Software Requirement Specifications (SRS) Document

Hive Sentinel: The Hacker's Confine

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Program: Computer Science FALL-2020

Semester: 7th

Submitted to

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December 31, 2023

Abstract

In today's digital world, where businesses and individuals rely heavily on technology, cybersecurity is crucial. While firewalls and antivirus software offer basic protection, the changing tactics of cyber threats require a proactive approach. The "Hive Sentinel" project, a comprehensive solution addressing the critical issue of monitoring and managing honeypots to enhance cybersecurity. These specialized tools, strategically placed across networks, divert potential attackers, and provide invaluable insights into emerging threats. Influenced by the Deception 2.0 strategies, the project ensures proactive threat detection through features such as automated honeypot deployment, continuous health monitoring, real-time threat detection, and snapshot restoration. Moreover, the project aims to map the data to the standardized MITRE ATT&CK framework to get further insights into threat analysis.

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1. Introduction

In today's interconnected world, where businesses and individuals heavily depend on digital systems, the importance of cybersecurity cannot be overstated. As our reliance on technology grows, so does the sophistication and frequency of digital threats and cyber-attacks. Traditional security measures, such as firewalls, which act as digital barriers to control incoming and outgoing network traffic, and antivirus software, designed to detect and eliminate malicious software, form the foundation of defence against common cyber threats.

In this dynamic and evolving digital environment, actively identifying, and addressing potential threats have become essential. Firewalls and antivirus tools are essential components, but they may not be sufficient on their own to tackle the ever-evolving tactics of cyber threats. Cybersecurity professionals recognize the value of a proactive approach to identify and understand the tactics, techniques, and procedures (TTPs) employed by malicious actors.

Honeypots, as a specialized cybersecurity tool, play a crucial role in this proactive defence strategy. By strategically placing decoy systems or resources across a network, organizations can lure potential attackers away from valuable assets and confidential information. These fake systems mimic genuine systems and services, inviting attackers to engage with them.

The primary objective of deploying honeypots is not just to divert and monitor unauthorized access attempts but also to gain insights into the attackers' methods and motivations. Analysis of the data collected from honeypots helps cybersecurity professionals better understand emerging threats, vulnerabilities, and attack patterns. This intelligence is invaluable for enhancing overall cybersecurity posture by enabling organizations to fine-tune their defences, update security protocols, and develop countermeasures against evolving cyber threats.

The information gathered from honeypots contributes to threat intelligence databases, enabling the global cybersecurity community to collaborate and share knowledge about emerging cyber threats. This collective intelligence helps organizations stay ahead of cyber adversaries and fortify their defences against potential future attacks. In essence, while traditional cybersecurity measures form a crucial baseline, honeypots add a proactive and adaptive dimension, enhancing the overall resilience of digital systems against an ever-evolving threat landscape.

1.1 Problem Statement

The lack of a dedicated health monitoring system for honeypots can lead to significant consequences for an organization's cybersecurity. Firstly, there is a risk of a false sense of security. If a honey pot is not functioning properly, it may fail to detect and capture malicious activities effectively. This can create a misleading belief that the network is adequately protected, leaving critical assets vulnerable to real threats. Secondly, the organization may face limited or inaccurate threat intelligence.

A compromised or malfunctioning honey pot may provide unreliable or incomplete information about attacker tactics and tools. This hampers the organization's ability to gather accurate threat intelligence, hindering their capacity to make informed decisions and take appropriate security measures. Furthermore, a vulnerable honey pot can introduce additional risk and exposure. Attackers can exploit the compromised honey pot as an entry point to infiltrate the network or gain insights into the organization's infrastructure. This not only undermines the effectiveness of the honey pot but also puts other systems and valuable assets at risk.

1.2 Scope

Among the various security mechanisms discussed—firewalls, antivirus, and honeypots—this project, “Hive Sentinel: The Hacker's Confine” specifically focuses on automating honeypot deployment and health monitoring. The basic modules of project are discussed below as illustrated in Figure 1.

