

**BACKDOOR ATTACK DETECTION BASED ON STEPPING STONE  
DETECTION APPROACH**

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**UNIVERSITI UTARA MALAYSIA**

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# **Backdoor Attack Detection Based on Stepping Stone Detection Approach**

A dissertation submitted to Dean of Research and Postgraduate Studies  
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By

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## **Abstract**

Network intruders usually use a series of hosts (stepping stones) to conceal the tracks of their intrusion in the network. This type of intrusion can be detected through an approach called Stepping Stone Detection (SSD). In the past years, SSD was confined to the detection of only this type of intrusion. In this dissertation, we consider the use of SSD concepts in the field of backdoor attack detection. The application of SSD in this field results in many advantages. First, the use of SSD makes the backdoor attack detection and the scan process time faster. Second, this technique detects all types of backdoor attack, both known and unknown, even if the backdoor attack is encrypted. Third, this technique reduces the large storage resources used by traditional antivirus tools in detecting backdoor attacks. This study contributes to the field by extending the application of SSD-based techniques, which are usually used in SSD-based environments only, into backdoor attack detection environments. Through an experiment, the accuracy of SSD-based backdoor attack detection is shown as very high.

**Keywords:** Stepping stone, stepping stone detection, backdoor, hacker, intrusion

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*Khalid Al-Minshid*

# TABLE OF CONTENTS

|  |            |
|--|------------|
| <b>PERMISSION TO USE .....</b>                                       | <b>i</b>   |
| <b>ABSTRACT.....</b>   | <b>ii</b>  |
| <b>ACKNOWLEDGEMENT .....</b>   | <b>iii</b> |
| <b>TABLE OF CONTENTS .....</b>                                       | <b>iv</b>  |
| <b>CHAPTER ONE INTRODUCTION .....</b>                                | <b>1</b>   |
| 1.1 Introduction .....   | 1          |
| 1.2 Research Background .....  | 2          |
| 1.3 Problem Statement .....  | 4          |
| 1.4 Research Question.....   | 5          |
| 1.5 Research Objectives.....   | 5          |
| 1.6 Scope.....   | 6          |
| 1.7 Significance of the Research .....                               | 6          |
| 1.8 Summary.....   | 7          |
| <b>CHAPTER TWO LITERATURE REVIEW.....</b>                            | <b>8</b>   |
| 2.1 Introduction .....   | 8          |
| 2.2 Terminology .....  | 9          |
| 2.2.1 Network Security Terminology .....                             | 9          |
| 2.2.2 SSD Terminology .....  | 13         |
| 2.3 Backdoor Attack.....   | 15         |
| 2.3.1 Types of Backdoors.....  | 15         |
| 2.3.2 Authors and Users of Backdoors .....                           | 17         |
| 2.3.3 Backdoor Detectors .....                                       | 18         |
| 2.3.4 Recent Backdoor's Detection Approaches and Related Works ..... | 22         |
| 2.4 Stepping Stone.....  | 24         |
| 2.4.1 Stepping Stone Chain .....                                     | 24         |
| 2.4.2 SSD Approach .....   | 24         |
| 2.4.3 SSD Evolution and Related Work .....                           | 26         |
| 2.4.3.1 The Past of SSD.....   | 26         |

