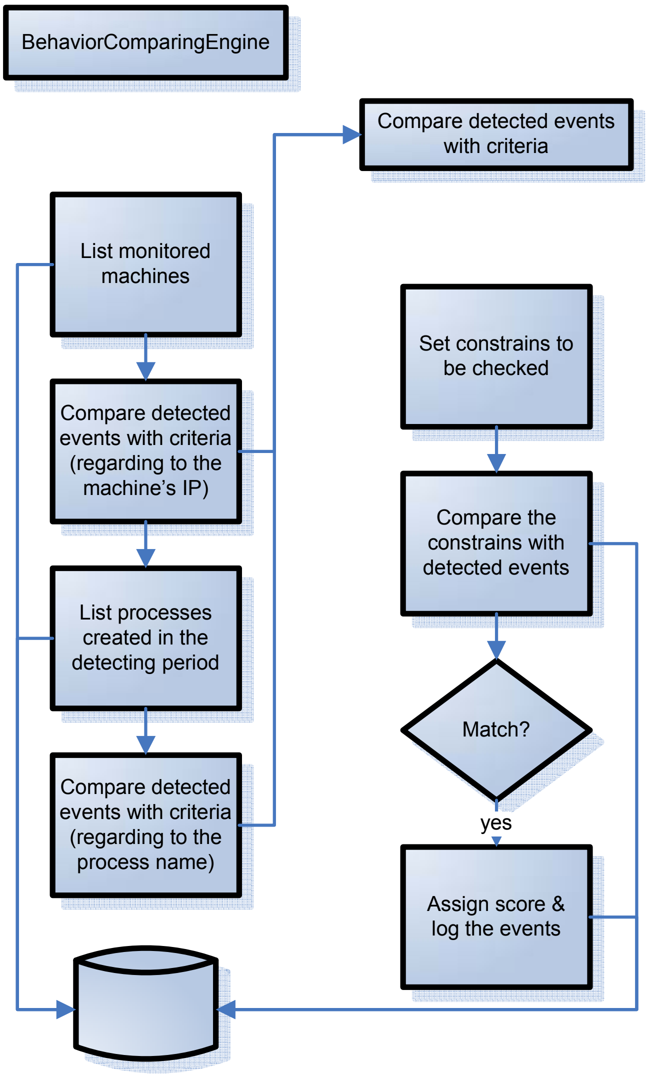

BehaviorComparingEngine
Compare detected events with criteria
List monitored machines
Compare detected events with criteria (regarding to the machine's IP)
List processes created in the detecting period
Compare detected events with criteria (regarding to the process name)
Set constrains to be checked
Compare the constrains with detected events
Match?
yes
Assign score & log the events

Figure 11 Process flow of BehaviorComparingEngine

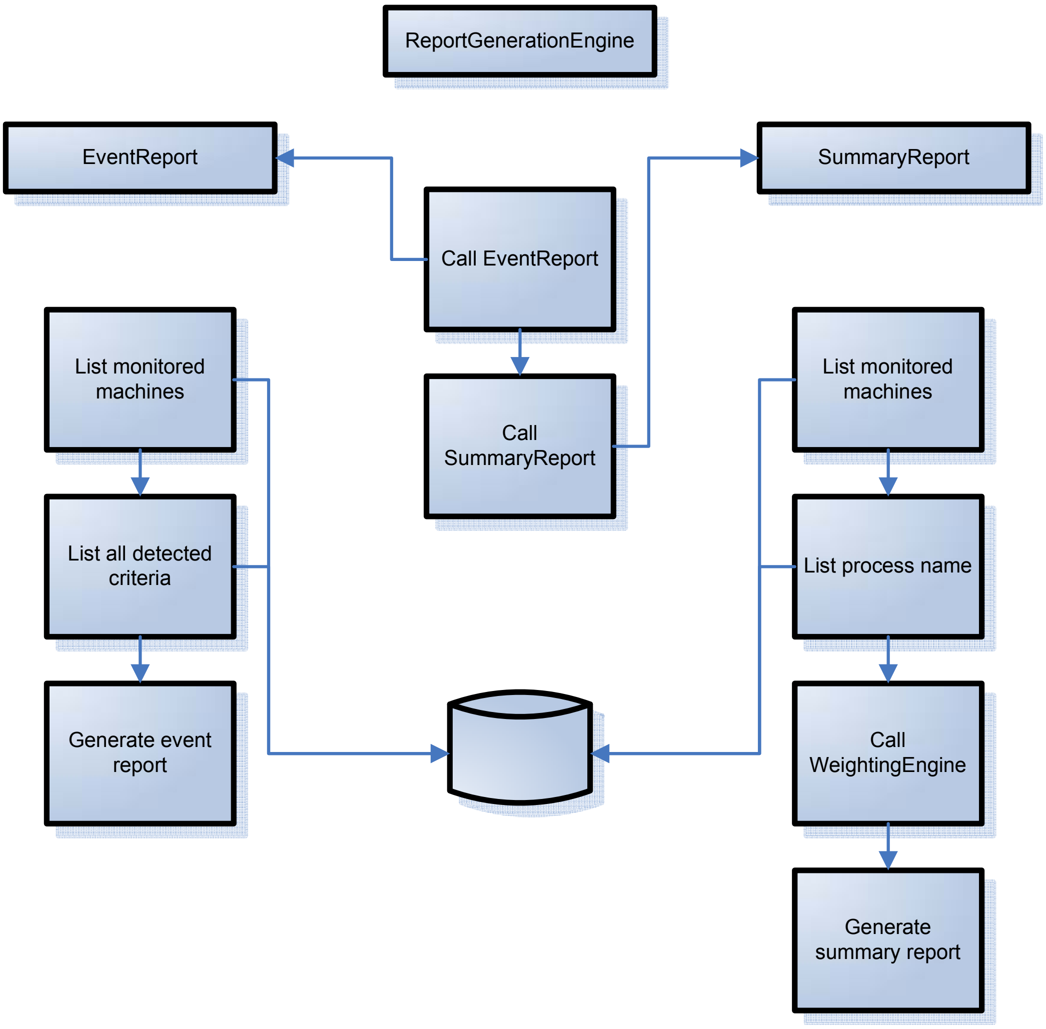


Figure 12 Process flow of ReportGenerationEngine

Database schema

Table III TABLE_AND_LOG_FILE_MAPPING

Column Name	Data Type	Nullable	Primary Key
TABLE_NAME	VARCHAR2(100)	No	1
FILE_NAME	VARCHAR2(1000)	No	2
SEPARATOR	VARCHAR2(100)	No	-
BEGIN_AT_LINE	NUMBER	No	-
DATE_FORMAT	VARCHAR2(100)	Yes	-

Table IV TABLE_SCHEMA

Column Name	Data Type	Nullable	Primary Key
TABLE_NAME	VARCHAR2(1000)	No	1
ATTRIBUTE_NAME	VARCHAR2(1000)	No	2
ATTRIBUTE_ORDER	NUMBER	No	-
ATTRIBUTE_TYPE	VARCHAR2(1000)	No	-

Table V EVENT_LOG

Column Name	Data Type	Nullable	Primary Key
ID	NUMBER	No	1
IP	VARCHAR2(100)	No	2
LOG_TYPE	VARCHAR2(100)	No	-
LOG_TIME	DATE	No	-
EVENT_ID	VARCHAR2(100)	Yes	-
USER_NAME	VARCHAR2(100)	Yes	-
GROUP_NAME	VARCHAR2(100)	Yes	-
EVENT_TYPE	VARCHAR2(100)	Yes	-
DESCRIPTION	VARCHAR2(1000)	Yes	-

Table VI TRAFFIC_LOG

Column Name	Data Type	Nullable	Primary Key
ID	NUMBER	No	1
IP	VARCHAR2(100)	No	2
LOG_TIME	DATE	No	-
PROTOCAL	VARCHAR2(100)	Yes	-
LOCAL_PORT	VARCHAR2(100)	Yes	-
LOCAL_IP	VARCHAR2(100)	Yes	-
REMOTE_PORT	VARCHAR2(100)	Yes	-
REMOTE_IP	VARCHAR2(100)	Yes	-
PID	VARCHAR2(100)	Yes	-
PROCESS_NAME	VARCHAR2(100)	Yes	-
USER_NAME	VARCHAR2(500)	Yes	-

Table VII ROOTKIT_REPORT

Column Name	Data Type	Nullable	Primary Key
ID	NUMBER	No	1
IP	VARCHAR2(100)	No	2
REPORT_TIME	DATE	No	-
HIDDEN_OBJECT_TYPE	VARCHAR2(100)	No	-
HIDDEN_OBJECT_NAME	VARCHAR2(600)	No	-

Table VIII DETECTING_LOG

Column Name	Data Type	Nullable	Primary Key
ID	NUMBER	No	1
IP	VARCHAR2(100)	No	2
DETECTING_TIME	DATE	Yes	-
PROCESS_ACTIVITY_NAME	VARCHAR2(500)	Yes	-
SCORE	NUMBER	Yes	-
FROM_LOG_TABLE	VARCHAR2(500)	Yes	-
FROM_LOG_ID	NUMBER	Yes	-
PROCESS_NAME	VARCHAR2(1000)	Yes	-

Table IX BLACK_PORT_NUMBER

Column Name	Data Type	Nullable	Primary Key
PORT_NUMBER	VARCHAR2(50)	No	1

Table X MONITORING_SERVICE_NAME

Column Name	Data Type	Nullable	Primary Key
SERVICE_NAME	VARCHAR2(500)	No	1

Table XI BLACK_PORT_NUMBER

Column Name	Data Type	Nullable	Primary Key
PORT_NUMBER	VARCHAR2(50)	No	1

Table XII APPLICATION_PARAMETER

Column Name	Data Type	Nullable	Primary Key
PARAMETER_NAME	VARCHAR2(4000)	No	1
DETECTING_PERIOD	NUMBER	No	-
ENABLE	NUMBER	Yes	-

Table XIII DLL_INJECTION_LOG

Column Name	Data Type	Nullable	Primary Key
ID	NUMBER	No	1
IP	VARCHAR2(100)	No	2
LOG_TIME	DATE	Yes	-
EVENT_TYPE	VARCHAR2(10)	Yes	-
EVENT_ACTION	VARCHAR2(10)	Yes	-
USER_NAME	VARCHAR2(500)	Yes	-
PARENT	VARCHAR2(500)	Yes	-
CHILD	VARCHAR2(500)	Yes	-
RESULT	VARCHAR2(500)	Yes	-

Table XIV IP_LIST

Column Name	Data Type	Nullable	Primary Key
IP	VARCHAR2(100)	No	1
ENABLE	NUMBER	Yes	-

Table XV WEIGHT_OF_PROCESS_ACTIVITIES

Column Name	Data Type	Nullable	Primary Key
PROCESS_ACTIVITY_NAME	VARCHAR2(200)	No	1
WEIGHT	NUMBER	No	-

CHAPTER VII

IMPLEMENTATION, EXPERIMENT AND RESULTS

Limitation

This experiment is applied to Windows XP and the similar OS architecture.

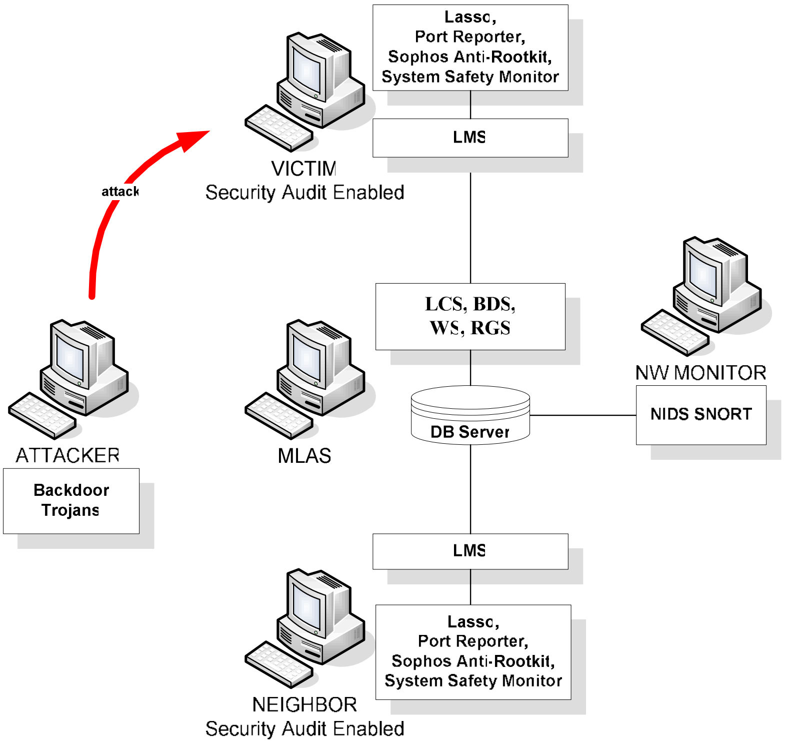


Figure 13 MLAS network diagram

Applications run on the machines

The VICTIM machine and the NEIGHBOR machine

- Enable security audit for these objects
  - A system32 directory following policy: audit this folder only for creating files
  - A program file directory following policy: audit this folder and sub for creating directory
  - A windows directory following policy: audit this folder only for creating files
  - Files hosts, system.ini, and win.ini following policy: audit this object only for writing data
- Run the Lasso for collecting Windows event log, which is binary data, to a text file.
- Run the Port Reporter for logging data traffic generated from local machine to remote machine.
- Run System Safety Monitor for real-time monitoring inter-process activities
- Schedule the RootkitBuster to run everyday. It will scan a local machine to find hidden files, hidden registry and hidden process. Then generate a log file
- Schedule LogFileParsing, a module in LMS, to parse these log files and store data into database. It will be run everyday.

The NW MONITOR machine

- Install Snort (with oracle supported option) and run as NIDS. Its alerts will be logged into the database

The ATTACKER machine

- Contain backdoor Trojan clients and servers for exploit the victim machine.

  Below is the list of backdoor Trojans, which were tested in experiments.

  - Assasin 2.0 Final
  - Beast 2.07
  - CIA 1.23 Pb1
  - Minimo Public 0.7
  - ProRat V1.9
  - SubSeven V.2.1.5

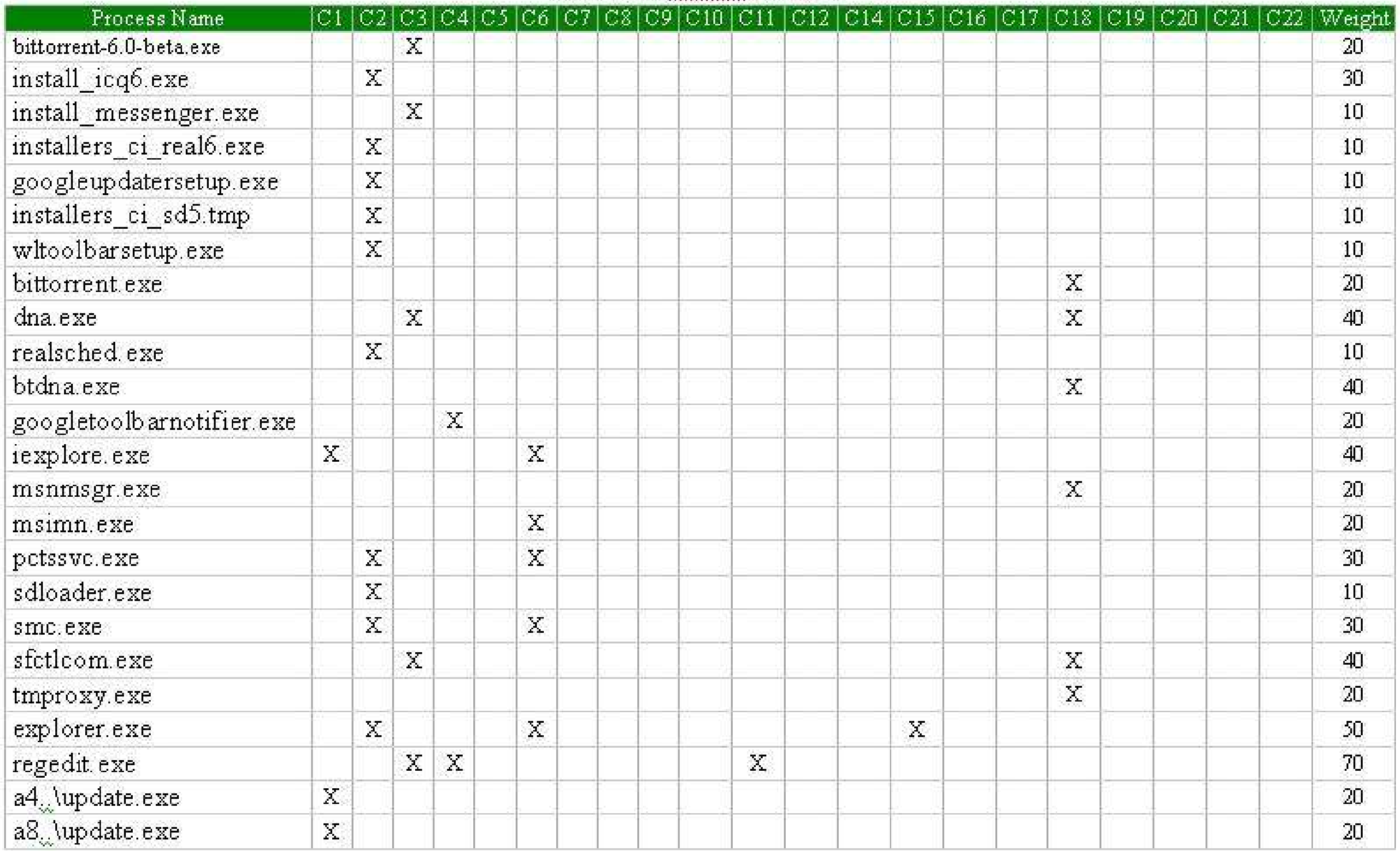
Application configuration and testing steps

[Appendix B: Application configuration and testing steps]