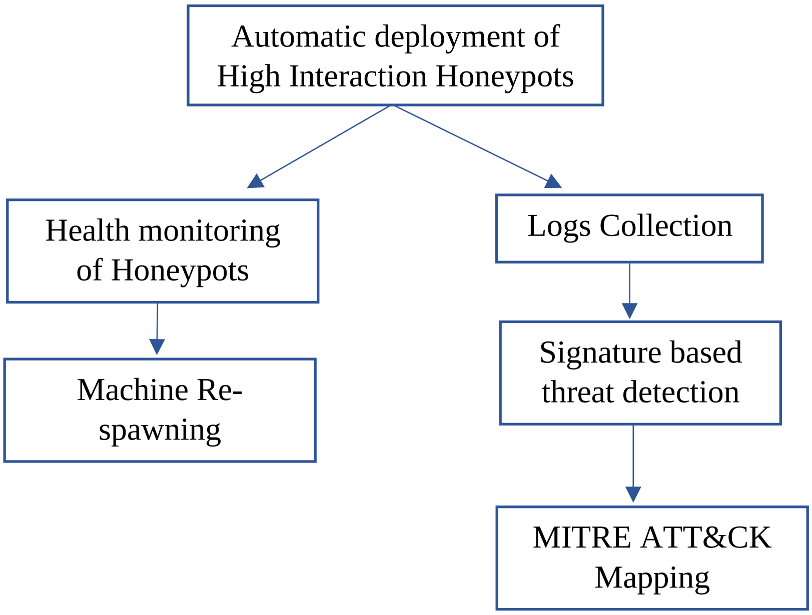

Automatic deployment of High Interaction Honeypots
Health monitoring of Honeypots
Logs Collection
Machine Re-spawning
Signature based threat detection
MITRE ATT&CK Mapping

Figure1: Basic Modules of Hive Sentinel

1) **Automatic Deployment of Honeypots:**
   Hive Sentinel places a significant emphasis on automation to enhance the efficiency and effectiveness of cybersecurity measures. The project involves the automated deployment of high interaction honeypots as part of the deception platform 2.0. These decoy systems are strategically placed to lure potential attackers, providing valuable insights into their tactics and methodologies.

2) **Logs Collection:**
   The project incorporates the essential process of log collection in honeypots, playing a vital role in detecting and analyzing malicious activities, offering insights into attack patterns, tools, and techniques for promptly identifying and containing security threats.

3) **Signature Based Threat Detection:**
   The project integrates signature-based threat detection in honeypots, using predefined patterns or signatures of known threats to identify malicious activities.

4) **MITRE ATT&Ck Mapping:**
The project involves the strategic practice of mapping generated honeypot logs to MITRE ATT&CK, providing a structured framework for understanding and categorizing cyber threats, enhancing overall threat detection capabilities.

5) **Health Monitoring:**
The project involves a comprehensive approach to health monitoring, incorporating the collection of critical parameters such as CPU time and memory usage. This integrated health monitoring system enables the system to promptly detect any irregularities or potential issues, utilizing the extracted health monitoring parameters from each honeypot. This vigilance not only contributes to the early detection of threats but also supports the ongoing improvement of honeypot defenses.

6) **Machine re-spawning:**
An innovative feature of the project is the machine re-spawning functionality, which operates in accordance with health monitoring guidelines. This capability ensures that compromised or malfunctioning honeypots can be restore, maintaining a resilient and continuously effective deception platform.

2. Objectives

Hive Sentinel is strategically designed to focus on advancing the capabilities of Deception 2.0 by delivering a range of advanced functionalities. Following objectives will enable the accomplishment of main aim of the project:

1. To provide automated deployment of high interaction honeypots for the deception platform 2.0.
2. To offer health monitoring for high interaction honeypots on the deception platform 2.0.
3. To provide machine re-spawning in accordance with health monitoring guidelines.
4. To enable hackers' intelligence gathering from high interaction honeypots.
5. To present a dashboard that displays gathered intelligence information through visual charts and statistics.

3. Literature review

Deception 1.0 initiated the use of basic decoys and honeypots, introducing the concept of misdirection in cybersecurity. Deception 2.0 addresses the deficiencies of Deception 1.0 by offering more advanced features. This progression signifies a sophisticated understanding of attacker behaviour and a commitment to staying ahead in the ever-evolving landscape of cybersecurity. A detailed overview of Deception 1.0 and Deception 2.0 is discussed below.

