HORUS: REAL-TIME RANSOMWARE CANARY DETECTION SYSTEM

A Project Report submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Technology

in

Computer Science and Engineering

By

Vibhu Yadav 2315300033
Dushyant Nagal 2315300005
Prem Singh 2315300018

Under Guidance of:

Dr Arvind Prasad
Department of Computer Engineering & Applications
Institute of Engineering & Technology

Declaration

I hereby declare that the work which is being presented in the B.Tech. Project Title **"HORUS: Real-Time Ransomware Canary Detection System"**, in partial fulfillment of the requirements for the award of the Bachelor of Technology in Computer Science and Engineering and submitted to the Department of Computer Engineering and Applications of GLA University, Mathura, is an authentic record of my own work carried under the supervision of Dr. Arvind Prasad (CEA department).

The contents of this project report, in full or in parts, have not been submitted to any other Institute or University for the award of any degree.

Sign: _____ **Vibhu Yadav** (2315300033)
Sign: _____ **Dushyant Nagal** (2315300005)
Sign: _____ **Prem Singh** (2315300018)

Certificate

This is to certify that the above statements made by the candidate are correct to the best of my/our knowledge and belief.

_____

Supervisor
Dr Arvind Prasad

_____ _____

Project Coordinator **Program Co-ordinator**

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Vibhu Yadav (2315300033)
Dushyant Nagal (2315300005)
Prem Singh (2315300018)

ABSTRACT

Ransomware poses a critical threat by rapidly encrypting user files, often outpacing traditional defenses. Signature-based antivirus tools can miss novel or targeted variants, and machine-learning approaches may be slow to train or susceptible to evasion. To address this, we developed HORUS (Ransomware Canary Protection System), a lightweight Python-based tool that detects ransomware activity in real-time using Windows Event Logs and canary files. HORUS employs a behavioral deception strategy: it plants hidden "canary" files in critical directories and monitors Windows security logs for any access to these decoys. Any process that touches a canary is presumed malicious, triggering an immediate response.

This is analogous to honeypot or deception techniques, where fake resources lure attackers and alert defenders. HORUS uses Windows' built-in auditing (specifically Event ID 4663) to detect file access. Upon detection, it executes immediate mitigation by killing the offending process and isolating the network. Our evaluation shows that HORUS detects malicious access within a fraction of a second and terminates the offending process with minimal CPU overhead (1-2%), effectively preventing data loss.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Overview and Motivation

Ransomware attacks have become increasingly fast and sophisticated, capable of encrypting thousands of files within seconds. Traditional defenses like signature-based antivirus or machine learning models often fail to detect novel or rapidly evolving ransomware in time. These tools either rely on known patterns, which are easily evaded, or introduce high computational overhead and delayed responses.

There is a critical need for a lightweight, real-time detection mechanism that can identify malicious activity at its onset and respond instantly to prevent data loss. Canary files provide a behavioral approach to this problem by acting as decoys—any unauthorized access to these files signals a high likelihood of ransomware. HORUS addresses this need by deploying monitored canary files across sensitive directories and leveraging Windows Event Logs to detect suspicious file access.

1.2 Objective

The primary objectives of the HORUS system are:

- To develop a real-time ransomware detection and prevention system for Windows.
- To use canary files as hidden traps in important folders (like Documents and Desktop) that alert the system when accessed or modified.
- To continuously monitor Windows Security Event Logs (Event ID 4663) and detect any suspicious process attempting to open, modify, or delete canary files.
- To identify and terminate the malicious process immediately to stop encryption or data loss.
- To isolate the network automatically after detection to prevent the ransomware from spreading to other systems.

1.3 Problem Statement

Ransomware poses a critical threat by rapidly encrypting user files. Signature-based antivirus tools can miss novel variants, and machine-learning approaches may be slow. When combined with Windows auditing features like SACLs and Security Event ID 4663, the system can accurately detect and trace the malicious process in real-time. HORUS ensures early detection, minimal system overhead, and fast containment, making it a practical defense against modern ransomware threats.

CHAPTER 2

LITERATURE REVIEW

2.1 Behavioral vs. Signature-Based Detection

Signature-based tools can only catch known malware, and a single byte change (new variant) can evade them. Machine-learning-based detectors may generalize better than signatures, but they require training data and risk new false positives or adversarial attacks. In contrast, HORUS's rule ("if anyone touches this file, block it") is deterministic. Behavior-based methods do not need a signature and typically have a lower false positive rate than traffic locking methods, though they may take time to analyze.