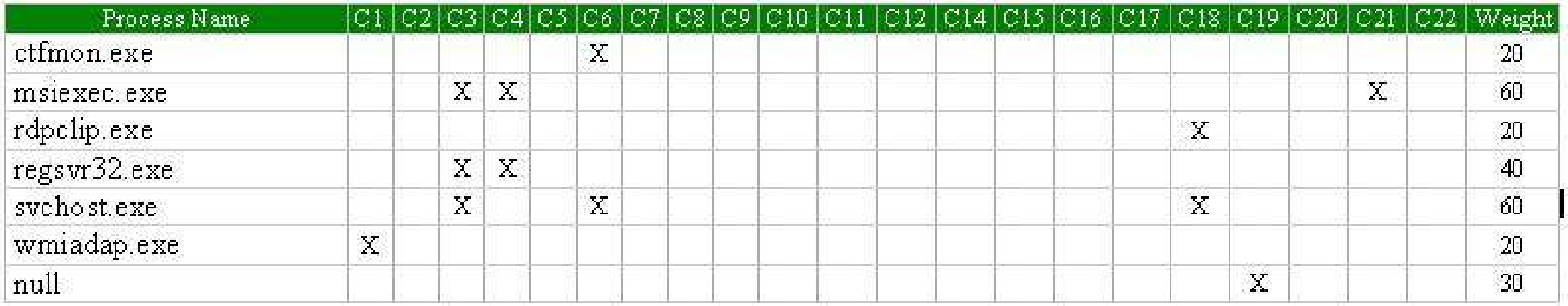
Experimental results

The Normal activities case

Table XVI Normal activities



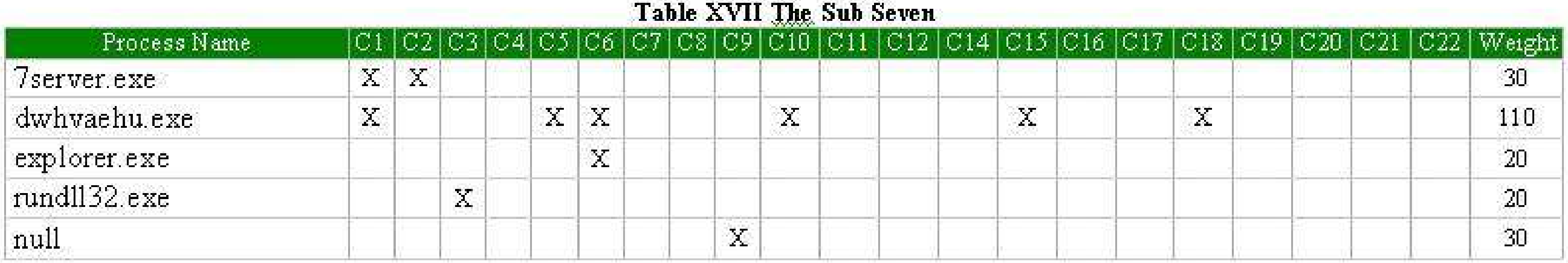
Process Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C14	C15	C16	C17	C18	C19	C20	C21	C22	Weight
bittorrent-6.0-beta.exe			X																			20
install_icq6.exe		X																				30
install_messenger.exe			X																			10
installers_ci_real6.exe		X																				10
googleupdatersetup.exe		X																				10
installers_ci_sd5.tmp		X																				10
wltoolbarsetup.exe		X																				10
bittorrent.exe																	X					20
dna.exe			X														X					40
realsched.exe		X																				10
btdna.exe																	X					40
googletoolbarnotifier.exe				X																		20
iexplore.exe	X					X																40
msnmsgr.exe																	X					20
msimn.exe						X																20
pctssvc.exe		X				X																30
sdloader.exe		X																				10
smc.exe		X				X																30
sfctlcom.exe			X														X					40
tmproxy.exe																	X					20
explorer.exe		X				X								X								50
regedit.exe			X	X							X											70
a4..\update.exe	X																					20
a8..\update.exe	X																					20



Process Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C14	C15	C16	C17	C18	C19	C20	C21	C22	Weight
ctfmon.exe						X																20
msiexec.exe			X	X																X		60
rdpclip.exe																	X					20
regsvr32.exe			X	X																		40
svchost.exe			X			X											X					60
wmiadap.exe	X																					20
null																		X				30

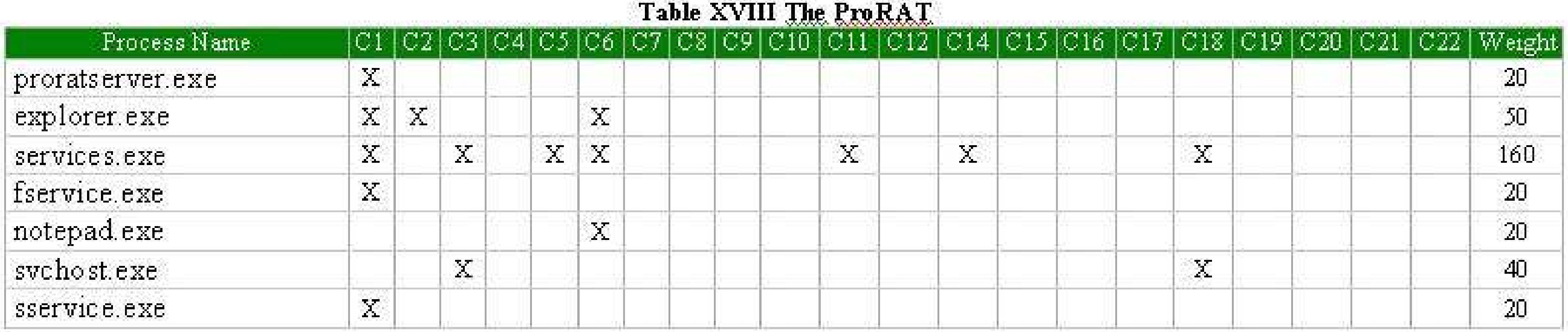
The Trojan case

Table XVII The Sub Seven



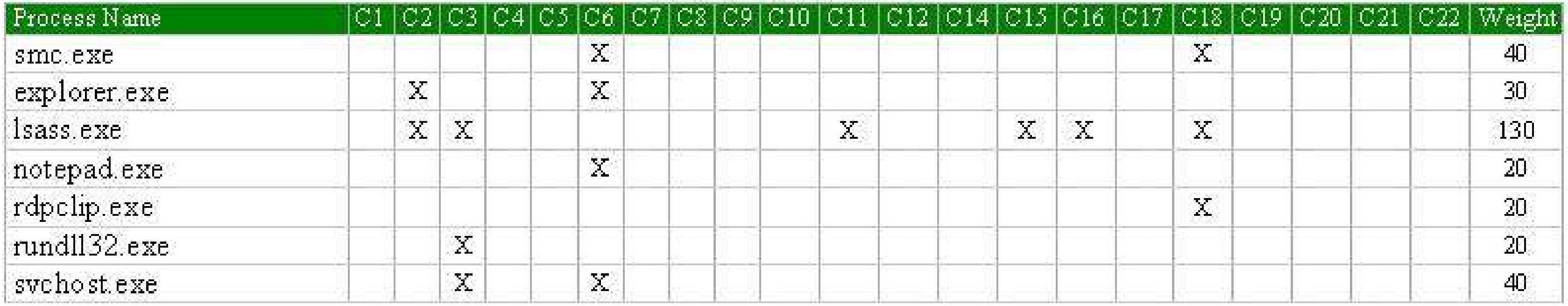
Process Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C14	C15	C16	C17	C18	C19	C20	C21	C22	Weight
7server.exe	X	X																				30
dwhvaehu.exe	X				X	X				X				X			X					110
explorer.exe						X																20
rundll32.exe			X																			20
null									X													30

Table XVIII The ProRAT



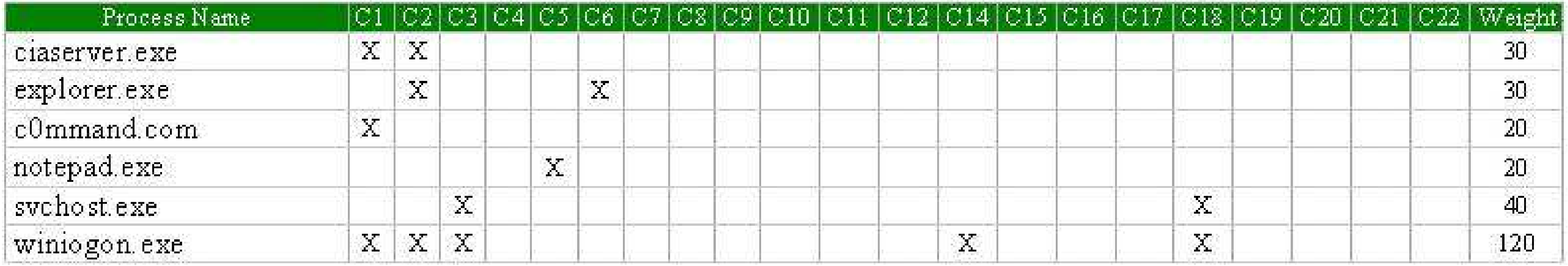
Process Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C14	C15	C16	C17	C18	C19	C20	C21	C22	Weight
proratserver.exe	X																					20
explorer.exe	X	X				X																50
services.exe	X		X		X	X					X		X				X					160
fservice.exe	X																					20
notepad.exe						X																20
svchost.exe			X														X					40
sservice.exe	X																					20

Table XIX The Minimo



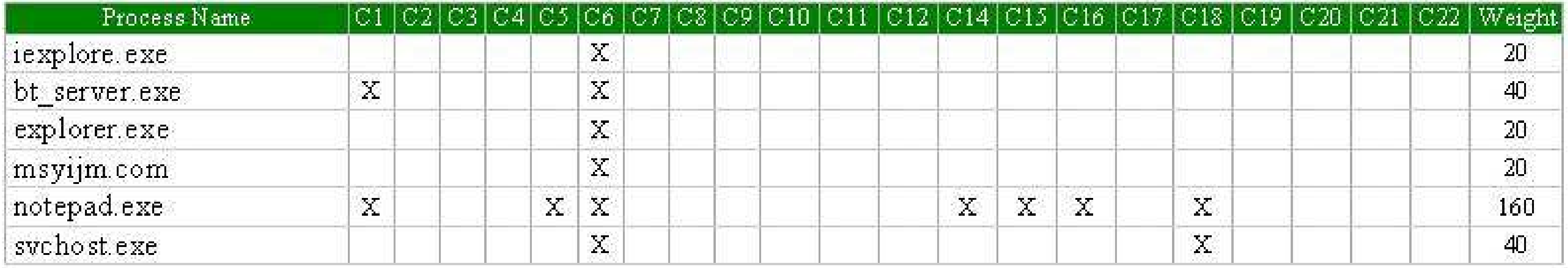
Process Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C14	C15	C16	C17	C18	C19	C20	C21	C22	Weight
smc.exe						X											X					40
explorer.exe		X				X																30
lsass.exe		X	X								X			X	X		X					130
notepad.exe						X																20
rdpclip.exe																	X					20
rundll32.exe			X																			20
svchost.exe			X			X																40

Table XX The CIA



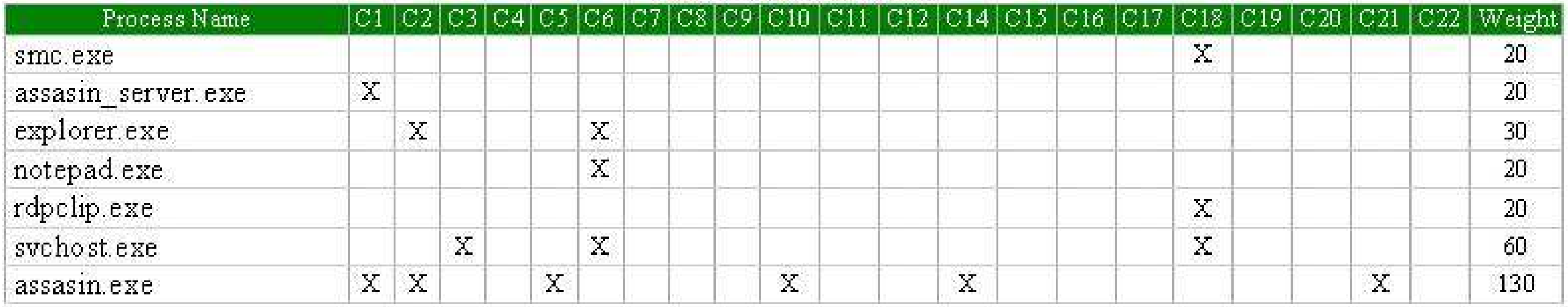
Process Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C14	C15	C16	C17	C18	C19	C20	C21	C22	Weight
ciaserver.exe	X	X																				30
explorer.exe		X				X																30
c0mmand.com	X																					20
notepad.exe					X																	20
svchost.exe			X														X					40
winiogon.exe	X	X	X										X				X					120

Table XXI The BEAST



Process Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C14	C15	C16	C17	C18	C19	C20	C21	C22	Weight
iexplore.exe						X																20
bt_server.exe	X					X																40
explorer.exe						X																20
msyijm.com						X																20
notepad.exe	X				X	X							X	X	X		X					160
svchost.exe						X											X					40

Table XXII The Assasin



Process Name	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C14	C15	C16	C17	C18	C19	C20	C21	C22	Weight
smc.exe																	X					20
assasin_server.exe	X																					20
explorer.exe		X				X																30
notepad.exe						X																20
rdpclip.exe																	X					20
svchost.exe			X			X											X					60
assasin.exe	X	X			X					X			X							X		130