Deception 1.0 pioneered the use of honeypots and decoys to divert and monitor attackers, providing a foundational layer of defence. It provided valuable insights into attackers' methodologies but fell short in adaptability and automation. The demerits included static setups requiring manual intervention, limited scalability, and vulnerability to sophisticated attacks due to its lack of dynamic response mechanisms. While it helped detect threats, its effectiveness weakened against evolving cyber threats due to its static nature and reliance on easily recognizable decoys. [1]

Deception 2.0 marks a significant evolution from its predecessor, Deception 1.0, by introducing a range of advancements in the field of cyber threat mitigation. A notable improvement lies in its seamless integration of both low and high-interaction methods, offering a fluid and adaptable approach termed Hybrid Interactivity/Fluid Deception.

Unlike Deception 1.0, the new version takes customization to the next level by tailoring low-interaction services to evade emulations, thus enhancing the overall deception strategy. Scalability is efficiently addressed through a dynamic DevOps model, overcoming deployment scale challenges by automating deployment and maintenance processes, ensuring ongoing freshness, and operational efficiency.

Security measures receive a substantial boost with the introduction of deception farms and projection points, strategically placed throughout the network as virtual traps. Deception farms act as decoy fields, confusing attackers by blending real assets with fake ones, reducing the risk of security breaches. Projection points, key locations for decoys, intensify the overall deception strategy, creating a dynamic defence that disrupts attackers and makes compromising the digital environment tougher.

Moreover, the expanded deception range goes beyond traditional honeypots, allowing the system to mimic a diverse array of enterprise resources. This expansion is complemented by ecosystem integration, as Deception 2.0 actively engages with the broader security ecosystem, promoting collaboration for more effective threat detection and response.

The implementation of intrinsic threat analysis further sets Deception 2.0 apart, ensuring continuous awareness and proactive responses to emerging threats. This dynamic and sophisticated component establishes its status as a powerful tool in modern threat mitigation strategies. In comparison, Deception 1.0 may be seen as more static, lacking the integrative and adaptive features that characterize the advancements introduced in Deception 2.0. [2]

3.1 Key Findings:

Based on the literature review, it has been established that a high-interaction honeypot must satisfy the following conditions to effectively engage with threats:

1. **Comprehensive Deception Setup:**
   The honeypot must feature multiple decoys, breadcrumbs, and baits strategically installed to identify exploits used and lateral movement paths.

2. **Interconnected Decoys for Lateral Movement:**
   Lateral movement within the network should lead the attacker to other decoys, enhancing the honeypot's effectiveness.

3. **Invisible Collection Mechanism:**
   The collection mechanism must remain invisible to the attacker, ensuring covert monitoring of their activities.

4. **Network Traffic Analysis:**
   Capture and correlation of network traffic with the attacker’s actions, aiding in identifying command and control centers, exfiltration activities, etc.

5. **Memory Dump Analysis:**
   Capability to review memory dumps to identify any files not saved to disk, providing a deeper understanding of the attacker's activities.

6. **Tracking Downloaded or Dropped Files:**
   Ability to track downloaded or dropped files, enabling the analysis of potentially malicious content.

4. Framework and Methodology

To efficiently execute the process of creating Hive Sentinel, a robust combination of frameworks and tools is essential. Figure 2 presents the actions and activities that are necessary for achieving an effective deployment of a honeypot system. A sequence of activities is illustrated in Figure 2 and discussed below.