|   |           |
|---|-----------|
| 2.4.3.2 Current SSD .....                                 | 27        |
| 2.4.3.3 Future SSD .....                                  | 30        |
| 2.4.3.4 Emerging Fields for Application of SSD .....      | 31        |
| 2.4.4 SSD Issues.....                                     | 31        |
| 2.4.4.1 Interactive and Non interactive Connection .....  | 31        |
| 2.4.4.2 Positive and Negative False .....                 | 33        |
| 2.4.4.3 Passive and Active Detection.....                 | 33        |
| 2.4.4.4 SDD Matching Concepts.....                        | 34        |
| 2.4.5 SSD Techniques.....                                 | 36        |
| 2.4.6 SSD Models .....                                    | 40        |
| 2.4.6.1 HSSD Model .....                                  | 41        |
| 2.4.6.2 NSSD Model:.....                                  | 42        |
| 2.5 SSD and Backdoor .....                                | 45        |
| 2.6 Summary.....  | 47        |
| <b>CHAPTER THREE RESEARCH METHODOLOGY .....</b>           | <b>48</b> |
| 3.1 Introduction .....                                    | 48        |
| 3.2 Operational Framework .....                           | 48        |
| 3.3 Research Design.....                                  | 50        |
| 3.4 Subject and Information Sources .....                 | 51        |
| 3.5 Experimental Process and Data Gathering .....         | 52        |
| 3.6 Data Analysis .....                                   | 52        |
| 3.7 Evaluation.....                                       | 53        |
| 3.8 Tools .....   | 54        |
| <b>CHAPTER FOUR SAMPLING AND EXPERIMENTAL SETUP .....</b> | <b>55</b> |
| 4.1 Sampling.....   | 55        |
| 4.2 Materials and Experiment Setup .....                  | 62        |
| 4.3 Challenges and Solutions.....                         | 65        |
| 4.4 Experiment Steps .....                                | 68        |
| 4.5 Summary.....  | 70        |

|   |            |
|---|------------|
| <b>CHAPTER FIVE RESEARCH FINDINGS AND DISCUSSION.....</b> | <b>71</b>  |
| 5.1 Introduction .....                                    | 71         |
| 5.2 Data Analysis .....                                   | 71         |
| 5.3 Findings .....  | 83         |
| 5.4 Results and Evaluation.....                           | 89         |
| <b>CHAPTER SIX CONCLUSION AND FUTURE WORK.....</b>        | <b>94</b>  |
| 6.1 Conclusion .....                                      | 94         |
| 6.2 Research Contributions.....                           | 95         |
| 6.3 Future Work.....                                      | 95         |
| <b>REFERENCES .....</b>                                   | <b>96</b>  |
| <b>PUBLICATIONS .....</b>                                 | <b>101</b> |



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## LIST OF TABLES

|   |    |
|---|----|
| Table 2.1: Signature-based and Anomaly-based Characteristics .....          | 21 |
| Table 2.2: Prior Works for Stepping Stone Detection Approach .....          | 29 |
| Table 2.3: Characteristics of SSD Techniques .....                          | 38 |
| Table 2.4: Characteristics of SSD Models .....                              | 44 |
| Table 3.1: The relation between attributes and variables .....              | 50 |
| Table 5.1: The detection ratio result for the known backdoors .....         | 90 |
| Table 5.2: The initial values for the detection result for 10 samples ..... | 91 |
| Table 5.3: TPR and FPR for the 10 known backdoors .....                     | 91 |
| Table 5.4: The detection ratio result for the unique samples.....           | 91 |