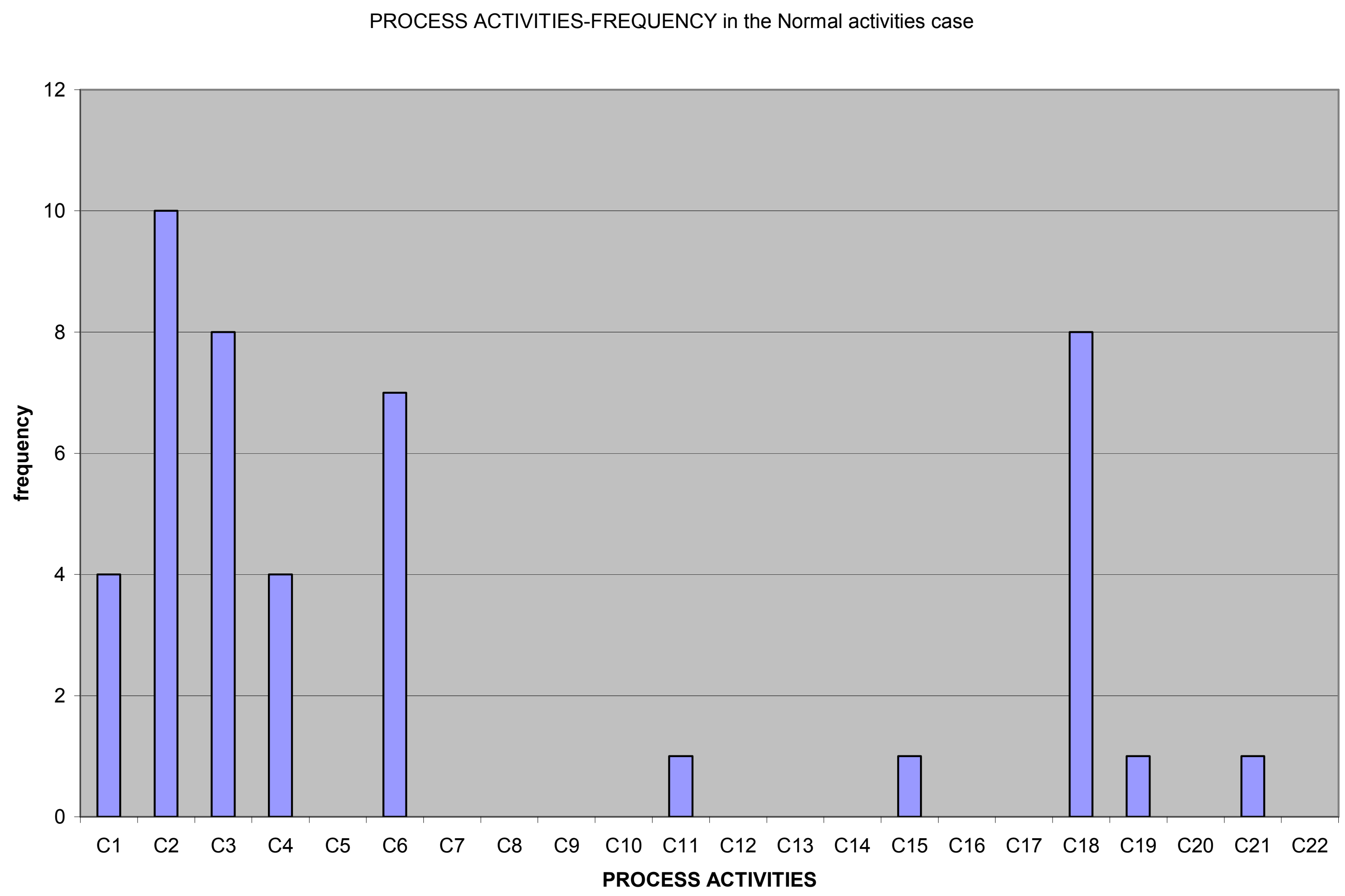


Figure 14 Process activity-frequency graph of the normal activities case

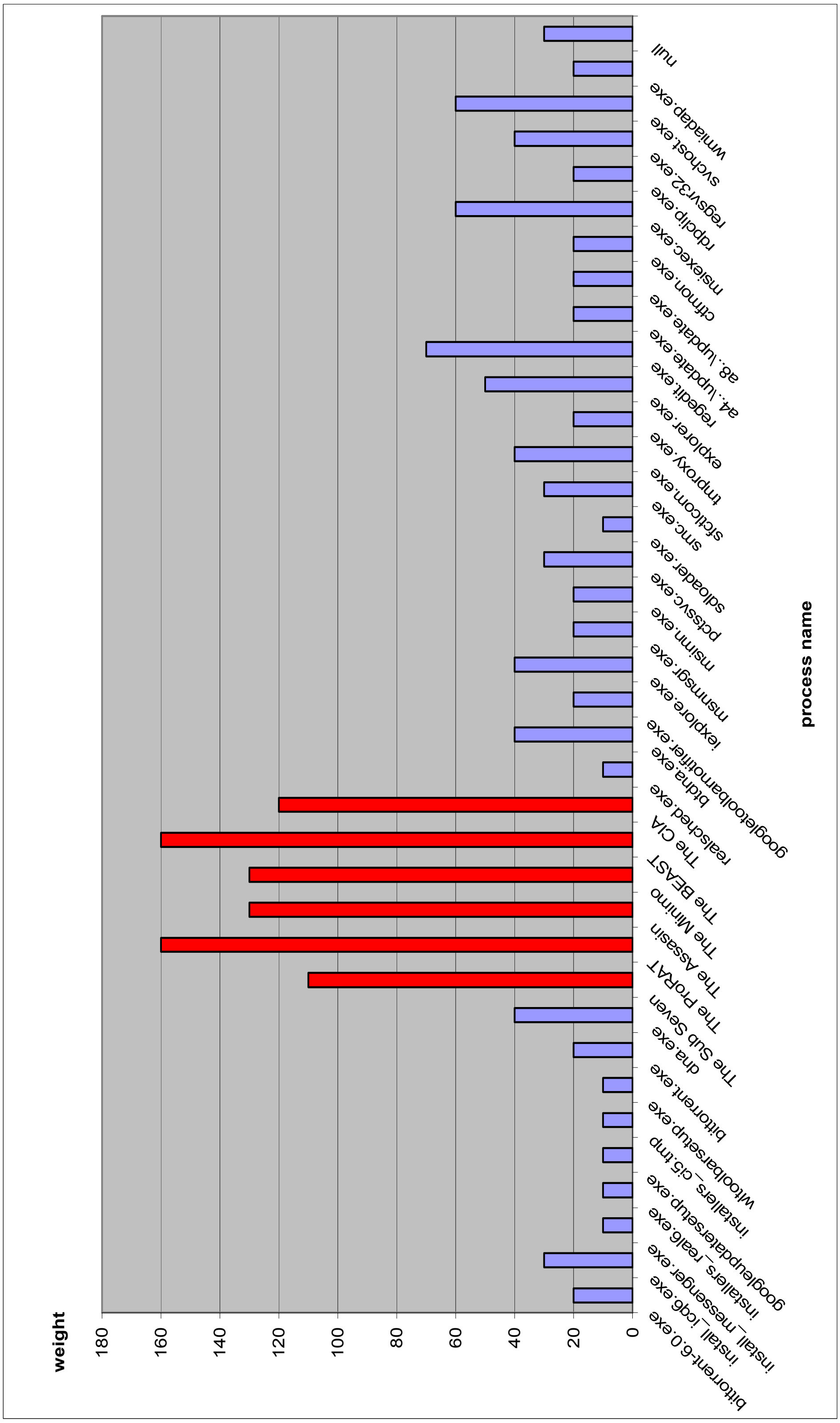


Figure 15 Process name-weight graph

Results analysis

Weighting

Table XVI Process activities and weight

PROCESS_ACTIVITY_NAME	WEIGHT
C1SavingFileIntoSystemFolder	2
C2RegisteringAsStartupProcess	1
C3ModifyingConfigOfWindowsMonitorTools	2
C4AddingBrowserHelper	2
C5SendingInfoViaChatApp	2
C6DLLInjection	2
C7CheckLink	3
C8HiddingItself	2
C9CheckAttackingNeighbors	3
C10ConnectingIRCServer	3
C11AccessingPasswordFile	3
C12Spamming	3
C14KillingOrDisablingSystemMonitoringTools	3
C15ModifyingHostsFile	2
C16LowLevelKeyboardAccess	3
C18OpeningPort	2
C19CreatingUserAccount	3
C20ServingAsServer	3
C21ModifyingWinIni_SystemIniFile	2
C22ReadSystemInformation	1

1. From the case Normal Activities we can see C2, C3, C6 and C18 are the general activities. We should give them less weight than others. At the first round of analysis, we give these process activities weight 1. In case of C3, C6 and C18, however, they can be the serious situations, which are harmful to the machine. We increase their weight to 2.

2. C7, C9, C10, C12, C14, C16 and C20 are identified as backdoor behaviors. These activities will not appear in the case Normal Activities whereas they will be detected sometimes in later Trojan test cases, so we give them weight 3.
3. C5 should be seen in the case Normal Activities because chat applications such as ICQ, MSN or AIM are popular programs, which many people use frequently. This process activity is hard to be detected because chat service providers' servers, ports or login approaches are often changed upon application version and manual configuration of each user. In case of C8, we can detect some system files, system processes or system registries hiding themselves in order to protect them from innocent users who try to modify or delete them without enough knowledge. However, both process activities are the part of backdoor Trojan behavior. We assign their weight to 2.
4. From considering the process activities C1, C4, C11, C19 and C21, Trojans use these activities to install and escalate themselves to get more privilege. We assign their weight 3. However, in the case Normal Activities, these activities can be found in some kinds of applications; for example, installing toolbars is a cause of meeting C4, or the process "msiexec.exe", which is used to install new programs that use Windows Installer package files, may have to access system objects such as Windows directory, system32 directory, win.ini and system.ini. Therefore, we change the weight of C1, C4 and C21 to 2
5. Finally, a machine's system information is an important thing for knowing its platform, service pack version, host name, etc. Attackers want to know it before they exploit a system. However, this kind of activity can be detected in normal

applications especially in reading system information. So, we assign weight of C22 to 1 and C15 to 2 because of lower detecting frequency

Threshold of process weight

The Normal activities case

The average of the normal process score: 820/30 = 27.3

The maximum process activities found in normal processes: 3

Top 3 process activities met in normal processes: C2, C3 and C18

The sum score of top 3 process activities: 50

The Trojan case

The average of the normal process score: 860/31 = 27.7

The maximum process activities found in normal processes: 3

Top 3 process activities met in normal processes: C1, C6 and C18

The sum weight of top 3 process activities: 60

The average of the backdoor Trojan process score: 810/6 = 135

The minimum process activities found in Trojan processes: 5

Top 5 process activities met in the backdoor Trojan processes: C1, C5, C6, C14 and C18

The sum weight of top 5 process activities: 110

Result

For the maximum threshold value of the normal process, I consider the top 3 process activities in the normal activities case because when I tested the Trojan case, some of correlative processes of a Trojan process appeared and could deviate the process weight.

Table XVII Threshold score

Score range	Result
Below 50	A normal process
51-109	A suspect process
Above 110	A backdoor Trojan process

If any machine contains a suspect process, they should be inspected closely. They may or may not be infected with a backdoor Trojan because MLAS contains a false positive alarm (more detail below). If any machine contains a process having a weight over 110, they are considered a victim of backdoor Trojans. In this case, administrators should quarantine them from the network and find the way to end them

Null process

Some process activities cannot be determined by the process name. For instance, attacking neighbors is detected by Snort. Because Snort doesn't provide information about process names, which create the attacking connection, MLAS cannot identify the process names. In case of processes hiding themselves, Windows event log sometimes cannot see them, so we cannot determine the process name either.

Because the weight isn't counted into any process name, these process activities can only be detected by looking at the level of the machine's IP and. Then, when administrators consider the threshold of process weight, we should add this weight into the process weight as well

False positive alarm

From the result in the Normal activities case, regedit.exe, svchost.exe, msiexec.exe and null process name were considered as false positive alarms. Their weights were considered as suspect processes but actually this false positive was caused by special activities made by administrators or by the machine's normal process behavior.

"regedit.exe" was created by administrators who wanted to check data inside Windows registry. This kind of activity can occur anytime when administrators notice something wrong in the system and want to check data inside the registry. So, if there are similar activities made by authorized users, the false positive alarm will occur and it can be ignored.

The process "svchost.exe" and "msiexec.exe" can create the false positive alarm because of their normal process behavior. The process svchost.exe is used to manage the local system and interoperate with other processes. Moreover, it has to open ports for receiving requests from other machines or processes. One solution we found for reducing a false positive alarm of this process is learning the process behavior about the opening ports frequently and safely. MLAS provides white-port tuning that allows administrators to tell the system what the safe ports are. The processes can open these ports without alerting process activity

C18.

The process msiexec.exe is a broker process used to install new programs that use Windows Installer package files (MSI). It accesses the system object instead of the real process. Because of this, its weight can be raised to the level of the suspect process. When administrators found this kind of process, they should take care of these processes separately.

Problems

1. The URL checking website, LinkScanner, has a limitation of the number of connections. So if MLAS send many requests over its limitation, the system will get a timeout error and have to wait until the scanner accept connections again.
2. The process activities C8 and C22 are difficult to be detected because there are many ways to achieve these activities. MLAS cannot cover every approach, so from the experimental result, MLAS couldn't detect C8 and C22.
3. Currently, there is no precise approach to detecting keyloggers. MLAS tries to monitor accessing low level of keyboard to detect the process activities C16 even though it's not the best way. From the experiment, MLAS can detect these process activities in some Trojans, but not all of them.
4. The System Safety Monitor software I tried, which is used in MLAS, is a trial version and will be expired if I don't buy a license extension. I tried to test the free version of this application but it didn't provide as many features as I needed.

CHAPTER VIII

CONCLUSIONS AND FUTURE WORK

MLAS is developed in order to detect backdoor Trojans at zero day or unknown backdoor Trojans. It uses the new technique called multiple logs analysis that analyzes log data collected by many monitoring tools. The Project Lasso collects security audit events and process activities from Windows Event Log. The System Safety Monitor records inter-process activities. Communication activities are captured by the Port Reporter and send remote IPs to LinkScanner and McAfee SiteAdvisor to check their harmfulness. The Sophos rootkit scanner is used to detect hidden processes and hidden files on a local machine. Also, Snort monitors traffic on a computer network and logs abnormal connections to the Oracle database server.

MLAS can detect the Trojan processes by looking at the total weight of process. A process having weight more than the threshold will be determined to be a Trojan process. From the experimental results, MLAS can detect each of six Trojan processes, which have the distinctive high process weight. Moreover, any suspect process will be detected by MLAS using the second threshold comparison.

MLAS can be improved to deploy on many kinds of operating systems. Because nowadays the operating systems are varied widely, developing MLAS in the first phase is based on Windows XP and other operating systems that have the same architecture. If you want to deploy MLAS on other systems, it should be adapted in some of the process activity detection approaches such as the location of system objects and monitoring tools compatibility. Moreover, emerging of new tools can improve MLAS in case of process activity detection. This problem can be seen in MLAS. It cannot find a tools or a way to detect an event, which meets the process activities in the list. Or it can just detect the side effect of the event that can create the false decision. Finally, computer security experience in auditing systems is necessary for MLAS as well. The better auditing can catch more events relating to process activities in the list.

The concept and framework of MLAS can be used to detect other kinds of malware on computer systems other than zero-day backdoor Trojans. It is able to study the malware's behavior, create new list of process activities and find appropriate tools to detect process activities' event. In the future, MLAS may become to a new powerful monitoring tool because of its effective framework and improved human knowledge.

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APPENDICES

APPENDIX A:

1. Startup registry keys and startup folders

- HKEY_LOCAL_MACHINE\System\Currentcontrolset\Services

  to create a Trojan process as a service.

- HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\Run\ and HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\RunOnce

  to create Trojan processes as background services when the logon dialog box first appears, or at this stage of the boot process only once per boot.

- KEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run

  to run Trojan processes each time a new user logs in.

- HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\Policies\Explorer\Run

  to start Trojan processes when Windows starts up.

- HKEY_LOCAL_MACHINE\Software\Microsoft\WindowsNT\CurrentVersion\Winlogon\Notify

  Windows will notify Trojan processes to be run when a logon event occurs.

- HKEY_CLASSES_ROOT\Exefile\shell\open\command

  Key name: (Default)

  Key value: "%1" %*

If value of “(Default)” key is changed to {%Trojan path% /exec:"%1" %*}, The Trojan will be automatically invoked when file type “exe” is called. Trojans can deal with other file type such as JPEG (HKEY_CLASSES_ROOT\Jpegfile\Shell\Open\Command "(Default)" = %Trojan path% /exec:%interpreter%).

- C:\Documents and Settings\All Users\Start Menu\ Programs\Startup

  A startup folder contains processes that the user wants to run at Windows startup.

2. Windows monitor tools’ configuration registry keys

- HKEY_LOCAL_MACHINE\Software\Microsoft\Security Center

  to modify configuration of a Windows security monitor tool.

- HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\WindowsUpdate\auto update

  to modify configuration of a Windows update service.

- HKEY_LOCAL_MACHINE\Software\Policies\Microsoft\WindowsFirewall\DomainProfile

  to modify configuration of Windows Firewall application

- HKEY_LOCAL_MACHINE\System\CurrentControlSet\Services\SharedAccess\Parameters\FirewallPolicy\StandardProfile\AuthorizedApplications\List

  A list of applications that can be passed through firewall.

3. Browser Helper Object

A "Browser Helper Object (BHO)" is a DLL that works with Internet Explorer for some special purpose. BHOs can be installed on machines for being supplement toolbars of the Internet Explorer application. They may or may not require user interface or users' permission for installing. So, they can reside in any machines without users' awareness. Trojans use this kind of DLL to monitor and gather information of users when they're surfing

4. Ports and login servers for sending machine's information

Destination port

- SMTP: TCP 25, 465
- MSN Messenger: TCP 1863
- Yahoo! Messenger: TCP 80
- ICQ: UDP 2000-4000, TCP 5190
- AOL Instant Messenger: TCP 5190

Login server

- AOL Instant Messenger: login.oscar.aol.com:443, login.oscar.aol.com, toc.oscar.aol.com and login.icq.com
- MSN Messenger: gateway.messenger.hotmail.com
- ICQ: login.icq.com and http.proxy.icq.com
- Yahoo! Messenger: msg.edit.yahoo.com/*

5. DLL injection

A Dynamically Linked Library (DLL) is a shared library, to which many processes can access. DLLs provide common functions that processes don't have to reproduce for their own. When any processes want to use DLLs, they load the DLLs into their virtual address space and call functions inside the loaded DLLs

DLL injection is inserting code into a program's memory space. It can be achieved by many approaches. The popular approach has the following steps:

- Start a process
- Create a DLL
- Open a target process
- Load the DLL into reserved virtual address space of the target process
- Create a remote thread inside the target process to run the loaded DLL

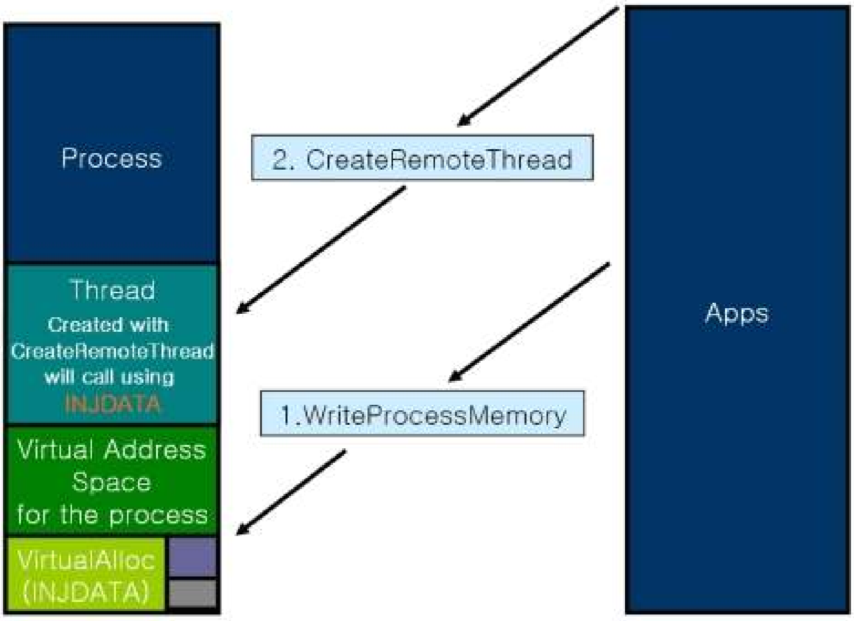


Figure 16 A process injects a DLL into a target process and creates a remote thread inside the target process [18]

For malicious applications, the objective of this activity is avoiding firewall detection. When a malicious process wants to communicate with an attacker, it creates a remote thread in a trusted process and uses this process name to bypass the firewall.

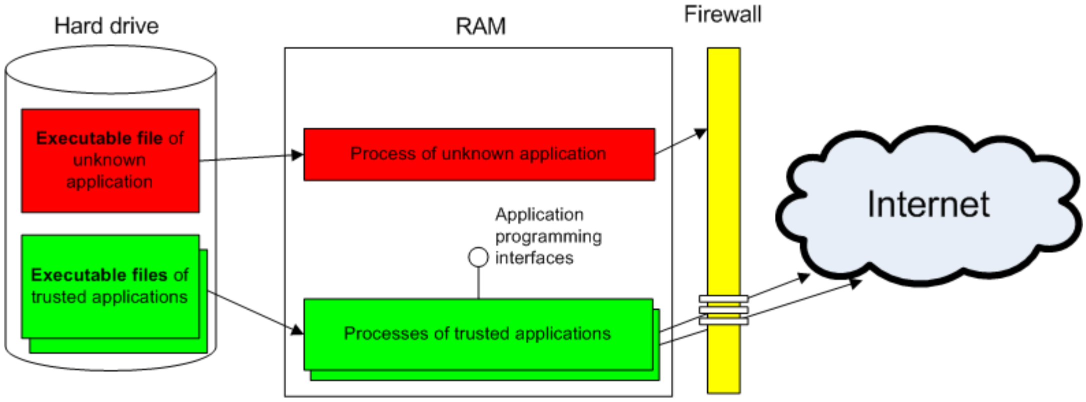

Hard drive
RAM
Firewall
Executable file of unknown application
Executable files of trusted applications
Process of unknown application
Application programming interfaces
Processes of trusted applications
Internet

Figure 17 A malicious process is bloceked from a firewall [19]

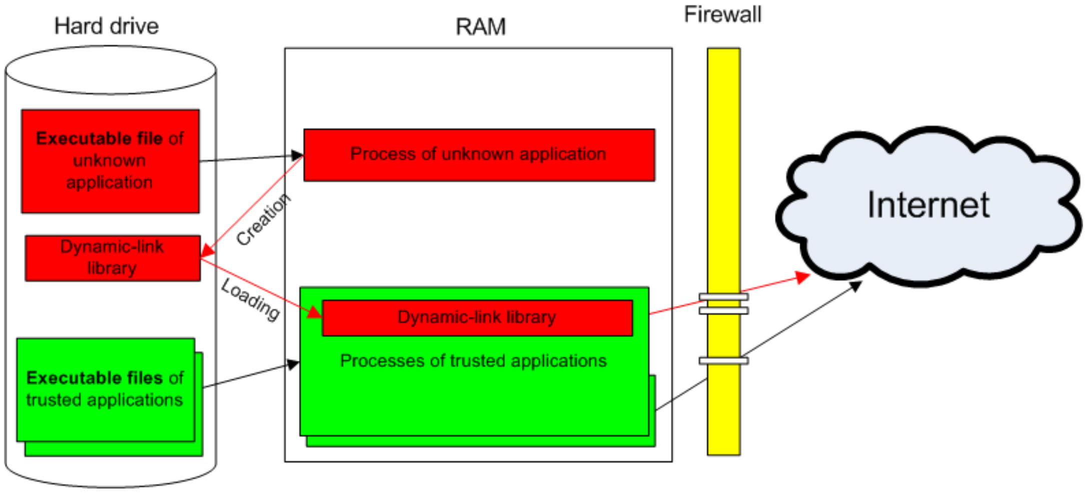

Hard drive
RAM
Firewall
Executable file of unknown application
Dynamic-link library
Executable files of trusted applications
Creation
Loading
Process of unknown application
Dynamic-link library
Processes of trusted applications
Internet

Figure 18 A malicious process inject a DLL into a trusted process for bypass firewall detection [19]

6. Rootkit

Definition of a rootkit

A rootkit is a program or set of programs that an intruder uses to hide their presence on a computer system and to allow access to the computer system in the future. To accomplish its goal, a rootkit will alter the execution flow of the operating system or manipulate the data set that the operating system relies upon for auditing and bookkeeping [20].