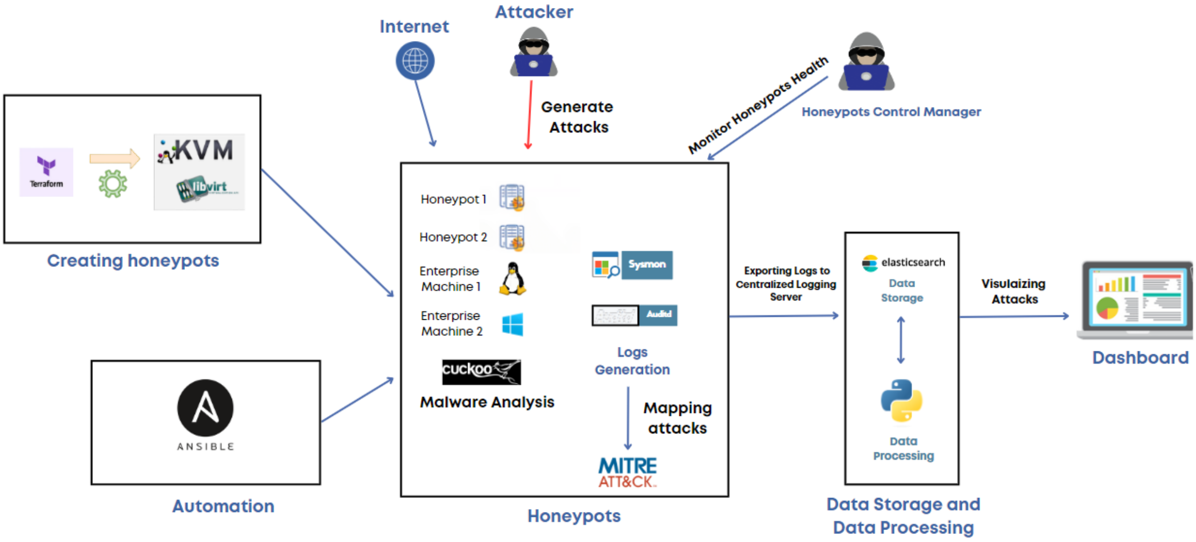


Figure 2: Project Architecture Diagram

As Illustrated in Figure 2 , the project begins with virtualization; Kernel-based Virtual Machine (KVM) facilitates hardware virtualization on Linux, allowing the concurrent operation of multiple virtual machines on a single host. For automation, Terraform streamlines infrastructure provisioning and management through code, helping to automatically create virtual machines on KVM. Ansible simplifies configuration, deployment, and task automation, proving particularly useful for automating the deployment of vulnerable services on honeypots.

Cuckoo Sandbox automates the analysis of suspicious files, contributing to the security posture. Process monitoring involves implementing Sysmon on Windows and Auditd on Linux, enhancing system security through detailed logging of process executions and network connections.

Security infrastructure integration is achieved through the incorporation of MITRE ATT&CK with generated logs from Sysmon and Auditd, providing a comprehensive framework for understanding cyber adversary tactics and techniques. After successfully generating logs and mapping them with the MITRE ATT&CK framework, export the logs to a centralized Elasticsearch database. Elasticsearch efficiently stores and indexes large datasets, enabling centralized monitoring.

Process the logs stored in Elasticsearch through Python to ensure they are in the same format, as they come from different honeypot machines running Windows and Linux. Visualization is facilitated by developing a dynamic React.js dashboard with a robust Python and Flask backend to monitor health parameters of honeypots, create machines, analyze MITTRE ATT&CK techniques, control management of honeypots.

This integrated approach ensures a comprehensive cybersecurity framework, seamlessly combining virtualization, automation, monitoring, database management, security integration, and visualization, thereby ensuring an efficient honeypot system.

4.1 Strategies for Identifying Threats from Generated Logs Through Sysmon

System Monitor (Sysmon) is a Windows-based device driver and system service which keeps track of all system activities even after a system reboot and logs it to the Windows event log. It augments the regular Windows logs with higher-level monitoring of events. It gives detailed information on the development of processes, network connections, and changes to the time taken to create files in a repository. Sysmon logs will be collected and exported to a centralized database for analysis, aiming to detect anomalous and potentially malicious activities.

Sysmon has the following capabilities:

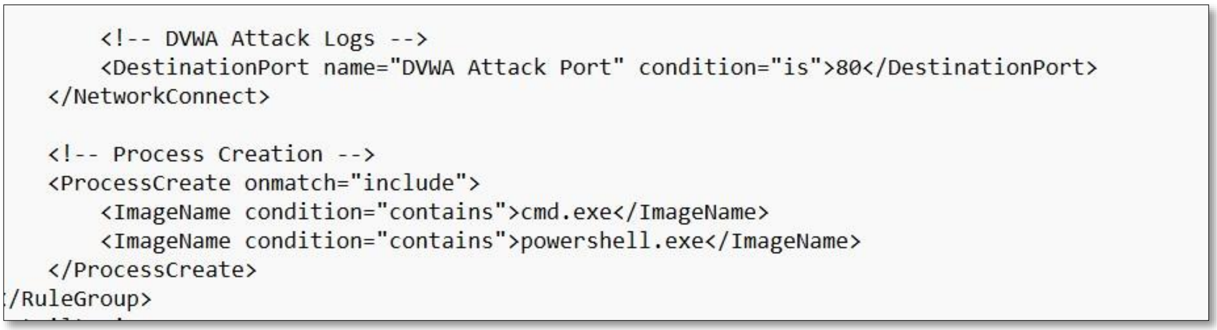
1) Logs process creation with complete command line
2) Logs file hashes (MD5, IMPASH, SHA256)
3) Process GUID (Global User ID) to correlate process events where IDs are reused.
4) Session GUID to keep track of events and logs generated during a logon session
5) Also logs network connection events, including Source and Destination IP/Port.
6) Capable of logging modifications to file timestamps, a common technique utilized by malware for defence evasion purposes.
7) Filtering rules to include or exclude certain events

Sysmon logs are stored under its own channel under “Applications and Services Logs” in the standard Windows Event Viewer. Sysmon monitors and logs events based on Event ID, where each event is assigned a unique ID. The configuration file for Sysmon, typically named "sysmonconfig.xml," plays a crucial role in determining which events are monitored and logged. This XML-based configuration file allows users to customize Sysmon's behaviour by specifying rules and filters for different types of events. By specifying customized rules in Sysmon configuration file we can create signature-based detection.

4.1.1 Scenario 1: Sysmon Rule for Identifying DVWA attacks

The Damn Vulnerable Web Application (DVWA) is a deliberately vulnerable web application designed for educational and testing purposes. It contains various vulnerabilities that users can exploit to understand and learn about common web application security issues.

Sysmon Configuration rule:



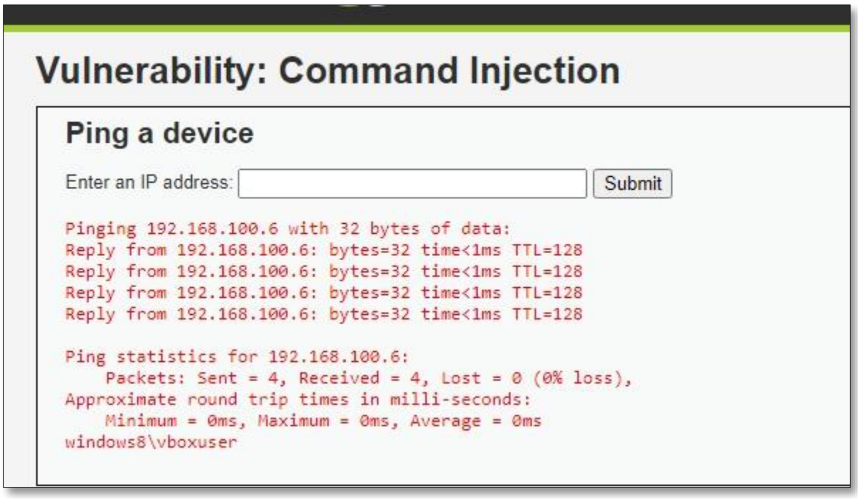
```
        <!-- DVWA Attack Logs -->
        <DestinationPort name="DVWA Attack Port" condition="is">80</DestinationPort>
    </NetworkConnect>

    <!-- Process Creation -->
    <ProcessCreate onmatch="include">
        <ImageName condition="contains">cmd.exe</ImageName>
        <ImageName condition="contains">powershell.exe</ImageName>
    </ProcessCreate>
:/RuleGroup>
```

Figure 3: Sysmon Configuration rule for DVWA

Sysmon rule is implemented to bind to port 80, the port on which DVWA is running. This rule is designed to trigger Sysmon to generate logs whenever events occur on port 80, specifically capturing commands executed through the command line (cmd) or PowerShell.

Command Injection Attack on DVWA:

A command injection attack is a type of security exploit where an attacker injects malicious commands into a command interpreter or shell, often through a vulnerable web application. This attack occurs when an application passes not filtered user input to a system shell, allowing the attacker to execute arbitrary commands on the underlying system.