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## LIST OF FIGURES

|   |    |
|---|----|
| Figure 1.1: Stepping Stones Chain Intrusion.....  | 3  |
| Figure 2.1: The Layer in the TCP/IP model and OSI model.....                            | 10 |
| Figure 2.2 : TCP packet structure .....   | 10 |
| Figure 2.3: IP header structure .....   | 11 |
| Figure 2.4: Stepping Stone Connection Chain .....                                       | 13 |
| Figure 2.5: Organization of backdoor detection.....                                     | 20 |
| Figure 2.6: One-to-one relationship .....   | 34 |
| Figure 2.7: One-to-many relationship.....   | 35 |
| Figure 2.8: Many-to-many relationship .....   | 35 |
| Figure 2.9: General Classification of SSD .....   | 40 |
| Figure 2.10: SSD Host-based model design.....   | 41 |
| Figure 2.11: SSD Network-based model design.....  | 42 |
| Figure 2.12: Backdoor Attack Traffic.....   | 45 |
| Figure 3.1: Operational Framework.....  | 49 |
| Figure 3.2: The relationship between variables and attributes .....                     | 51 |
| Figure 4.1: The interface of Spy Net Client's software .....                            | 56 |
| Figure 4.2 : The interface of Sub7 Gold client's software.....                          | 57 |
| Figure 4.3: The tools that can be used to encrypt and make new samples .....            | 58 |
| Figure 4.4: The interface to one of the encryption tools.....                           | 59 |
| Figure 4.5: Test result for the sample UUM_Backdoor before the encryption.....          | 60 |
| Figure 4.6: Test result for the sample (UUM_Backdoor) after the encryption.....         | 60 |
| Figure 4.7: Eset Smart Security 6 test result for the sample after the encryption. .... | 61 |
| Figure 4.8: Network Topology used for Offline Design testbed.....                       | 63 |
| Figure 4.9: Backdoor's client (attacker) software that used offline design .....        | 63 |
| Figure 4.10: Network Topology used for Online Design testbed .....                      | 64 |
| Figure 4.11:UUM_Backdoor in virtual machine software (VMware) environment               | 65 |
| Figure 4.12: UUM_Backdoor in real environment .....                                     | 66 |
| Figure 4.13: Virtual Machine software environment.....                                  | 67 |
| Figure 4.14: System restore method in Virtual Machine software .....                    | 67 |

|  |    |
|--|----|
| Figure 4.15: Eset Smart Security 6 tool process. ....                                    | 68 |
| Figure 4.16: Using Wireshark tool to capture the network packets .....                   | 69 |
| Figure 5.1 : Scenario (1), the flow between the backdoor and the attacker .....          | 73 |
| Figure 5.2 : Scenario (1), the capture packets in the victim side .....                  | 73 |
| Figure 5.3: Scenario (1), the capture packets in the attacker side .....                 | 74 |
| Figure 5.4: Scenario (2), flow between the backdoor and the host of the attacker ...     | 75 |
| Figure 5.5: Scenario (2), Poison backdoor in the victim side.....                        | 76 |
| Figure 5.6: Scenario (2), Poison backdoor in the attacker side. ....                     | 76 |
| Figure 5.7: Scenario (3), the victim host is active and the attacker host is offline ... | 77 |
| Figure 5.8: Scenario (3), the capture packets in the victim side. ....                   | 78 |
| Figure 5.9: Scenario (4), the flow between the APT backdoor and the attacker.....        | 79 |
| Figure 5.10: Scenario (4), the backdoor use outgoing flow only .....                     | 80 |
| Figure 5.11 : Scenario (5), using the intermediate server .....                          | 81 |
| Figure 5.12 : Scenario (5), the capture packets in the victim side .....                 | 82 |
| Figure 5.13: The information of the intermediate online server .....                     | 82 |
| Figure 5.14 : The activity graph of the backdoor .....                                   | 84 |
| Figure 5.15: The backdoor activity .....   | 84 |
| Figure 5.16: Backdoor detection based on the round trip time (RTT) technique .....       | 85 |
| Figure 5.17: Backdoor's scenario without round trip time .....                           | 86 |
| Figure 5.18: Detection Backdoor Technique Based on Stepping Stone Approach ..            | 88 |
| Figure 5.19: The detection result for the known samples .....                            | 90 |
| Figure 5.20: Avira Antivirus Scan Process Time.....                                      | 92 |
| Figure 5.21: Eset Smart Security 7 Scan Process Time.....                                | 93 |
| Figure 5.22: SSD Detection Time .....  | 93 |

## LIST OF APPENDICES

|   |     |
|---|-----|
| Appendix A The Snapshots to SSD Results .....               | 102 |
| Appendix B The Snapshots to Antivirus and IDS Results ..... | 109 |



# CHAPTER ONE

## INTRODUCTION

### 1.1 Introduction

Network applications are an important part of our daily lives. We cannot dispense with the use of these networks. At the same time, security attacks have been dramatically increasing. Security attacks come from users who do not have authorization to access the network and use the software. Most of the time, an unauthorized access is run by using a special malicious software called “malware.”