How does the Rootkit work?

The Rootkit processes run in a low level mode, which can intercept applications' call to the operating system and modify the result sent back to the applications. For example, when an user runs the Task manager for monitor running processes, the task manager makes a system call to the operating system for retrieving a list of running processes. The Rootkit intercepts this system call and delete its own process name in the list returned to the Task manager. So, the user cannot see the Rootkit process. From this kind of activity, the Rootkit can hide its existence such as communication ports, files and registries [21].

7. Keylogger

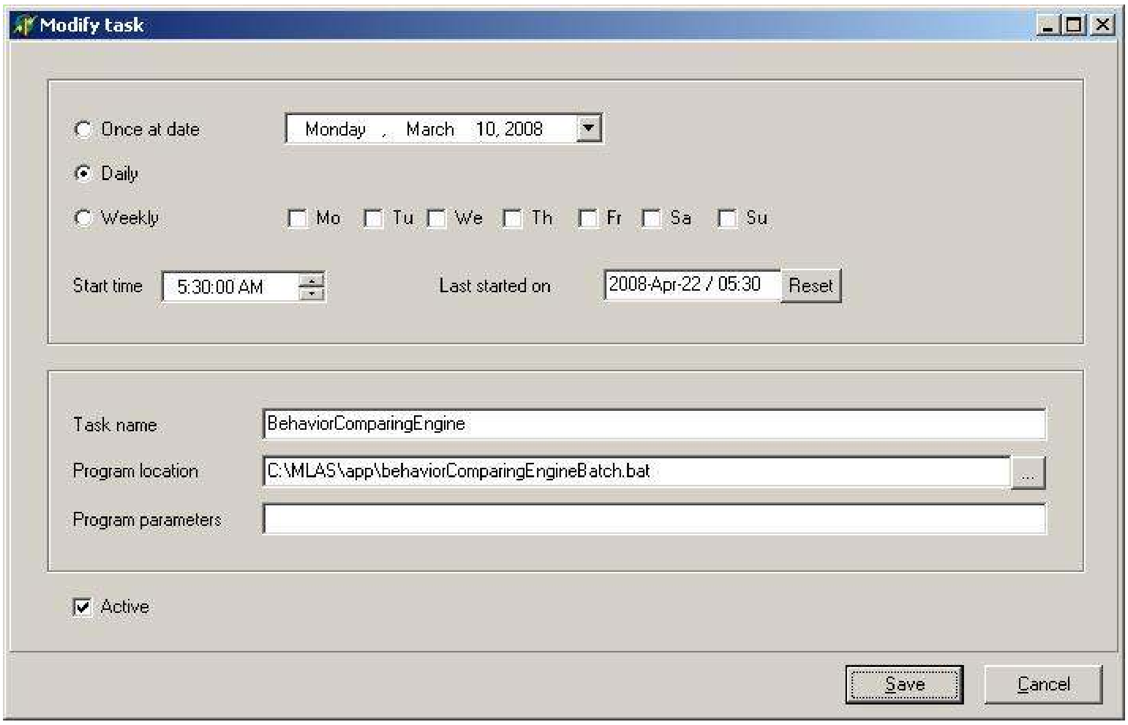
The Keylogger is a program used to keep track of information that a user typed in any application and save it into a file, which is usually encrypted and hidden from the user. It can log any important information such as credit card numbers, username and password. It may be detected by checking low level access of keyboard of a process.

APPENDIX B: Application configuration and testing steps

1. Application configuration

The MLAS machine

The BehaviorComparingEngine task schedule



○ Once at date Monday , March 10, 2008

● Daily

○ Weekly □ Mo □ Tu □ We □ Th □ Fr □ Sa □ Su

Start time 5:30:00 AM

Last started on 2008-Apr-22 / 05:30

Task name BehaviorComparingEngine

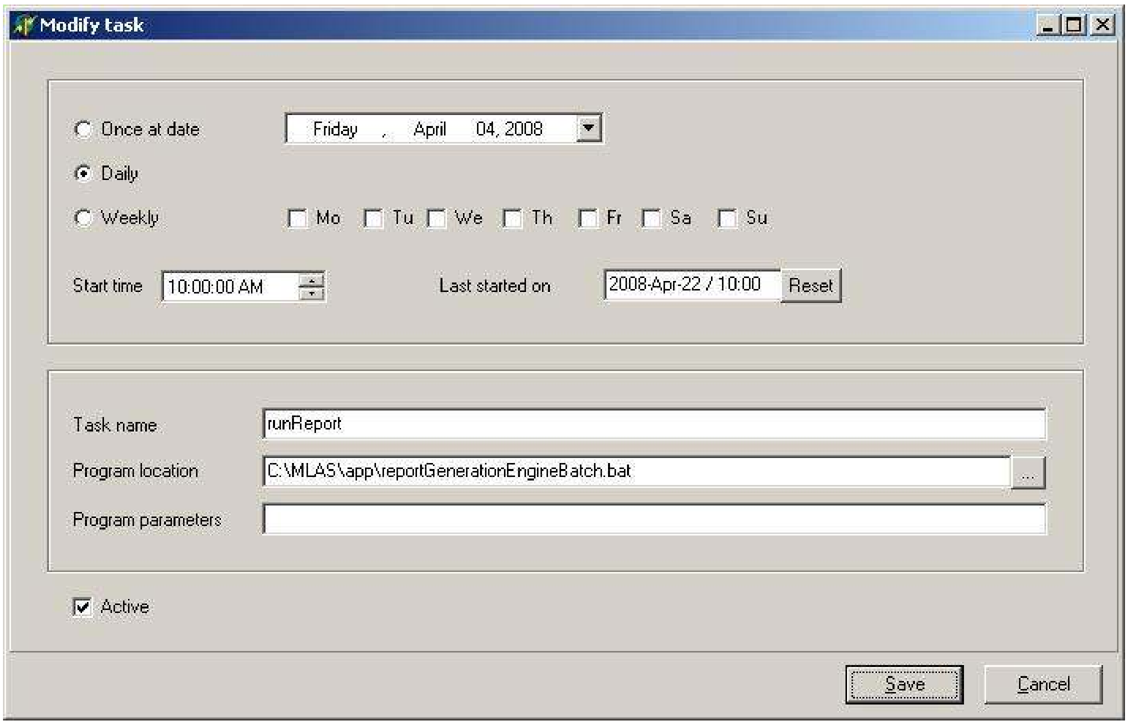
Program location C:\MLAS\app\behaviorComparingEngineBatch.bat

Program parameters

☑ Active

Figure 19 BehaviorComparingEngine task schedule

The ReportGenerationEngine task schedule



○ Once at date Friday , April 04, 2008

● Daily

○ Weekly □ Mo □ Tu □ We □ Th □ Fr □ Sa □ Su

Start time 10:00:00 AM

Last started on 2008-Apr-22 / 10:00

Task name runReport

Program location C:\MLAS\app\reportGenerationEngineBatch.bat

Program parameters

☑ Active

Figure 20 ReportGenerationEngine task schedule

The batch files

behaviorComparingEngineBatch.bat

```
cd C:\MLAS\app
java BehaviorComparingEngine > app.log
```

reportGenerationEngineBatch.bat

```
cd C:\MLAS\app
java ReportGenerationEngine
```

Oracle Database Server

Database Setting

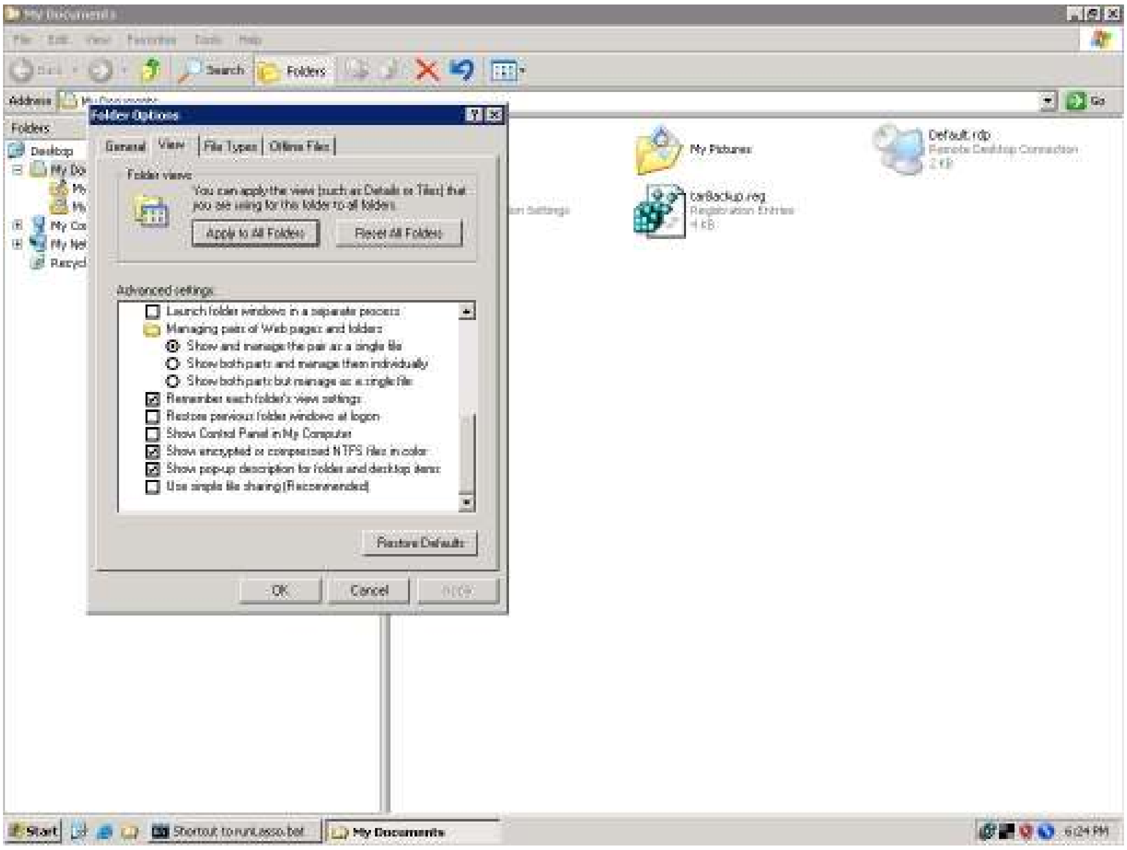
Oracle Database 10g Express Edition Release 10.2.0.1.0 - Product
PL/SQL Release 10.2.0.1.0 - Production
CORE 10.2.0.1.0 Production
TNS for 32-bit Windows: Version 10.2.0.1.0 - Production
NLSRTL Version 10.2.0.1.0 - Production
dbname: XE

user: sinchai
password: JfNkK852
user:snort
password: JfNkK852

The VICTIM machine and the NEIGHBOR machine

Security audit

1. Explorer>Tools>View: deselects "Use simple file sharing"



Folder views

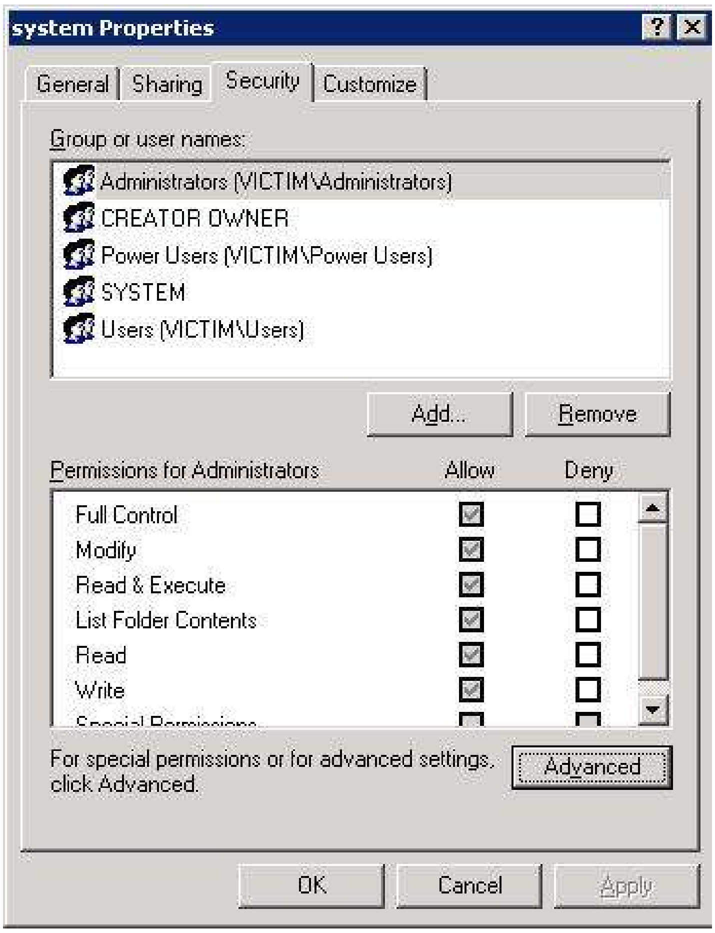
You can apply the view (such as Details or Tiles) that you are using for this folder to all folders.

Advanced settings:

☐ Launch folder windows in a separate process
Managing pairs of Web pages and folders
● Show and manage the pair as a single file
○ Show both parts and manage them individually
○ Show both parts but manage as a single file
☒ Remember each folder's view settings
☐ Restore previous folder windows at logon
☐ Show Control Panel in My Computer
☒ Show encrypted or compressed NTFS files in color
☒ Show pop-up description for folder and desktop items
☐ Use simple file sharing (Recommended)

Figure 21 Use simple file sharing option

2. [Audit Object]>Sharing and Security>Security



Group or user names:

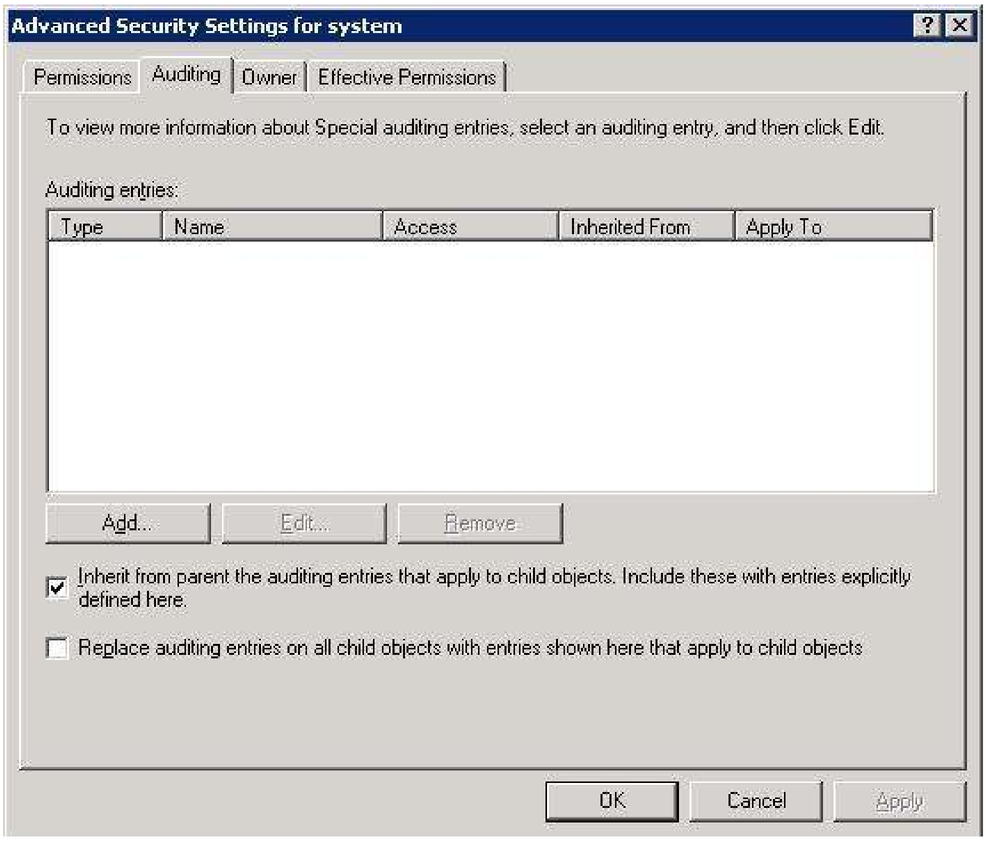
- Administrators (VICTIM\Administrators)
- CREATOR OWNER
- Power Users (VICTIM\Power Users)
- SYSTEM
- Users (VICTIM\Users)

Permissions for Administrators	Allow	Deny
Full Control	☑	□
Modify	☑	□
Read & Execute	☑	□
List Folder Contents	☑	□
Read	☑	□
Write	☑	□
Special Permissions	□	□

For special permissions or for advanced settings, click Advanced.