Vulnerability: Command Injection

Ping a device

Enter an IP address:

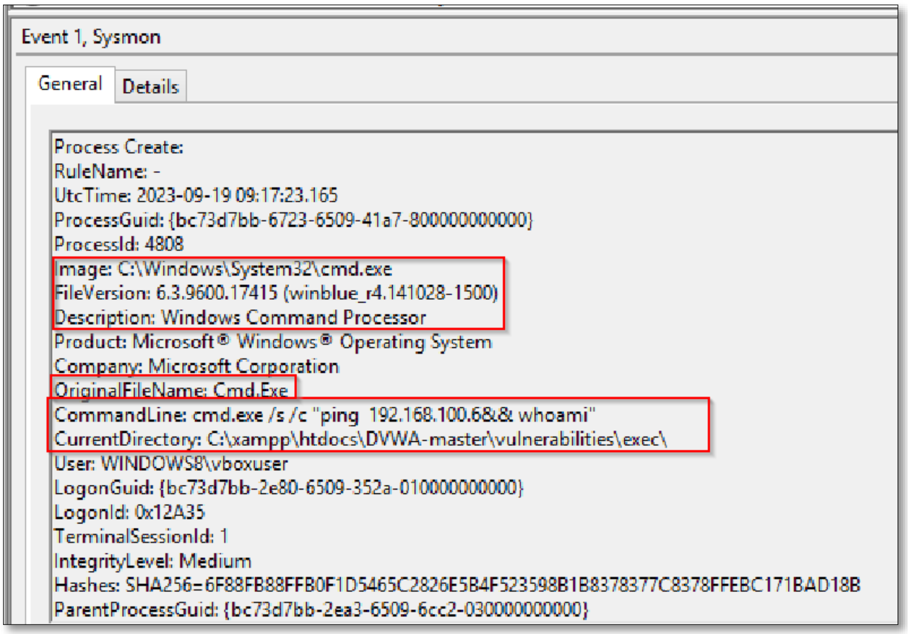
```
Pinging 192.168.100.6 with 32 bytes of data:
Reply from 192.168.100.6: bytes=32 time<1ms TTL=128
Reply from 192.168.100.6: bytes=32 time<1ms TTL=128
Reply from 192.168.100.6: bytes=32 time<1ms TTL=128
Reply from 192.168.100.6: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.100.6:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
windows8\vboxuser
```

Figure 4: Command Injection attack on DVWA

Executing command: ‘ping 192.168.100.6 && whoami’ through input field.

This command will ping 192.168.100.6 and find the current user of device through cmd.

Sysmon generated log for command injection attack according to rule in figure 3:



```
Process Create:
RuleName: -
UtcTime: 2023-09-19 09:17:23.165
ProcessGuid: {bc73d7bb-6723-6509-41a7-800000000000}
ProcessId: 4808
Image: C:\Windows\System32\cmd.exe
FileVersion: 6.3.9600.17415 (winblue_r4.141028-1500)
Description: Windows Command Processor
Product: Microsoft® Windows® Operating System
Company: Microsoft Corporation
OriginalFileName: Cmd.Exe
CommandLine: cmd.exe /s /c "ping  192.168.100.6&& whoami"
CurrentDirectory: C:\xampp\htdocs\DVWA-master\vulnerabilities\exec\
User: WINDOWS8\vboxuser
LogonGuid: {bc73d7bb-2e80-6509-352a-010000000000}
LogonId: 0x12A35
TerminalSessionId: 1
IntegrityLevel: Medium
Hashes: SHA256=6F88FB88FFB0F1D5465C2826E5B4F523598B1B8378377C8378FFEBC171BAD18B
ParentProcessGuid: {bc73d7bb-2ea3-6509-6cc2-030000000000}
```

Figure 5: Sysmon log for DVWA attack

5. Functional Requirements

The project must meet the following functional requirements to establish an effective honeypot system that will efficiently contribute to proactive cybersecurity defense mechanisms.

1. A dashboard providing the following functionalities:
    - Automatically create virtual machines and deploy vulnerable services on them.
    - Monitor health parameters of honeypots and facilitate machine re-spawning.
    - Analyze MITRE ATT&CK techniques.
    - Control the management of honeypots.
2. Continuous monitoring of system resources, network connectivity, and application services of honeypots.
3. Real-time detection and alerting of suspicious or malicious activities targeting the honeypots.
4. Generation of detailed logs, reports, and analysis of honeypot activities for threat intelligence purposes.
5. Mapping of generated logs with MITRE ATT&CK to get insights into hacker tactics, techniques, and procedures.
6. Monitor and organize security events in one central place.
7. Control management system to monitor health of honeypots.
8. Snapshot restoration capabilities to reset honeypots to a clean state after attacks or specific penetration levels.