In the last ten years, malware attacks have become a common crime story online. Nowadays, well-known threats, including viruses, worms, trojans, backdoors, exploits, password stealers, and spyware, have reached millions, and among these threats, the backdoor attack has a high rate of intrusion across global networks around the world (Microsoft, 2012).

The backdoor attack is a hidden technique used to gain remote access to a machine or another system without authentication. It was a major threat in recent years and is one of the threats that cause serious concerns because the outbound it generates consists of several types of packages and exerts dangerous control over a range of hosts (B. Choi & Cho, 2012). As such, detecting backdoors has become an urgent demand today.

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## REFERENCES

- Agrawal, H., Alberi, J., Bahler, L., Conner, W., Micallef, J., Virodov, A., & Snyder, S. R. (2010). *Preventing insider malware threats using program analysis techniques*. Paper presented at the MILITARY COMMUNICATIONS CONFERENCE, 2010-MILCOM 2010.
- Balzarotti, D., Cova, M., Karlberger, C., Kruegel, C., Kirda, E., & Vigna, G. (2010). *Efficient detection of split personalities in malware*. Paper presented at the Network and Distributed System Security Symposium (NDSS).
- Banerjee, U., Vashishtha, A., & Saxena, M. (2010). Evaluation of the Capabilities of WireShark as a Tool for Intrusion Detection. *International Journal of Computer Applications*, 6(7).
- Borders, K., Zhao, X., & Prakash, A. (2006). *Siren: Catching evasive malware*. Paper presented at the Security and Privacy, 2006 IEEE Symposium on.
- Choi, B., & Cho, K. (2012). Detection of Insider Attacks to the Web Server. *Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications (JoWUA)*, 3(4), 35-45.
- Choi, W. S., & Choi, S. G. (2013). *An enhanced method for mitigation of network traffic using TCP signalling control*. Paper presented at the Advanced Communication Technology (ICACT), 2013 15th International Conference on.
- Crawford, M., & Peterson, G. (2013). *Insider Threat Detection using Virtual Machine Introspection*. Paper presented at the System Sciences (HICSS), 2013 46th Hawaii International Conference on.
- Decloedt, H. E., & Van Heerden, R. (2010). Rootkits, Trojans, backdoors and new developments.
- Dittmann, J., Karpuschewski, B., Fruth, J., Petzel, M., & Munder, R. (2010). *An exemplary attack scenario: threats to production engineering inspired by the Conficker worm*. Paper presented at the Proceedings of the First International Workshop on Digital Engineering.

- G. T. I. S. Center. (n.d.). Open Malware Retrieved July 13 2013, from <http://oc.gtisc.gatech.edu:8080>
- Gribble, S., Levy, H., Moshchuk, A., & Bragin, T. (2013). Detection of spyware threats withn virtual machine. : US Patent 20,130,014,259.
- Idika, N., & Mathur, A. P. (2007). A survey of malware detection techniques. *Purdue University*, 48.
- Kampasi, A., Zhang, Y., Di Crescenzo, G., Ghosh, A., & Talpade, R. (2007). *Improving stepping stone detection algorithms using anomaly detection techniques*.
- Kang, B., Kim, H. S., Kim, T., Kwon, H., & Im, E. G. (2011). *Fast malware family detection method using control flow graphs*. Paper presented at the Proceedings of the 2011 ACM Symposium on Research in Applied Computation.
- Kuo, Y.-W., & Huang, S.-H. (2008). *An Algorithm to Detect Stepping-Stones in the Presence of Chaff Packets*. Paper presented at the Parallel and Distributed Systems, 2008. ICPADS'08. 14th IEEE International Conference on.
- Kurose, J. F., & Ross, K. W. (2012). *Computer networking*: Pearson Education.
- Li, P. (2011). *Detecting stepping stones in internet environments*. Victoria: Deakin University.
- Li, P., Zhou, W., & Wang, Y. (2010). *Getting the real-time precise round-trip time for stepping stone detection*. Paper presented at the Network and System Security (NSS), 2010 4th International Conference on.
- Maarof, M. A., & Osman, A. H. (2012). Malware Detection Based on Hybrid Signature Behaviour Application Programming Interface Call Graph. *American Journal of Applied Sciences*, 9.
- Menahem, E., Shabtai, A., Rokach, L., & Elovici, Y. (2009). Improving malware detection by applying multi-inducer ensemble. *Computational Statistics & Data Analysis*, 53(4), 1483-1494.
- Microsoft. (2012). Microsoft Security Intelligence Report "*WORLDWIDE THREAT ASSESSMENT*" (Vol. 13): Technical Report.