Figure 22 Security tab

3. Advance>Audit



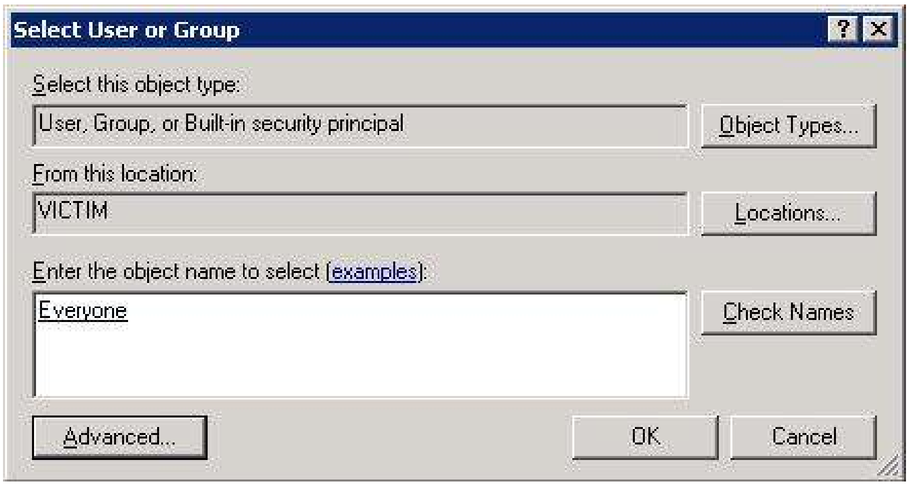
To view more information about Special auditing entries, select an auditing entry, and then click Edit.

☑ Inherit from parent the auditing entries that apply to child objects. Include these with entries explicitly defined here.

□ Replace auditing entries on all child objects with entries shown here that apply to child objects

Figure 23 Audit tab

4. Add: Everyone



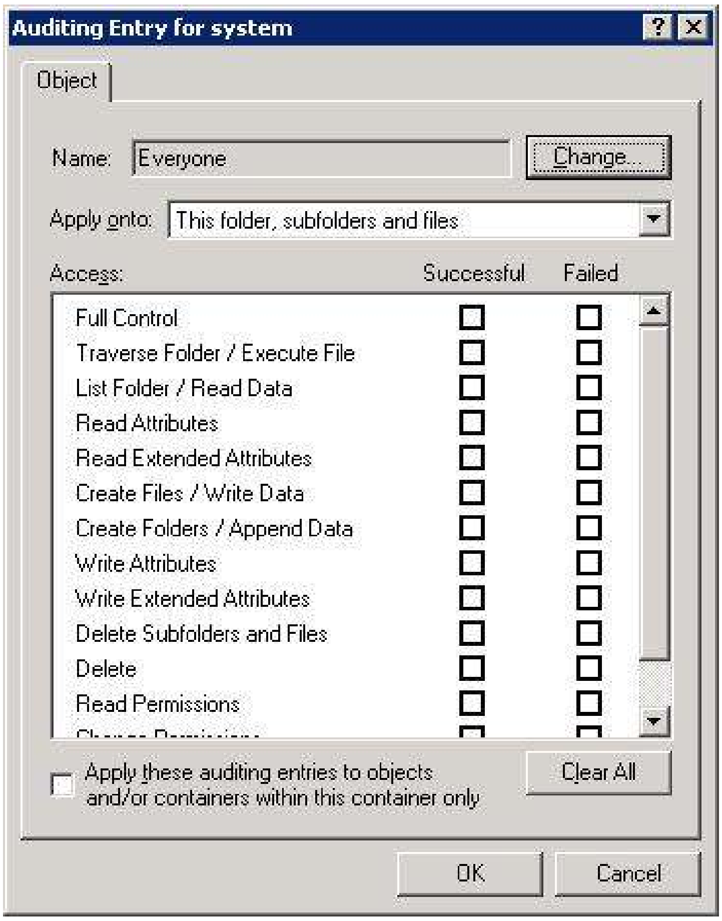
Select this object type: User, Group, or Built-in security principal

From this location: VICTIM

Enter the object name to select (examples): Everyone

Figure 24 User selection window

5. OK>selects or deselects desired events



Name: Everyone

Apply onto: This folder, subfolders and files

Access:	Successful	Failed
Full Control	□	□
Traverse Folder / Execute File	□	□
List Folder / Read Data	□	□
Read Attributes	□	□
Read Extended Attributes	□	□
Create Files / Write Data	□	□
Create Folders / Append Data	□	□
Write Attributes	□	□
Write Extended Attributes	□	□
Delete Subfolders and Files	□	□
Delete	□	□
Read Permissions	□	□

□ Apply these auditing entries to objects and/or containers within this container only

Figure 25 Object event audit tab

6. set the configuration

Table XVIII Object audit configuration

Audited object	Audit apply to	Audited event
system32	this folder only	create file
program file	this folder and subfolders	create dir
windows	this folder only	create file
hosts, system.ini, win.ini	this object only	write data append data write attr write atten attr change permission
C:\WINDOWS\system32\config\SAM	this object only	All
C:\WINDOWS\repair\sam	this object only	All

HCU\Software\Microsoft\ Protected Storage System Provider	this key and subkeys	All
Documents and Settings\Application Data\ Microsoft\Credentials	this folder and subfolders	All
HCU\Software\Microsoft\Internet Explorer\ IntelliForms\Storage2	this key and subkeys	All
C:\Documents and Settings\KARAWUT\ Application Data\Microsoft\Address Book	this folder and subfolders	read data
HLM \software\microsoft\windows nt\ currentVersion	this key only	query value
HCU\Software\Microsoft\Windows\ CurrentVersion\Policies\System	this key only	set value
HLM\System\Currentcontrolset\Services\	this key only	create subkey
HLM\Software\Microsoft\Windows\ CurrentVersion\Run[Services]	this key only	set value
HLM\Software\Microsoft\Windows\ CurrentVersion\Run[Services]Once	this key only	set value
HLM\Software\Microsoft\Windows\ CurrentVersion\Run[Services]OnceEx	this key only	set value
HCU\Software\Microsoft\Windows\ CurrentVersion\Run	this key only	set value
HLM\Software\Microsoft\Windows\ CurrentVersion\Policies\Explorer\Run	this key only	set value
HLM\Software\Microsoft\Windows NT CurrentVersion\Winlogon\Notify	this key only	create subkey
HCR\Exefile\shell\open\command\	this key only	set value
C:\Documents and Settings\All Users\Start Menu\ Programs\Startup	this folder only	write data, append data
HLM\Software\Microsoft\Security Center	this key and subkeys	set value
HLM\Software\Microsoft\Windows\ CurrentVersion\WindowsUpdate\auto update	this key	set value
HLM\Software\Policies\Microsoft\ WindowsFirewall\DomainProfile	this key and subkeys	set value, create sub
HLM\System\CurrentControlSet\Services\ SharedAccess\Parameters\FirewallPolicy\ StandardProfile\AuthorizedApplications\List	this key only	set value
HLM\SOFTWARE\Microsoft\Windows\ CurrentVersion\Explorer\ Browser Helper Objects	this key and subkeys	create subkey

Project Lasso

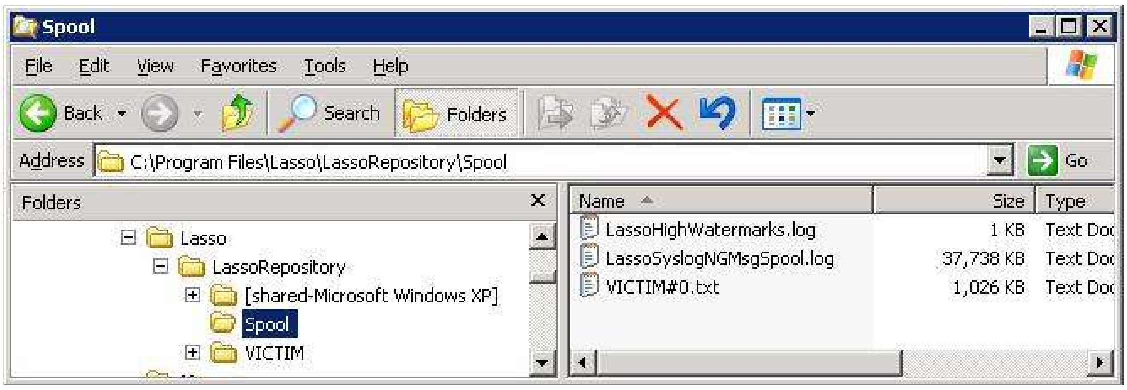
The configuration file “Lasso.ini”

```
SkipInitDLLScan,0
LogAppliance,127.0.0.1,514
RepositoryPath,C:\Program Files\Lasso\LassoRepository\
SpoolPath,C:\Program Files\Lasso\LassoRepository\Spool\
EventPollInterval,10
SpoolFileSize,0.01           # spool file size in %
WatermarkWriteInterval,100
MaxTraceFileSize,1
MaxNumWorkerThreads,4
DllLoadInterval,3600
HighWaterMarks,ON
#DefaultLassoShare,LassoShare=C:\LassoTemp
CheckHostListInterval,3600
NewHostSkipHistorical,0
EnableShareDlls,1
CheckRemHostAvail,0
EnableAdminSharesIfDisabled,0
DebugLevel,31
LogLevel,7
DebugHostFileSize,10 #  VICTIM#0 SIZE
AccessReport,0
```

The configuration file Hostlist.ini

```
localhost,security,system
```

The directory structure

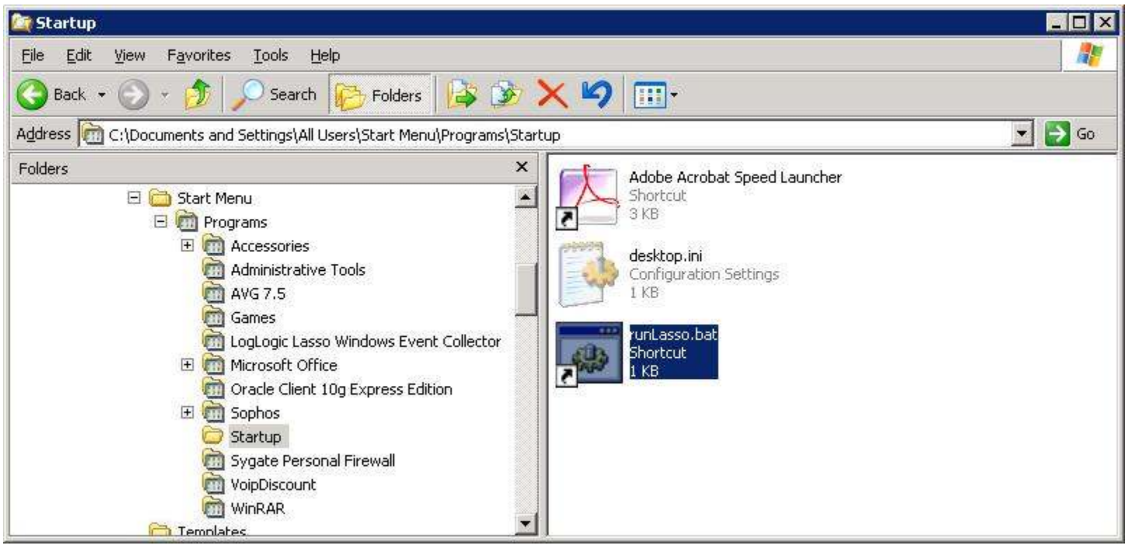


C:\Program Files\Lasso\LassoRepository\Spool

Name	Size	Type
LassoHighWatermarks.log	1 KB	Text Doc
LassoSyslogNGMsgSpool.log	37,738 KB	Text Doc
VICTIM#0.txt	1,026 KB	Text Doc

Figure 26 Lasso's directory structure

The startup process



Address C:\Documents and Settings\All Users\Start Menu\Programs\Startup

```
Start Menu
  Programs
    Accessories
    Administrative Tools
    AVG 7.5
    Games
    LogLogic Lasso Windows Event Collector
    Microsoft Office
    Oracle Client 10g Express Edition
    Sophos
    Startup
    Sygate Personal Firewall
    VoipDiscount
    WinRAR
Templates
```

Adobe Acrobat Speed Launcher
Shortcut
3 KB

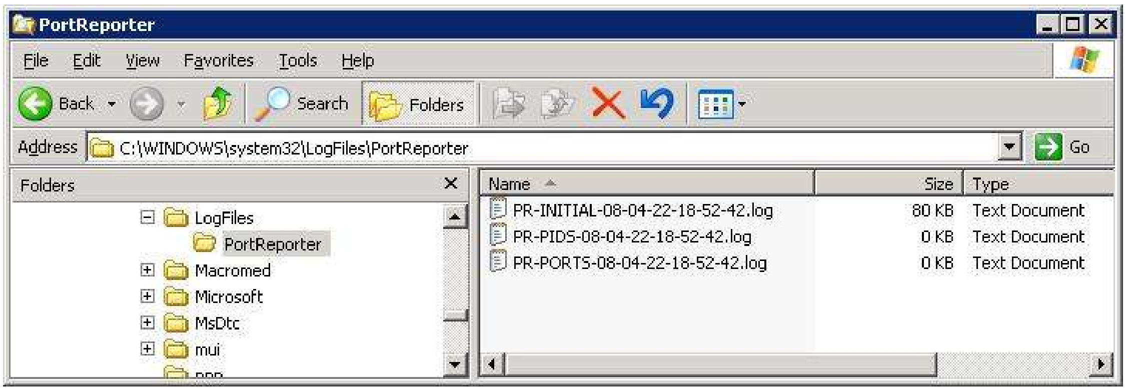
desktop.ini
Configuration Settings
1 KB

runLasso.bat
Shortcut
1 KB

Figure 27 Lasso's startup process

The Port Reporter

The directory structure



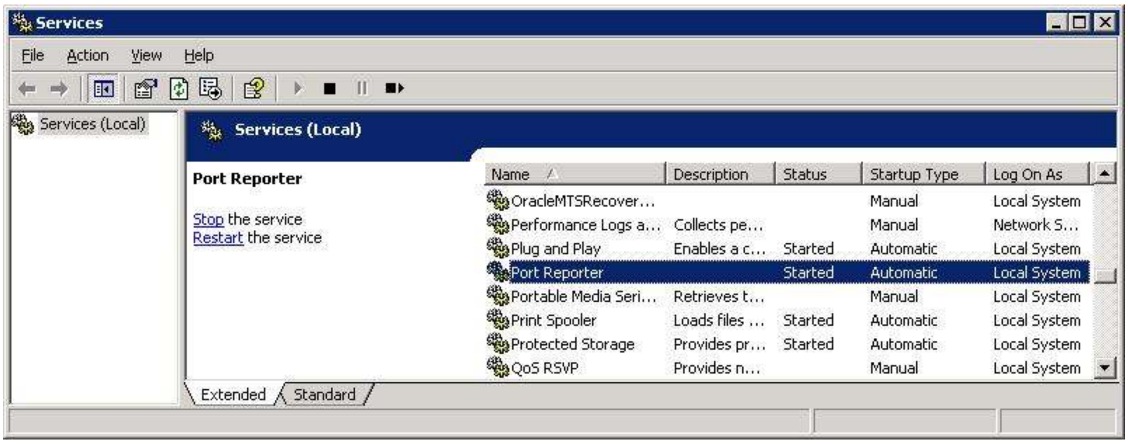
Address C:\WINDOWS\system32\LogFiles\PortReporter

```
LogFiles
  PortReporter
Macromed
Microsoft
MsDtc
mui
ppp
```

Name	Size	Type
PR-INITIAL-08-04-22-18-52-42.log	80 KB	Text Document
PR-PIDS-08-04-22-18-52-42.log	0 KB	Text Document
PR-PORTS-08-04-22-18-52-42.log	0 KB	Text Document

Figure 28 Port Reporter's directory structure

The startup service



Port Reporter

Stop the service
Restart the service

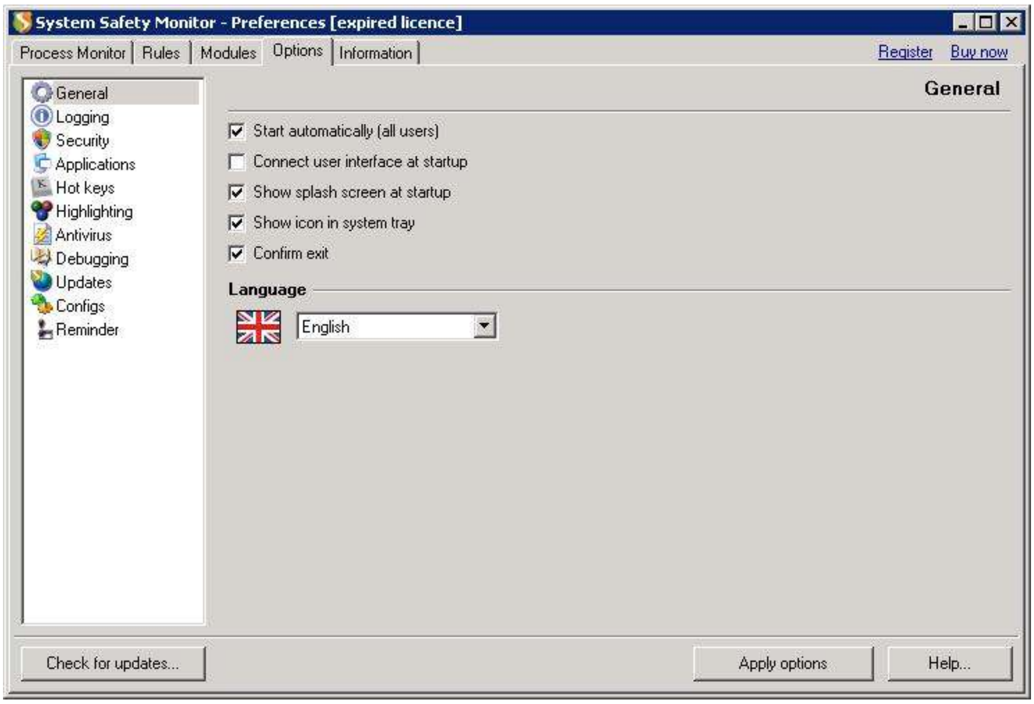
Name	Description	Status	Startup Type	Log On As
OracleMTSRecover...			Manual	Local System
Performance Logs a...	Collects pe...		Manual	Network S...
Plug and Play	Enables a c...	Started	Automatic	Local System
Port Reporter		Started	Automatic	Local System
Portable Media Seri...	Retrieves t...		Manual	Local System
Print Spooler	Loads files ...	Started	Automatic	Local System
Protected Storage	Provides pr...	Started	Automatic	Local System
QoS RSVP	Provides n...		Manual	Local System