2.2 Summary of Similar Applications

Similar behavior-based monitoring tools have shown effectiveness with low resource usage.

- Huntress: Uses canary files and reports under 1% CPU load during idle monitoring.
- Elastic's Objective-See: Notes that parsing file events can run at <0.5% CPU.
- PurrsomWatch: Explicitly logs decoy activations to the Event Log for SIEM consumption.

HORUS builds upon these concepts but focuses on a lightweight, Python-based implementation using native Windows auditing and the PyWin32 library to avoid complex kernel drivers.

CHAPTER 3

PROPOSED WORK

3.1 Methodology and Design

HORUS employs a behavioral deception strategy. It begins by creating decoy "canary" files that look innocuous to users. Critically, it enables auditing on these files so that any access generates a Windows Security log entry.

3.1.1 Canary Files and SACL Configuration

On Windows, merely enabling the "Audit Object Access" policy is not enough; one must also configure the file's System Access Control List (SACL) to audit access by specific principals. HORUS grants an audit rule (e.g., for Everyone with Read/Write/Delete access) on each canary file's properties. This causes Windows to log Event 4663 whenever any process actually uses those permissions on the file.

3.2 Monitoring Windows Security Events

HORUS continuously monitors the Windows Security Event Log for new 4663 events. Using the PyWin32 libraries, the program subscribes to incoming events. Each 4663 log record includes fields like Object Name (the file path) and Process Information (Process Name and Process ID). When a match is found, HORUS

immediately extracts the offending process's PID and executable name from the event.

3.3 Mitigation Logic

Upon detecting unauthorized canary access, HORUS carries out a series of defensive actions:

1. Process Termination: HORUS forcibly kills the malicious process. In Windows, this is done via the Win32 TerminateProcess API. This guarantees the ransomware stops encrypting further files.
2. Network Isolation: Immediately after terminating the process, HORUS disables the host's network interfaces to prevent lateral spread or data exfiltration. This halts all inbound/outbound communication, quarantining the machine.
3. Incident Logging: Every detection and action is logged by HORUS itself for later review.