- Mila. (2013). Contagio Malware Dump Retrieved Sep 30, 2013, from <http://contagiodump.blogspot.com/2013/04/collection-of-pcap-files-from-malware.html#more>
- Modi, C., Patel, D., Borisaniya, B., Patel, H., Patel, A., & Rajarajan, M. (2012). A survey of intrusion detection techniques in cloud. *Journal of Network and Computer Applications*.
- Mohan, R. (2013). Network Analysis and Application Control Software based on Client-Server Architecture. *arXiv preprint arXiv:1304.5015*.
- Mudzingwa, D., & Agrawal, R. (2012). *A study of methodologies used in intrusion detection and prevention systems (IDPS)*. Paper presented at the Southeastcon, 2012 Proceedings of IEEE.
- NETRESEC. (2010, 2013). NETRESEC Retrieved November, 01, 2013, from <http://www.netresec.com>
- Ni, L., Yang, J., Zhang, R., & Song, D. (2008). *Matching TCP/IP Packets to Resist Stepping-Stone Intruders' Evasion*. Paper presented at the System Theory, 2008. SSST 2008. 40th Southeastern Symposium on.
- Omar, M. N. (2005). *The Optimization of Stepping Stone Detection Algorithm in Intrusion Detection System* Master Universiti Teknologi Malaysia, Skudai, Johor,.
- Omar, M. N. (2011). *Approach for Solving Active Perturbation Attack problem in Stepping Stone Detection*. PHD, Universiti Sains Malaysia, Malaysia (USM) Penang.
- Omar, M. N., Amphawan, A., & Din, R. (2012). Evolution of Stepping Stone Detection and Emerging Applications. *11 WSEAS International Conference on Information Security and Privacy (ISP'12)*.
- Omar, M. N., Amphawan, A., & Din, R. (2013). A Stepping Stone Perspective to Detection of Network Threats.
- Paxson, V., & Zhang, Y. (2000). *Detecting backdoors*. Paper presented at the Proc. of 9th USENIX Security Symposium.

- Ping, L., Wanlei, Z., & Yini, W. (2010, 1-3 Sept. 2010). *Getting the Real-Time Precise Round-Trip Time for Stepping Stone Detection*. Paper presented at the Network and System Security (NSS), 2010 4th International Conference on.
- Prasad, M. S., Babu, A. V., & Rao, M. K. B. (2013). An Intrusion Detection System Architecture Based on Neural Networks and Genetic Algorithms. [International Journal of Computer Science and Management Research]. *International Journal of Computer Science and Management Research*, 2.
- Radmand, A. (2009). A ghost in software Retrieved sep, 21, 2013, from <http://cs.columbusstate.edu/cae-ia/StudentPapers/radmand.azadeh.pdf>
- Salimi, E., & Arastouie, N. (2011). *Backdoor Detection System Using Artificial Neural Network and Genetic Algorithm*. Paper presented at the Computational and Information Sciences (ICCIS), 2011 International Conference on.
- Sathyanarayan, V., Kohli, P., & Bruhadeshwar, B. (2008). *Signature generation and detection of malware families*. Paper presented at the Information Security and Privacy.
- Shabtai, A., Kanonov, U., Elovici, Y., Glezer, C., & Weiss, Y. (2012). "Andromaly": a behavioral malware detection framework for android devices. *Journal of Intelligent Information Systems*, 1-30.
- Shullich, R., Chu, J., Ji, P., & Chen, W. (2011). A Survey of Research in Stepping-Stone Detection. *International Journal of Electronic Commerce*, 2(2).
- Siddiqui, M., Wang, M. C., & Lee, J. (2008). *A survey of data mining techniques for malware detection using file features*. Paper presented at the Proceedings of the 46th Annual Southeast Regional Conference on XX.
- Sobh, T. (2008). *Novel algorithms and techniques in telecommunications, automation and industrial electronics*: Springer.
- Sonawane, S., Prasad, G., & Pardeshi, S. (2012). A survey on intrusion detection techniques. *World Journal of Science and Technology*, 2(3).