Figure 29 Port Reporter's startup service

System safety monitor

Application configuration

General configuration



General

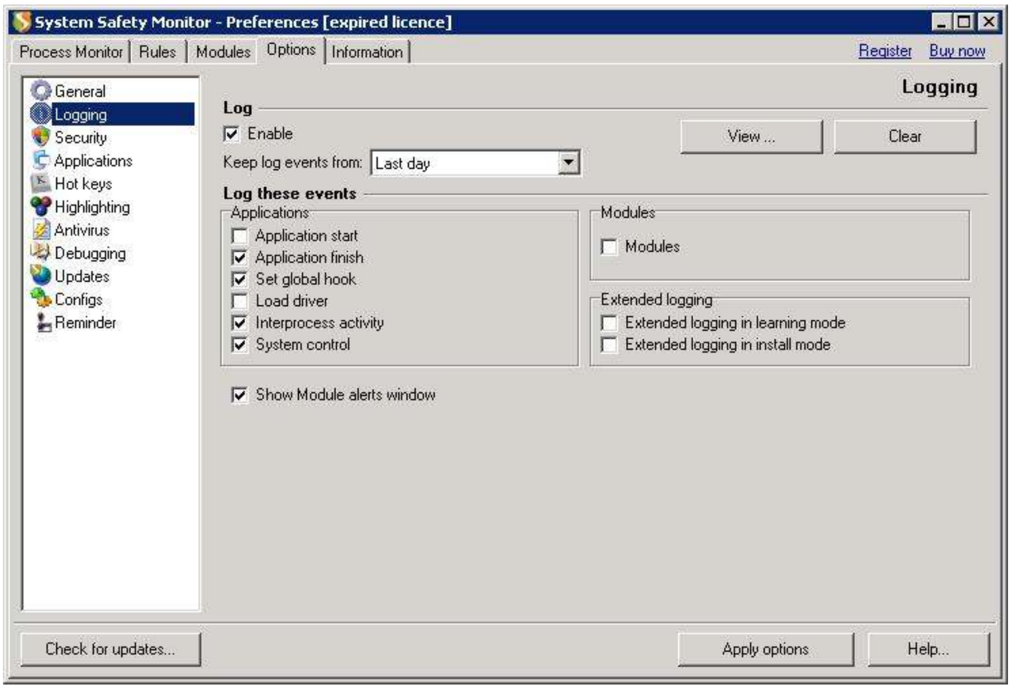
☑ Start automatically (all users)
☐ Connect user interface at startup
☑ Show splash screen at startup
☑ Show icon in system tray
☑ Confirm exit

Language

English

Figure 30 System Safety Monitor's general configuration

Logging configuration



Logging

Log

☑ Enable

Keep log events from: Last day

Log these events

Applications

□ Application start
☑ Application finish
☑ Set global hook
□ Load driver
☑ Interprocess activity
☑ System control

Modules

□ Modules

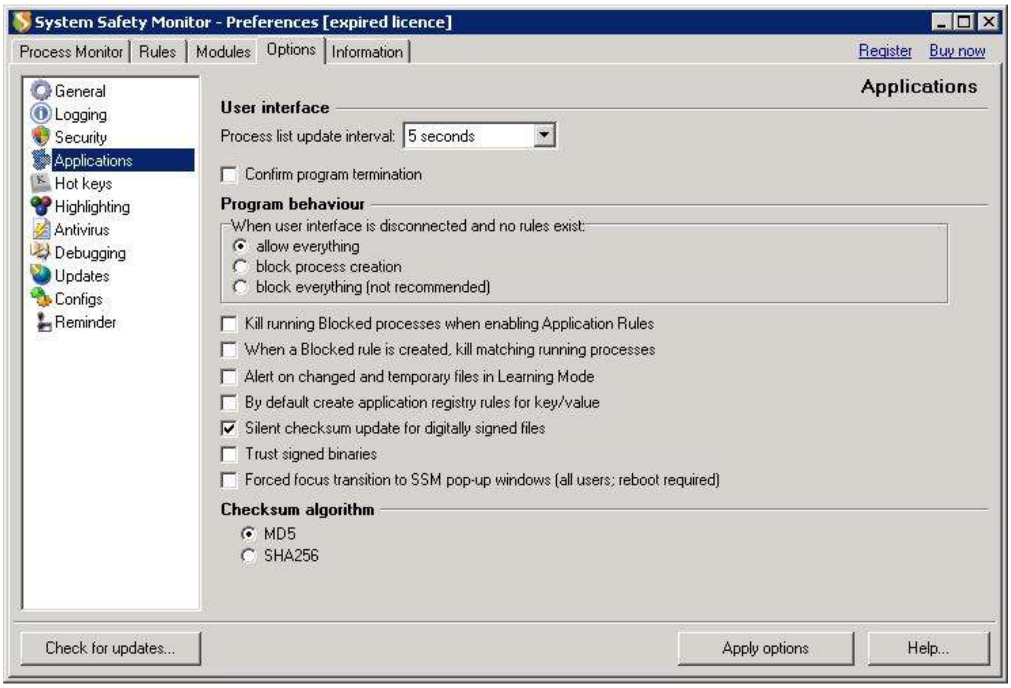
Extended logging

□ Extended logging in learning mode
□ Extended logging in install mode

☑ Show Module alerts window

Figure 31 System Safety Monitor's logging configuration

Applications configuration



Applications

User interface

Process list update interval: 5 seconds

□ Confirm program termination

Program behaviour

When user interface is disconnected and no rules exist:

● allow everything
○ block process creation
○ block everything (not recommended)

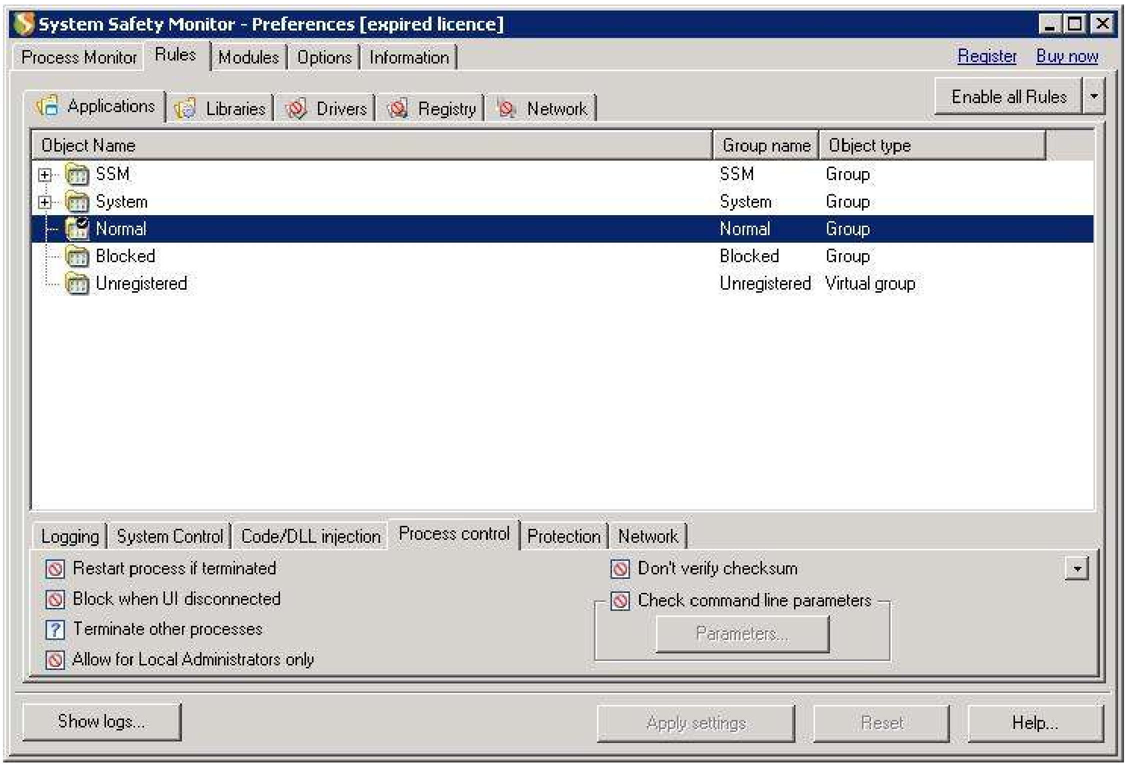
□ Kill running Blocked processes when enabling Application Rules
□ When a Blocked rule is created, kill matching running processes
□ Alert on changed and temporary files in Learning Mode
□ By default create application registry rules for key/value
☑ Silent checksum update for digitally signed files
□ Trust signed binaries
□ Forced focus transition to SSM pop-up windows (all users; reboot required)

Checksum algorithm

● MD5
○ SHA256

Figure 32 System Safety Monitor's applications configuration

Rule configuration: everything is default except “Rules>Process control>Terminate other processes”



Object Name	Group name	Object type
SSM	SSM	Group
System	System	Group
Normal	Normal	Group
Blocked	Blocked	Group
Unregistered	Unregistered	Virtual group

⊘ Restart process if terminated

⊘ Block when UI disconnected

? Terminate other processes

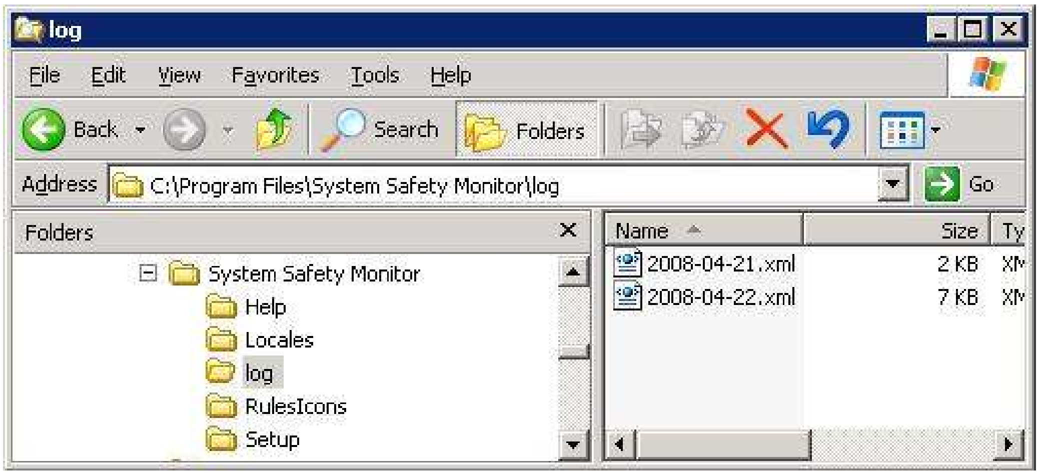
⊘ Allow for Local Administrators only

⊘ Don't verify checksum

⊘ Check command line parameters

Figure 33 System Safety Monitor's rule configuration

The directory structure



Address: C:\Program Files\System Safety Monitor\log

- System Safety Monitor
  - Help
  - Locales
  - log
  - RulesIcons
  - Setup

Name	Size	Ty
2008-04-21.xml	2 KB	XM
2008-04-22.xml	7 KB	XM

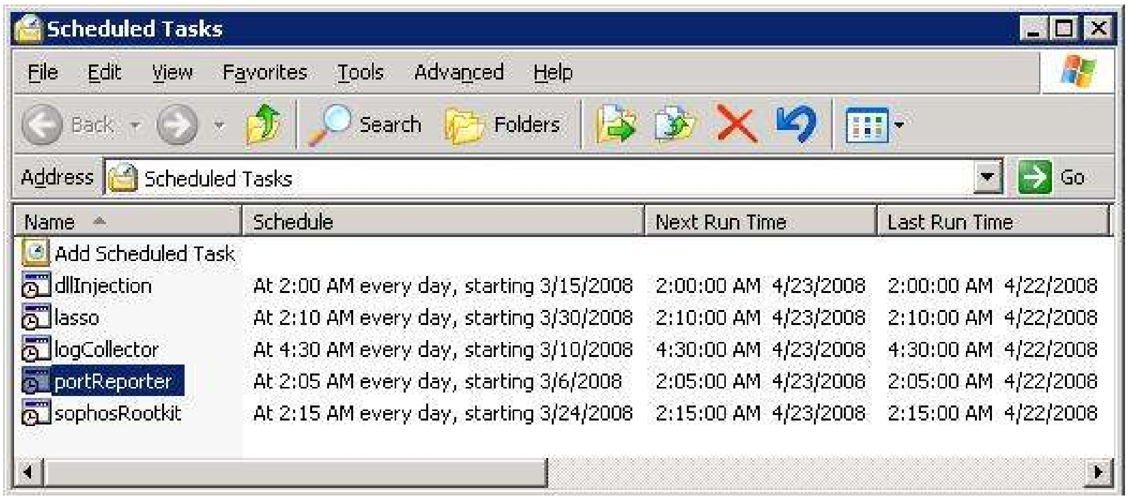
Figure 34 System Safety Monitor's directory structure

LogFileParsing

Command

```
java LogFileParsing > app.log
```

Task schedule



Name	Schedule	Next Run Time	Last Run Time
Add Scheduled Task			
dllInjection	At 2:00 AM every day, starting 3/15/2008	2:00:00 AM 4/23/2008	2:00:00 AM 4/22/2008
lasso	At 2:10 AM every day, starting 3/30/2008	2:10:00 AM 4/23/2008	2:10:00 AM 4/22/2008
logCollector	At 4:30 AM every day, starting 3/10/2008	4:30:00 AM 4/23/2008	4:30:00 AM 4/22/2008
portReporter	At 2:05 AM every day, starting 3/6/2008	2:05:00 AM 4/23/2008	2:05:00 AM 4/22/2008
sophosRootkit	At 2:15 AM every day, starting 3/24/2008	2:15:00 AM 4/23/2008	2:15:00 AM 4/22/2008

Figure 35 LogFileParsing's task schedule

Batch files

lasso.bat

```
del /Q C:\batchJob\logs\lasso.txt
copy /Y C:\"Program Files"\Lasso\LassoRepository\Spool\VICTIM#0.txt
C:\batchJob\logs\lasso.txt
```

dllInjection.bat

```
cd C:\Program Files\System Safety Monitor\log
for /F "tokens=5 skip=5" %%A IN ('dir /O-D *.xml') DO (
            copy /Y %%A C:\batchJob\logs\dllInjectionLog.xml
            copy /Y %%A C:\batchJob\oldLog\
            del /Q %%A
)
```

portReporter.bat

```
del /Q C:\batchJob\logs\portReporter.txt
copy /Y C:\WINDOWS\system32\LogFiles\PortReporter\pr-ports*
C:\batchJob\logs\portReporter.txt
del /Q C:\WINDOWS\system32\LogFiles\PortReporter\*
```

rootKitBuster.bat

```
del /Q C:\batchJob\logs\RootkitBuster.txt
del /Q C:\"Program Files"\RootkitBuster\TMRBLog\*
cd C:\"Program Files"\RootkitBuster
RootkitBuster.exe /s /a
copy /Y C:\"Program Files"\RootkitBuster\TMRBLog\TMRB00001.TXT
C:\batchJob\logs\RootkitBuster.txt
```

sophosRootkit.bat

```
del /Q C:\batchJob\logs\sophosRootkit.txt
cd C:\Program Files\Sophos\Sophos Anti-Rootkit
sarcli -log="C:\batchJob\logs\sophosRootkit.txt"
```

logCollector.bat

```
cd C:\batchJob\app
java LogFileParsing > app.log
```

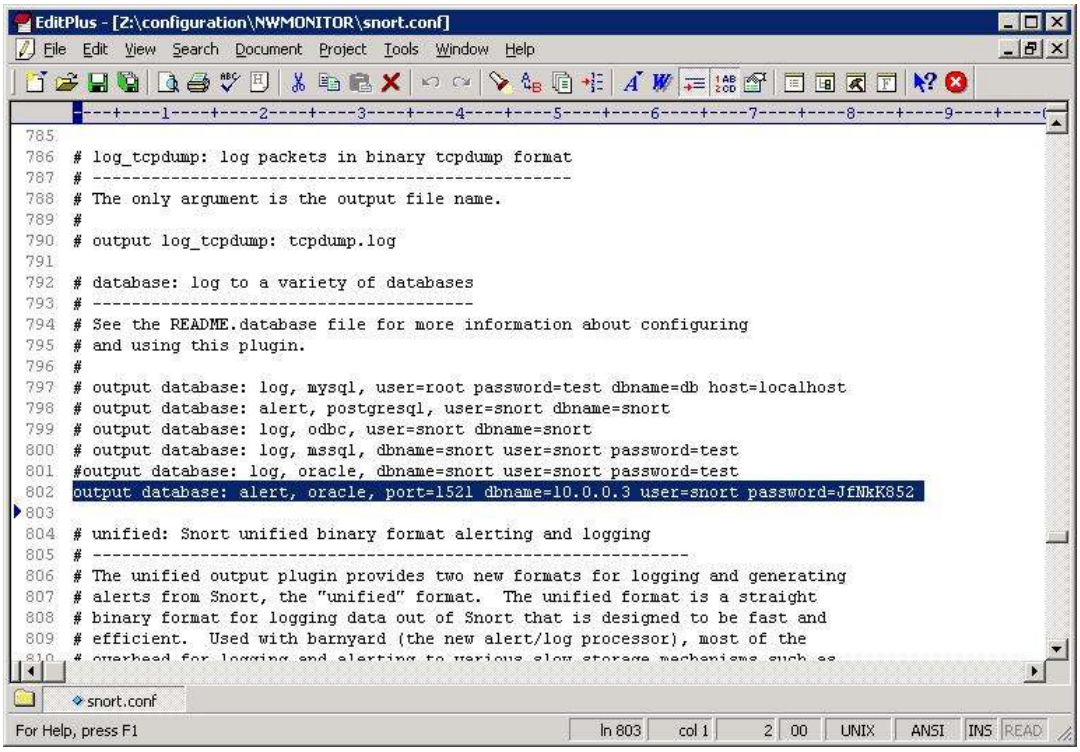
The NW MONITOR machine

Snort (with oracle supported option)