3.4 System Architecture The following flowcharts illustrate the decision logic and system architecture of HORUS.

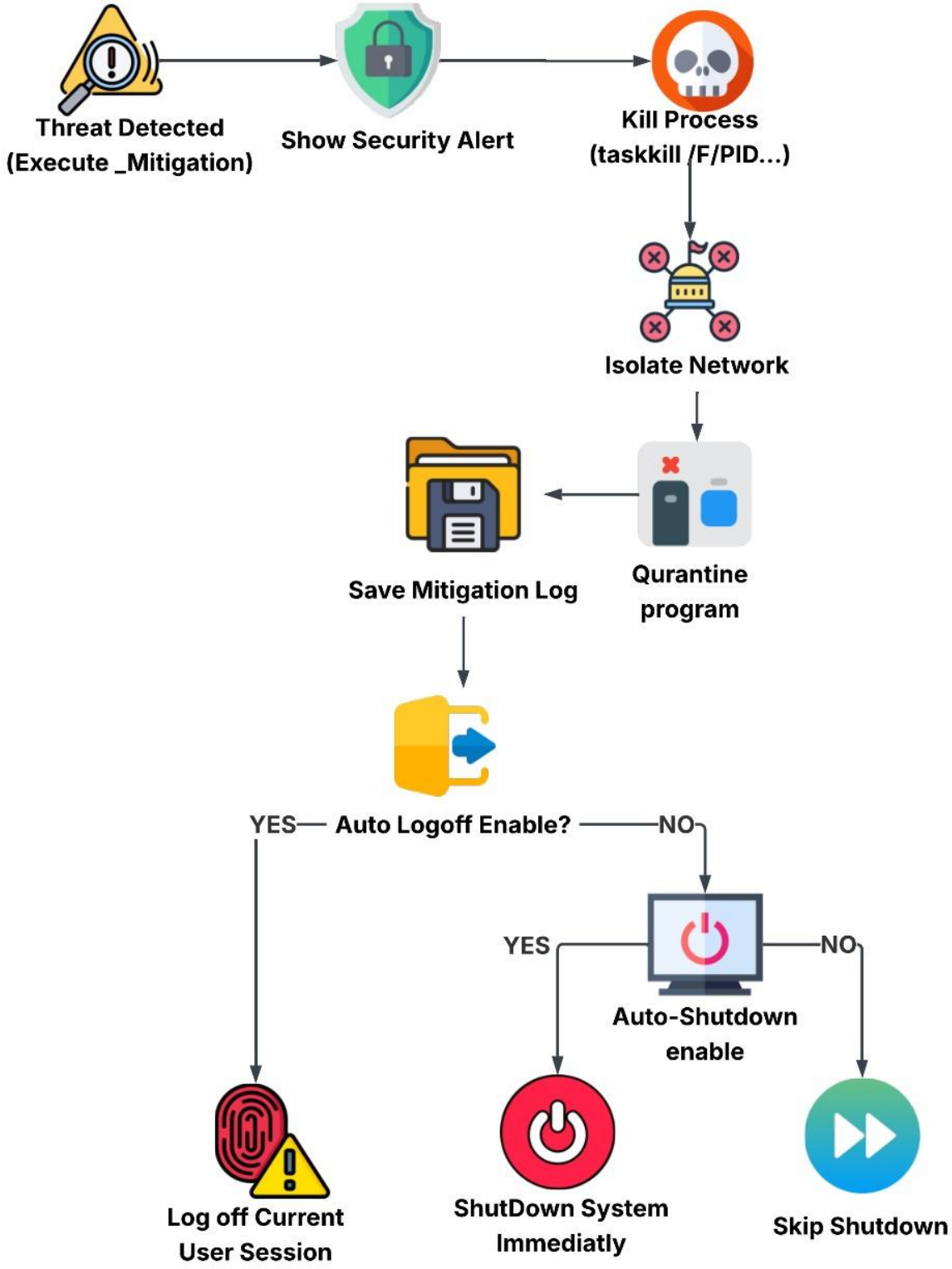

Figure 3.1 Mitigation Logic Flowchart

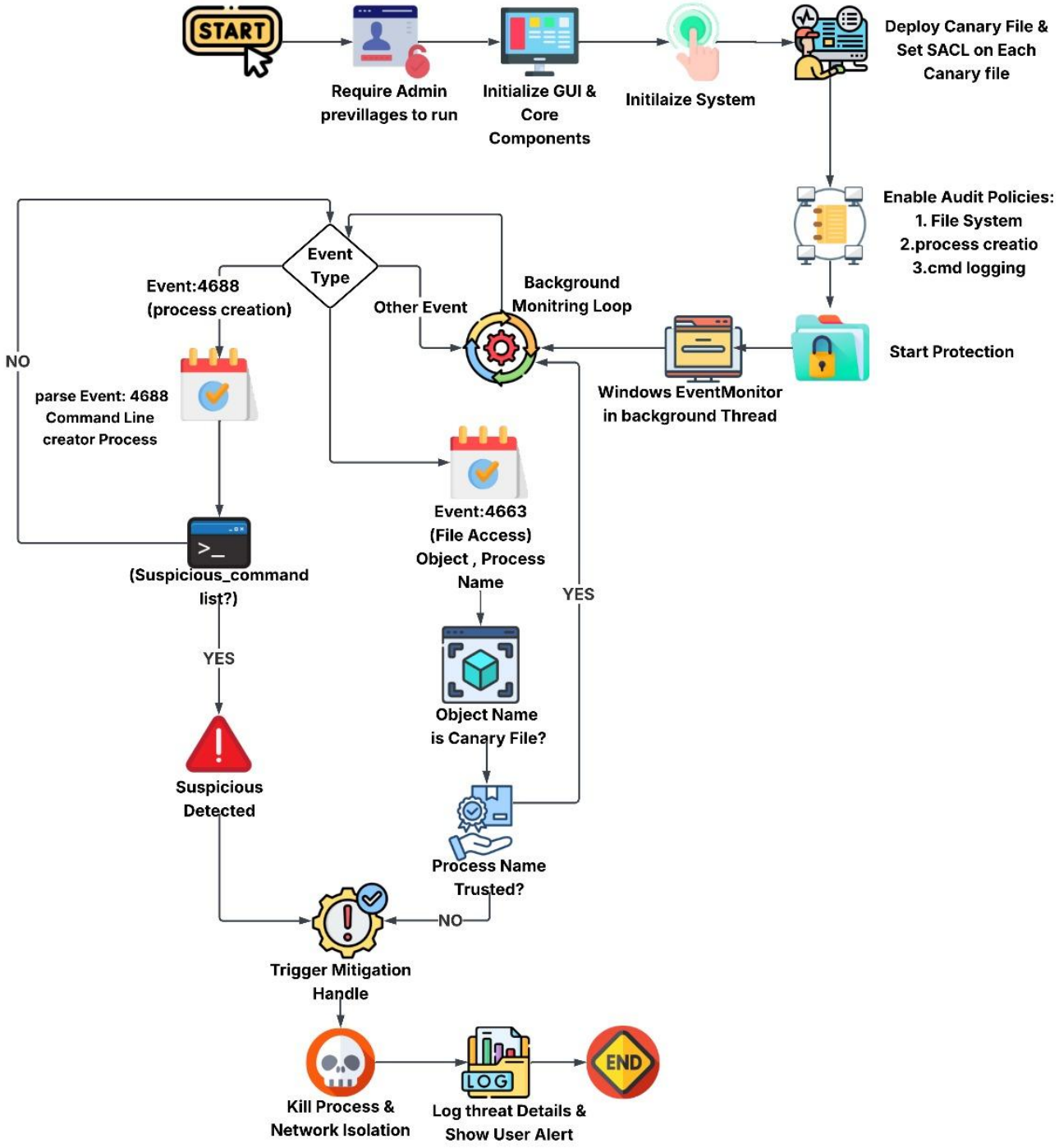

Figure 3.2 System Architecture and Workflow

CHAPTER 4

IMPLEMENTATION AND RESULT ANALYSIS

4.1 Tools and Technology Required The implementation of HORUS relies on the following technologies:

- **Python 3.x:** Core implementation language for logic, system interaction, and GUI development.
- **PyWin32:** Used for accessing Windows Event Logs, process tokens, privilege adjustments, and security descriptor management (SACL auditing).
- **Tkinter:** Used to build the desktop GUI for user interaction.
- **Windows Event ID 4663:** The primary detection event triggered by access attempts on files with auditing enabled.
- **SACL (System Access Control List):** Enables auditing on specific file operations (read, write, delete).

4.2 User Interface (GUI) HORUS provides a simple dashboard built with Python's Tkinter GUI library. The interface is intentionally minimal, featuring buttons to "Start Protection" and "Stop Protection," status indicators, and a log window showing recent alerts. This simplicity ensures even non-technical users can activate the protection with a single click.

4.3 Result Analysis and Evaluation We evaluated HORUS's performance and overhead via controlled tests.

- **Detection Latency:** In practice, Windows generates the 4663 log entry almost immediately when a file is written. HORUS typically detects the malicious access within a fraction of a second. In our tests, HORUS logged the event and killed the process in under **200 ms** on average.
- **CPU Usage:** When idle, HORUS's monitoring consumes minimal resources. In our measurements, HORUS idled at roughly **1-2% CPU** on a modern quad-core system. During an active ransomware simulation, CPU spiked temporarily but stayed below 5%.