- Soni, C. (2013). Capturing of HTTP protocol packets in a wireless network. *International Journal of Wired and Wireless Communications*, 1(2), 5-10.
- Sukwong, O., Kim, H. S., & Hoe, J. C. (2011). Commercial antivirus software effectiveness: an empirical study. *Computer*, 63-70.
- Tahan, G., Rokach, L., & Shahar, Y. (2012). Mal-ID: Automatic Malware Detection Using Common Segment Analysis and Meta-Features. *The Journal of Machine Learning Research*, 98888, 949-979.
- Virustotal. (2013). VirusTotal Retrieved July 13, 2013, from <https://www.virustotal.com/>
- VMware. Inc. (2013). VMware software Retrieved Oct 19, 2013, from <https://www.vmware.com/ap>
- W. Foundation. (2013). Wireshark Retrieved July 13, 2013, from <http://www.wireshark.org/>
- Waksman, A., & Sethumadhavan, S. (2011). *Silencing hardware backdoors*. Paper presented at the Security and Privacy (SP), 2011 IEEE Symposium on.
- Wang, X., & Reeves, D. (2011). Robust correlation of encrypted attack traffic through stepping stones by flow watermarking. *Dependable and Secure Computing, IEEE Transactions on*, 8(3), 434-449.
- Welch, V., Pearson, D., Tierney, B., & Williams, J. (2012). Security at the Cyber Border: Exploring Cybersecurity for International Research Network Connections.
- Wu, H.-C., & Huang, S.-H. (2007). *Detecting stepping-stone with Chaff perturbations*. Paper presented at the Advanced Information Networking and Applications Workshops, 2007, AINAW'07. 21st International Conference on.
- Yang, J., & Lee, B. (2008). Detecting Stepping-Stone Intrusion and Resisting Evasion through TCP/IP Packets Cross-Matching *Autonomic and Trusted Computing* (pp. 2-12): Springer.
- Zhang, Y., & Paxson, V. (2000). *Detecting stepping stones*. Paper presented at the Proceedings of the 9th USENIX Security Symposium.

## PUBLICATIONS

- 1) Alminshid, K., & Omar, M. N. (2013, 23-25 Sept). *Detecting backdoor using stepping stone detection approach*. Paper presented at the Informatics and Applications (ICIA), 2013 Second International Conference on, Lodz, Poland, published by the IEEE Xplore, index by the (ICIA),2013 Second International Conference Proceeding.
- 2) Basha, A. D., Mnaath, S. H., Alminshid, K., & Umar, I. N. (2013). Importance Applications Mobile Agent technology for Virtual E-learning Environment: Proposed Model. *International Journal of Enhanced Research in Science Technology & Engineering*, 2(5), (24-28), 2319-7463.
- 3) Mnaath, S. H., Basha, A. D., Alminshid, K., & Jamaludin, R. (2013). The Opportunities and Difficulties for M-learning to Enhancing students learning results. *International Journal of Enhanced Research in Science Technology & Engineering*, 2(5), (24-28), 2319-7463.