Command

```
snort -de -i3 -l ..\log -h 10.0.0.0/24 -c ..\etc\snort.conf
```

Configuration for Oracle supported


EditPlus - [Z:\configuration\NWMONITOR\snort.conf]
File Edit View Search Document Project Tools Window Help
snort.conf
For Help, press F1
ln 803
col 1
2
00
UNIX
ANSI
INS
READ

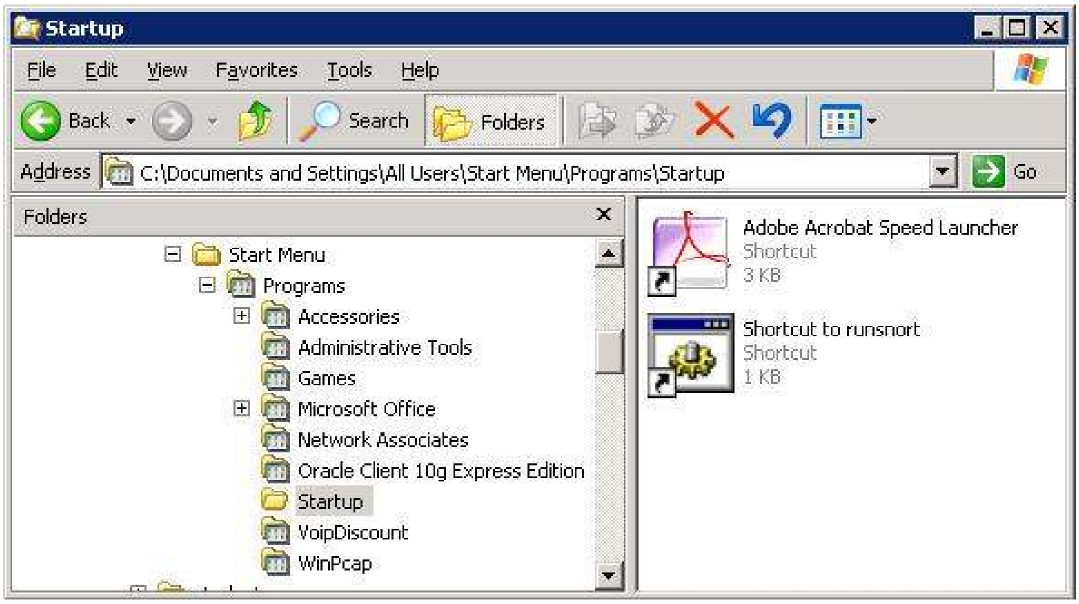
```
# log_tcpdump: log packets in binary tcpdump format
# -------------------------------------------------
# The only argument is the output file name.
#
# output log_tcpdump: tcpdump.log

# database: log to a variety of databases
# ---------------------------------------
# See the README.database file for more information about configuring
# and using this plugin.
#
# output database: log, mysql, user=root password=test dbname=db host=localhost
# output database: alert, postgresql, user=snort dbname=snort
# output database: log, odbc, user=snort dbname=snort
# output database: log, mssql, dbname=snort user=snort password=test
#output database: log, oracle, dbname=snort user=snort password=test
output database: alert, oracle, port=1521 dbname=10.0.0.3 user=snort password=JfNkK852

# unified: Snort unified binary format alerting and logging
# -------------------------------------------------------------
# The unified output plugin provides two new formats for logging and generating
# alerts from Snort, the "unified" format.  The unified format is a straight
# binary format for logging data out of Snort that is designed to be fast and
# efficient.  Used with barnyard (the new alert/log processor), most of the
# overhead for logging and alerting to various slow storage mechanisms such as
```

Figure 36 Snort's configuration for Oracle supported

The startup process



Address: C:\Documents and Settings\All Users\Start Menu\Programs\Startup

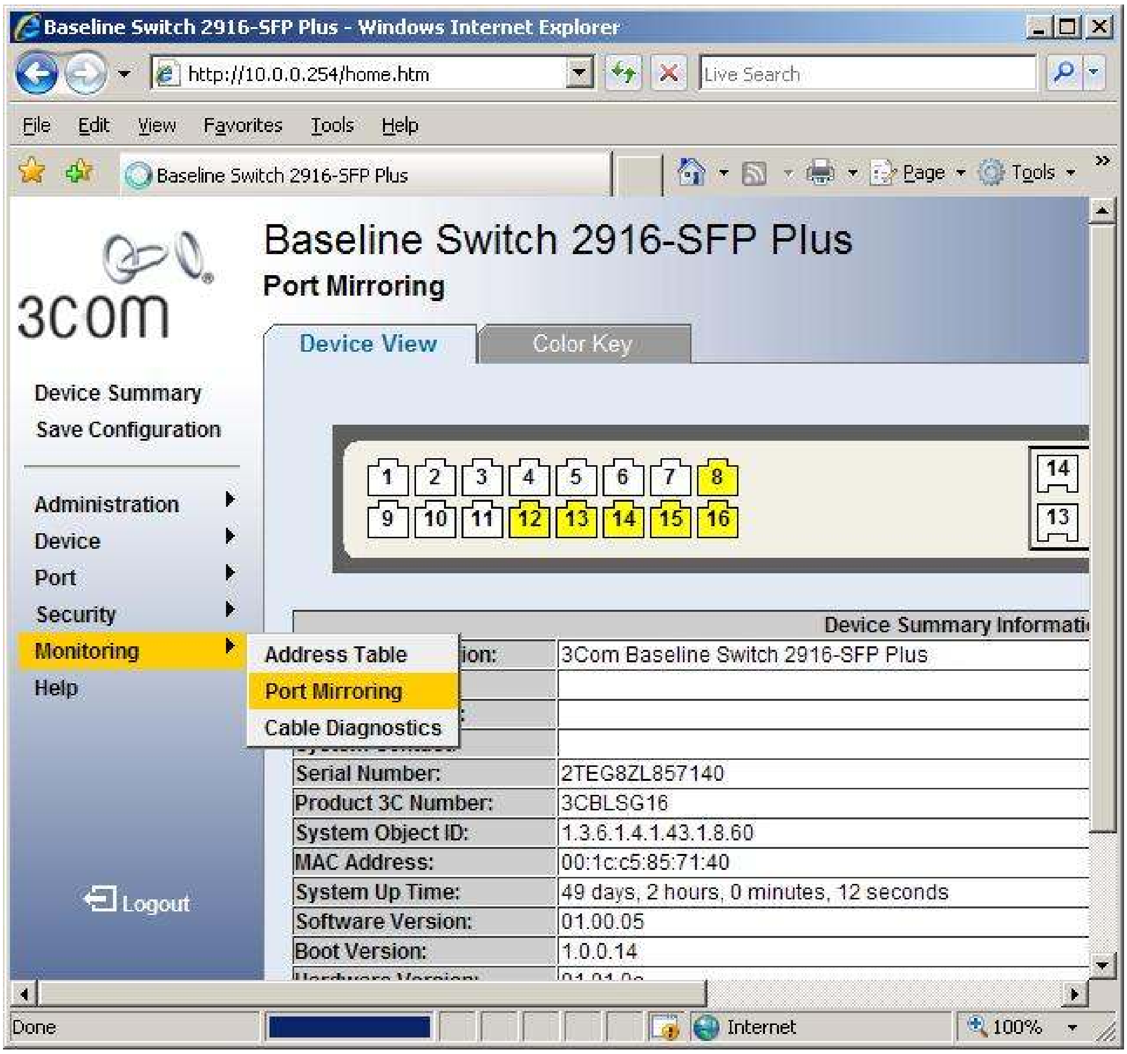
Figure 37 Snort's startup process

Backdoor Trojan Removal

In case of detecting unknown backdoor Trojan, Snort was removed the rule for detecting Trojans.

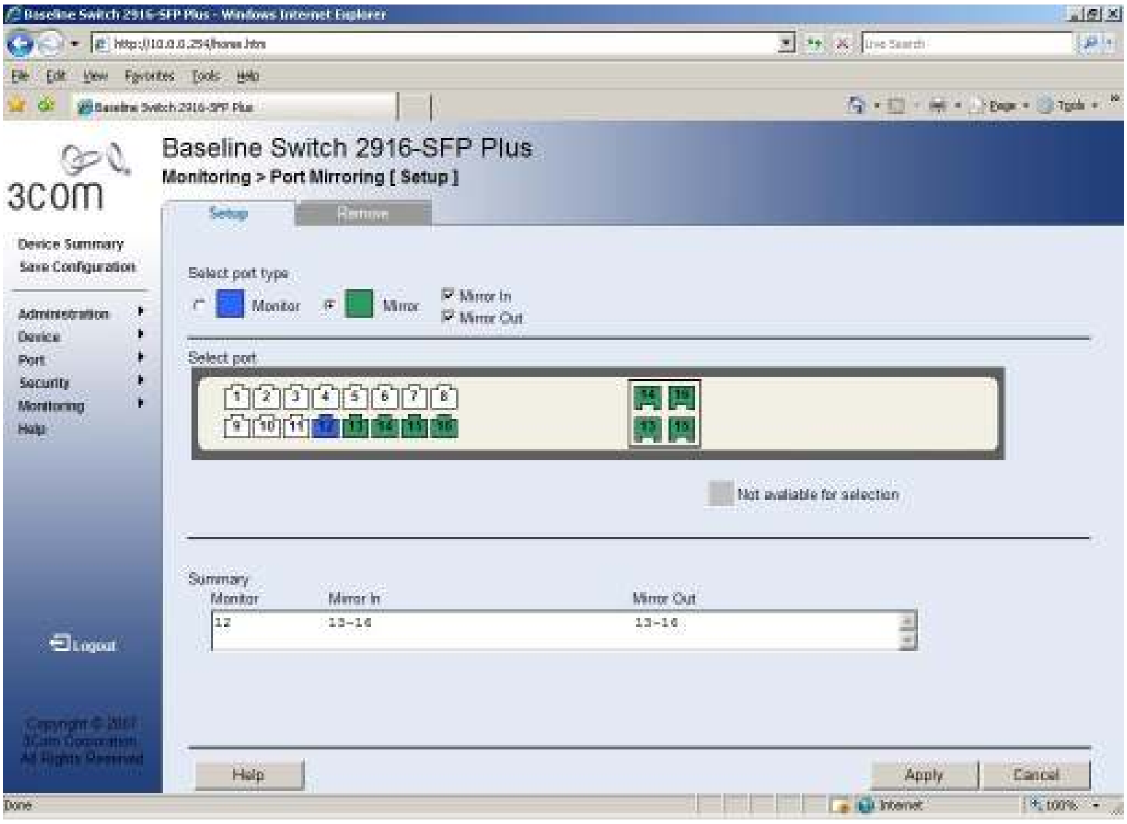
Switch

Switch configuration: Port monitoring



Device Summary Informati	
ion:	3Com Baseline Switch 2916-SFP Plus
:	
Serial Number:	2TEG8ZL857140
Product 3C Number:	3CBLSG16
System Object ID:	1.3.6.1.4.1.43.1.8.60
MAC Address:	00:1c:c5:85:71:40
System Up Time:	49 days, 2 hours, 0 minutes, 12 seconds
Software Version:	01.00.05
Boot Version:	1.0.0.14

Figure 38 Switch configuration



Baseline Switch 2916-SFP Plus - Windows Internet Explorer
http://10.0.0.254/home.htm
File Edit View Favorites Tools Help
Baseline Switch 2916-SFP Plus
3com
Device Summary
Save Configuration
Administration
Device
Port
Security
Monitoring
Help
Logout
Copyright © 2007 3Com Corporation All Rights Reserved
Setup
Remove
Not available for selection
Help
Apply
Cancel
Done
Internet
100%

Baseline Switch 2916-SFP Plus

Monitoring > Port Mirroring [Setup]

Select port type

○ Monitor ● Mirror ☑ Mirror In ☑ Mirror Out

Select port

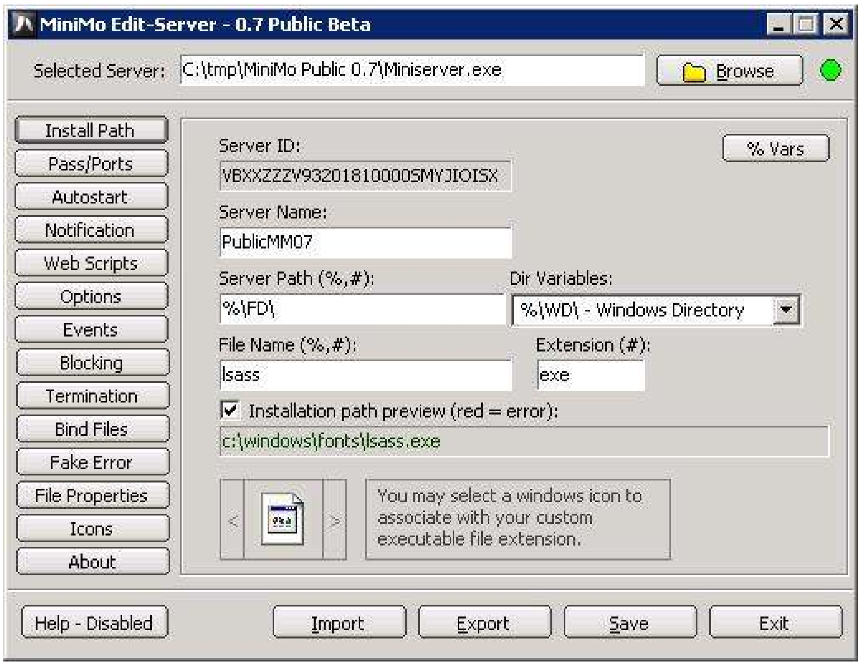
Summary

Monitor	Mirror In	Mirror Out
12	13-16	13-16

Figure 39 Port monitoring page

2. Testing steps

1. create a Trojan server on the machine ATTACKER



MiniMo Edit-Server - 0.7 Public Beta

Selected Server: C:\tmp\MiniMo Public 0.7\Miniserver.exe

Server ID: VBXXZZZV932018100005MYJIOISX

Server Name: PublicMM07

Server Path (%,#): %\FD\

Dir Variables: %\WD\ - Windows Directory

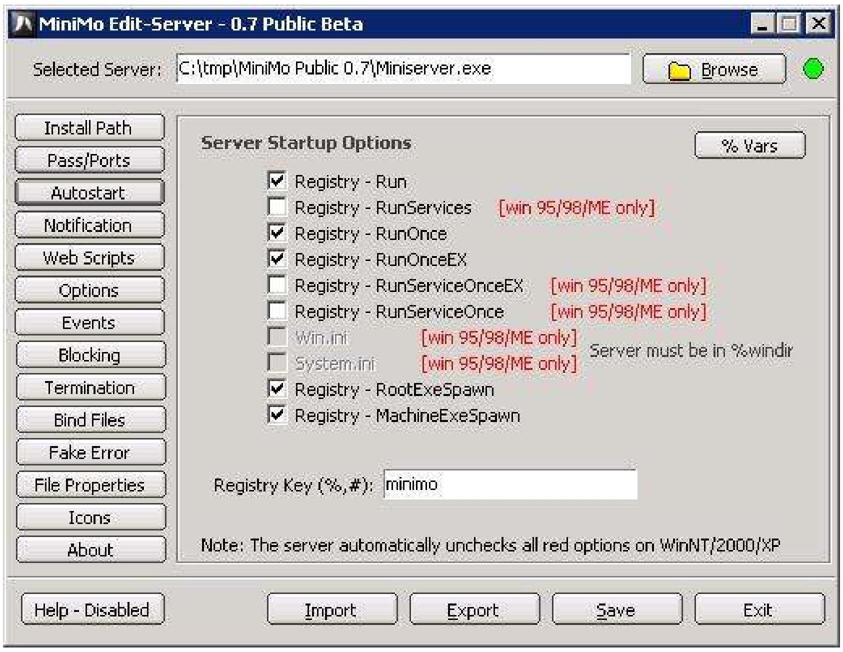
File Name (%,#): lsass

Extension (#): exe

☑ Installation path preview (red = error): c:\windows\fonts\lsass.exe

You may select a windows icon to associate with your custom executable file extension.