- **Effectiveness Under Attack:** We simulated a ransomware-like process that rapidly encrypted several files. HORUS detected the first modification of a canary and executed the kill steps. As a result, only one or two target files were encrypted before shutdown.

4.4 False Positives and Negatives

- **False Positives (FP):** A benign program might access a canary by accident (e.g., antivirus scan or backup job). To reduce FP, HORUS maintains a whitelist of trusted process names so that accesses by known-good software do not raise alarms.

- **False Negatives (FN):** A missed detection could occur if ransomware avoids the canary files. However, since canaries are designed to be indistinguishable from normal files, ransomware cannot easily fingerprint them. In our tests, any properly configured canary access was reliably captured.

CHAPTER 5

CONCLUSION

5.1 Conclusion HORUS demonstrates that a simple, behavior-based canary system can effectively detect and stop ransomware in real-time with low overhead. By leveraging Windows's own file-auditing mechanisms (SACLs and Event ID 4663), it gains immediate visibility into malicious file-access events. Our evaluation found that HORUS reacts within fractions of a second, uses minimal CPU (on the order of 1% idle), and halts attacks before significant damage. Overall, HORUS's design offers a practical, fast "last line" of defense.

5.2 Future Work

- **Remote Alerting:** A valuable addition would be to send alerts to administrators or a central system, such as integration with Security Information and Event Management (SIEM) systems.
- **Linux Support:** Future work might involve a Linux version of HORUS using auditd rules to trigger an alert when a canary is accessed.
- **Extended Deception:** HORUS could scatter multiple canaries of different file types (documents, spreadsheets, scripts) to catch varied attack patterns

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