Figure 40 setting installation path



MiniMo Edit-Server - 0.7 Public Beta

Selected Server: C:\tmp\MiniMo Public 0.7\Miniserver.exe

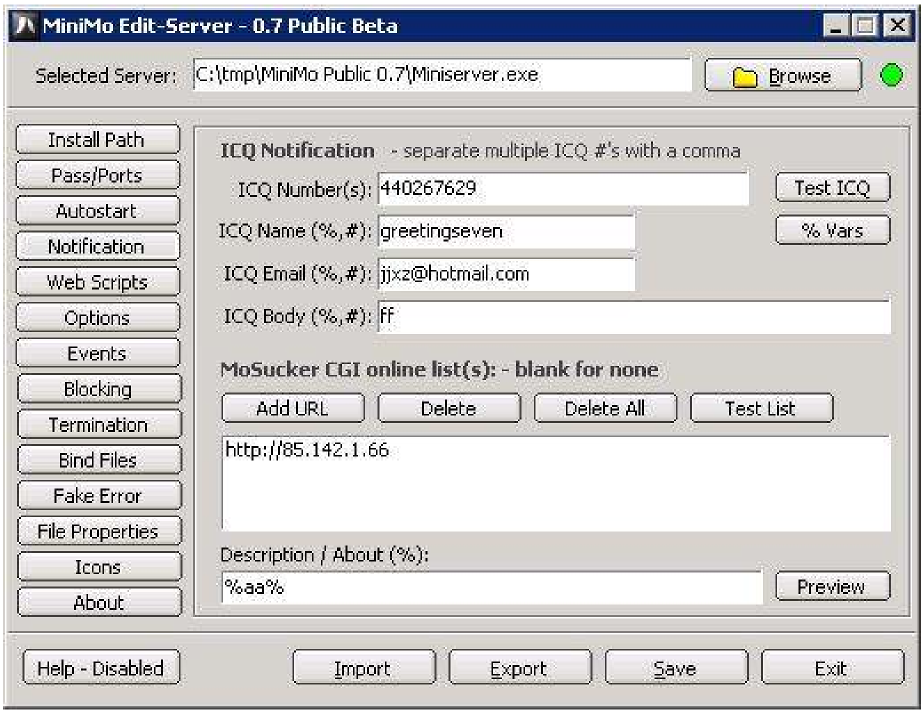
Server Startup Options

☑ Registry - Run
☐ Registry - RunServices [win 95/98/ME only]
☑ Registry - RunOnce
☑ Registry - RunOnceEX
☐ Registry - RunServiceOnceEX [win 95/98/ME only]
☐ Registry - RunServiceOnce [win 95/98/ME only]
☐ Win.ini [win 95/98/ME only]
☐ System.ini [win 95/98/ME only]
Server must be in %windir
☑ Registry - RootExeSpawn
☑ Registry - MachineExeSpawn

Registry Key (%,#): minimo

Note: The server automatically unchecks all red options on WinNT/2000/XP

Figure 41 Setting autostart



MiniMo Edit-Server - 0.7 Public Beta

Selected Server: C:\tmp\MiniMo Public 0.7\Miniserver.exe

ICQ Notification - separate multiple ICQ #'s with a comma

ICQ Number(s): 440267629

ICQ Name (%,#): greetingseven

ICQ Email (%,#): jjxz@hotmail.com

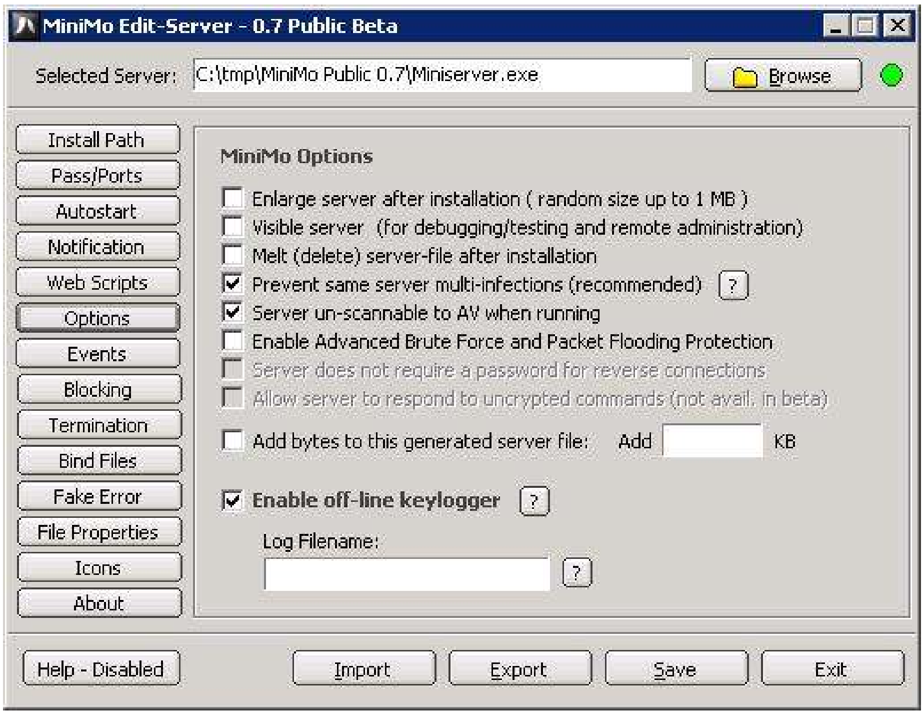
ICQ Body (%,#): ff

MoSucker CGI online list(s): - blank for none

http://85.142.1.66

Description / About (%): %aa%

Figure 42 Setting notification



MiniMo Edit-Server - 0.7 Public Beta

Selected Server: C:\tmp\MiniMo Public 0.7\Miniserver.exe

MiniMo Options

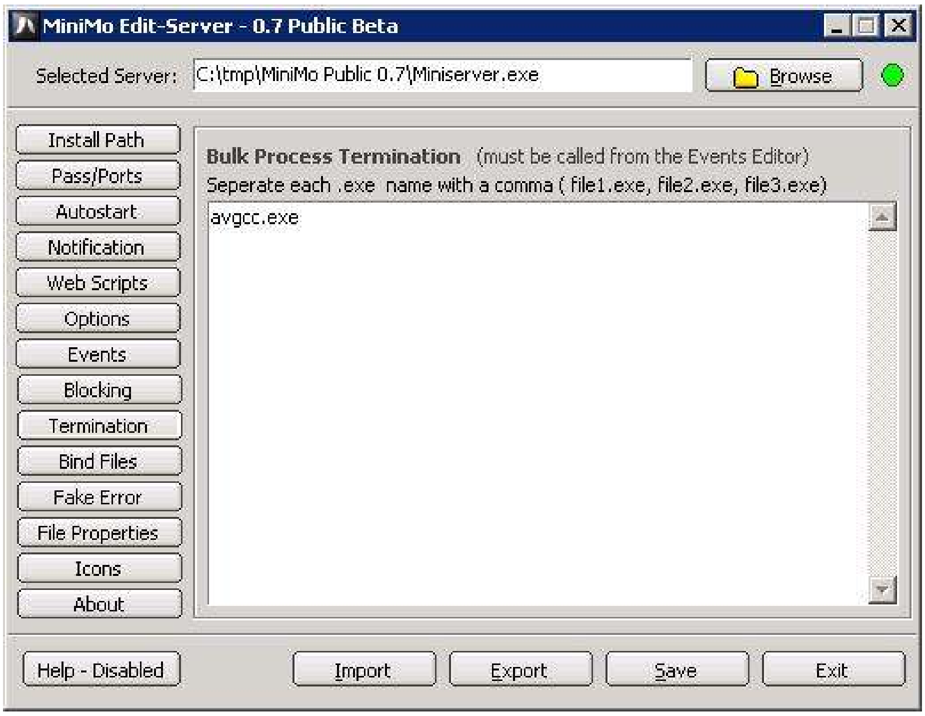
- ☐ Enlarge server after installation (random size up to 1 MB)
- ☐ Visible server (for debugging/testing and remote administration)
- ☐ Melt (delete) server-file after installation
- ☑ Prevent same server multi-infections (recommended)
- ☑ Server un-scannable to AV when running
- ☐ Enable Advanced Brute Force and Packet Flooding Protection
- ☐ Server does not require a password for reverse connections
- ☐ Allow server to respond to uncrypted commands (not avail. in beta)

☐ Add bytes to this generated server file: Add KB

☑ Enable off-line keylogger

Log Filename:

Figure 43 setting keylogger


MiniMo Edit-Server - 0.7 Public Beta

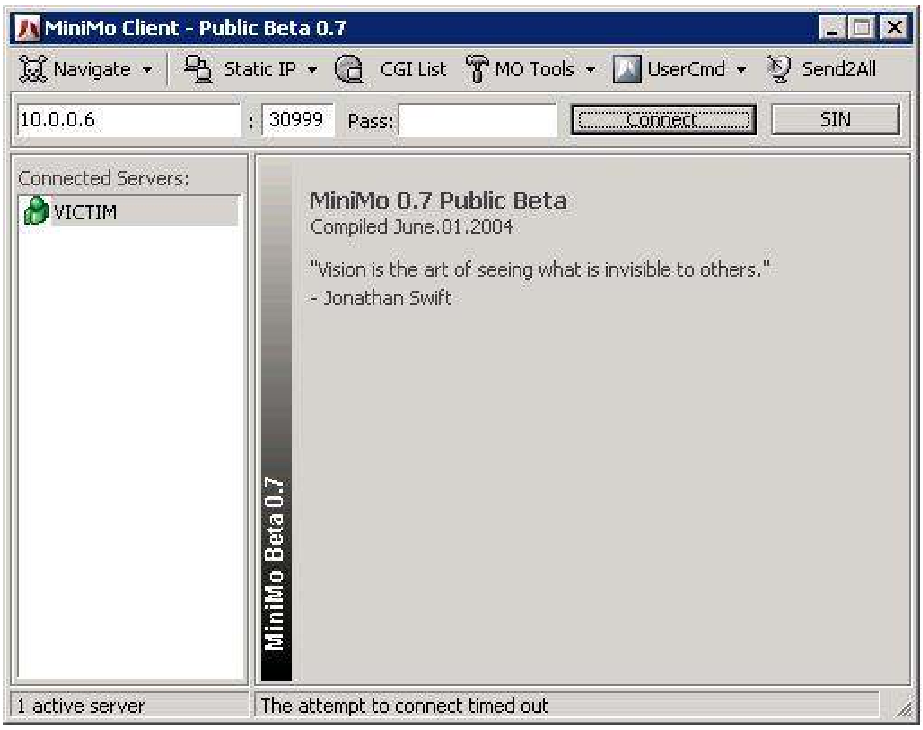
Selected Server: C:\tmp\MiniMo Public 0.7\Miniserver.exe

Bulk Process Termination (must be called from the Events Editor)
Seperate each .exe name with a comma (file1.exe, file2.exe, file3.exe)

```
avgcc.exe
```

Figure 44 Setting process termination

2. connect to the VICTIM


MiniMo Client - Public Beta 0.7

10.0.0.6 : 30999 Pass:

Connected Servers:
VICTIM

MiniMo 0.7 Public Beta
Compiled June.01.2004

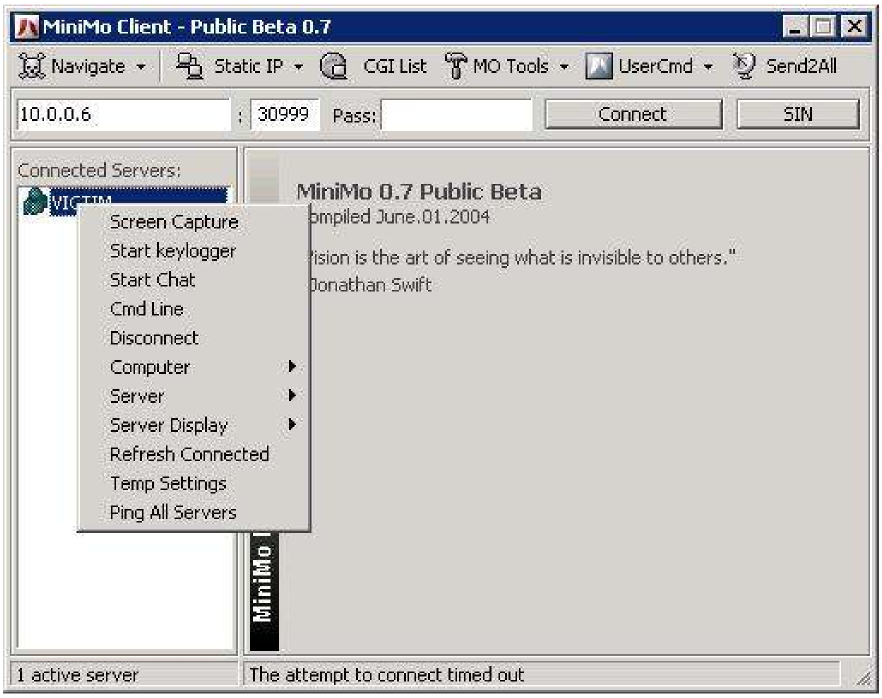
"Vision is the art of seeing what is invisible to others."
- Jonathan Swift

1 active server

The attempt to connect timed out

Figure 45 Connecting to the VICTIM

3. Controls the VICTIM



10.0.0.6 : 30999

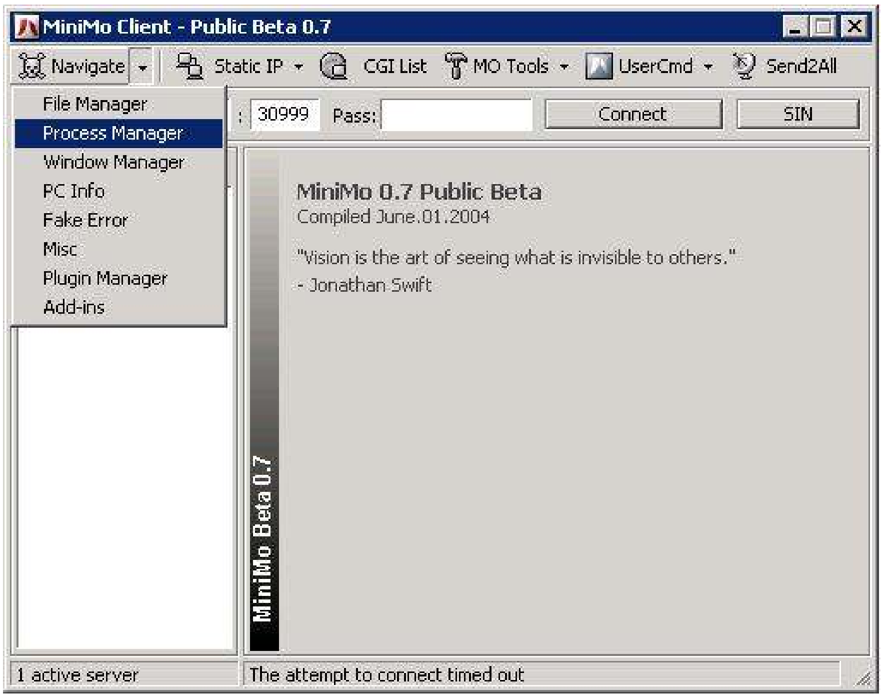
MiniMo 0.7 Public Beta
ompiled June.01.2004

ision is the art of seeing what is invisible to others."
Jonathan Swift

1 active server

The attempt to connect timed out

Figure 46 Controlling the VICTIM



: 30999

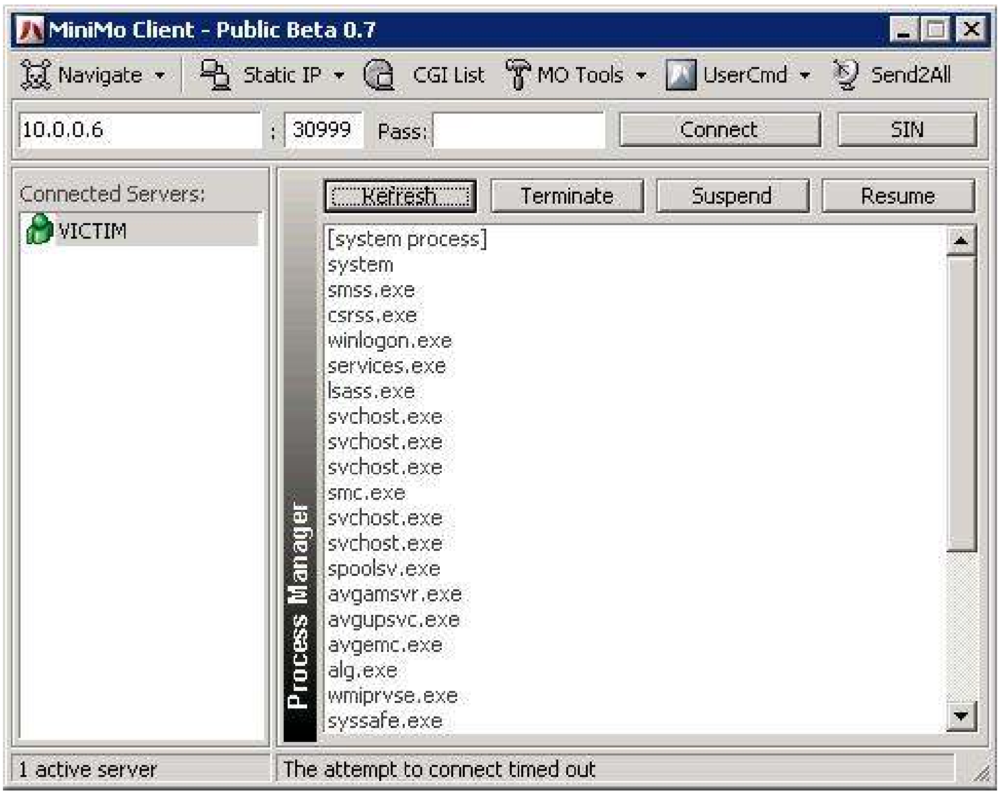
MiniMo 0.7 Public Beta
Compiled June.01.2004

"Vision is the art of seeing what is invisible to others."
- Jonathan Swift

1 active server

The attempt to connect timed out

Figure 47 Controlling the VICTIM



```
10.0.0.6 : 30999
```

VICTIM

```
[system process]
system
smss.exe
csrss.exe
winlogon.exe
services.exe
lsass.exe
svchost.exe
svchost.exe
svchost.exe
smc.exe
svchost.exe
svchost.exe
spoolsv.exe
avgamsvr.exe
avgupsvc.exe
avgemc.exe
alg.exe
wmiprvse.exe
syssafe.exe
```

1 active server

The attempt to connect timed out

Figure 48 Retrieving the VICTIM's processes

4. Run test.bat on the machine VICTIM

```
cd C:\Program Files\System Safety Monitor\log
for /F "tokens=5 skip=5" %%A IN ('dir /O-D *.xml') DO (
    copy /Y %%A C:\batchJob\logs\dllInjectionLog.xml
    copy /Y %%A C:\batchJob\oldLog\
    del /Q %%A
)

del /Q C:\batchJob\logs\portReporter.txt
copy /Y C:\WINDOWS\system32\LogFiles\PortReporter\pr-ports*
C:\batchJob\logs\portReporter.txt
del /Q C:\WINDOWS\system32\LogFiles\PortReporter\*

del /Q C:\batchJob\logs\sophosRootkit.txt
cd C:\Program Files\Sophos\Sophos Anti-Rootkit
sarcli -proc -log="C:\batchJob\logs\sophosRootkit.txt"

del /Q C:\batchJob\logs\lasso.txt
copy /Y C:\"Program Files"\Lasso\LassoRepository\Spool\VICTIM#0.txt
C:\batchJob\logs\lasso.txt

cd C:\batchJob\app
java LogFileParsing > app.log
```

5. run behaviorComparingEngineBatch.bat on the machine MLAS

6. runs reportGenerationEngineBatch.bat on the machine

7. Two reports generated from ReportGenerationEngine will be in the same directory with ReportGenerationEngine