6. Hardware Specification

1. **Server: Dell PowerEdge R740**

   In the Hive Sentinel project, a server is essential for creating multiple virtual machines, including honeypots and real machines. The server has the capability to run 24/7, aligning with the project's requirement for continuous honeypot operation to protect the real system. The Dell PowerEdge R740 server fulfills the project needs.

   The Dell PowerEdge R740 is a high-performance server known for its reliability and scalability. Its robust architecture and management capabilities make it an ideal choice for handling complex tasks like control management and health monitoring in honeypot projects. It offers features for remote management, ensuring efficient control and monitoring of honeypots spread across different environments.

2. **RAM: 64 GB**

   The 64 GB RAM capacity is crucial for this project as it allows for seamless multitasking and data handling. In a honeypot environment, where multiple instances might run simultaneously, this ample RAM ensures that the system can process and analyze a significant amount of data without experiencing performance bottlenecks. It supports concurrent processes for real-time monitoring and analysis of activities within the honeypots.

3. **CPU Cores: 8**

   In this project, the utilization of 8 CPU cores is essential to leverage substantial processing power. These cores enable efficient parallel processing, allowing for quick analysis of incoming data, rapid responses to potential threats, and the ability to run multiple monitoring and analysis tools concurrently. This capability is vital for ensuring timely threat detection and response in a dynamic environment.

4. **Storage: 1 TB**

   In this project, a 1 TB storage capacity is essential for storing logs, captured data, and information collected from honeypots. In a security monitoring scenario, where vast amounts of data are generated regularly, having sufficient storage is critical for retaining historical data for forensic analysis, identifying patterns, and investigating security incidents. It provides the necessary space to archive logs and maintain a comprehensive record of honeypot activities.

   These specifications collectively form the foundation for an efficient and robust infrastructure, capable of handling the diverse demands of control management and health monitoring within a honeypot project. They ensure that the system remains responsive, capable of handling extensive data processing, and equipped to support the project's objectives of security analysis and threat detection.

7. Proposed Tools and Platforms

1. Virtualization

- **KVM:**
  KVM (Kernel-based Virtual Machine) is a Linux kernel module that enables hardware virtualization. It allows running multiple virtual machines (VMs) on a single physical host providing a flexible and efficient platform for virtualization.

2. Automation

- **Terraform:**
  Terraform is an open-source tool for automating the provisioning and management of infrastructure through code. Using a simple declarative language, users define their desired infrastructure state, and Terraform handles the coordination of resources across various cloud providers or on-premises environments. It enables efficient and repeatable infrastructure deployment, making it easier to scale, modify, and maintain complex systems with minimal manual intervention. Used to automate the creation of virtual machines.

- **Ansible:**
  Ansible is an open-source automation tool that simplifies configuration management, application deployment, and task automation. It uses YAML syntax for playbooks, defining tasks and configurations in a human-readable format. Ansible does not require agents on managed hosts, making it agentless and easy to use for automating IT processes. Used to automate the deployment of vulnerable services on honeypots.

3. Process Monitoring

- **Sysmon and Auditd:**
  Sysmon (Implemented on Windows) and Auditd (Implemented on Linux) enhance system security by logging detailed information like process executions and network connections, aiding in threat detection. Generated logs provide valuable forensic data for post-incident analysis, enabling proactive monitoring. This comprehensive logging ensures visibility and accountability, crucial for maintaining a secure and compliant computing environment. Implement Sysmon and Auditd to gain insights into process activities within the honeypot environment through logs generation.

- **Cuckoo Sandbox:**
  Cuckoo Sandbox is an open-source malware analysis system that automates the execution of suspicious files in a controlled environment. It provides detailed reports on malware behavior, helping analysts understand and respond to potential threats. Cuckoo Sandbox supports various analysis techniques, making it a valuable tool for cybersecurity professionals in malware research and incident response.

4. Database:

- **Elastic Search:**
  Elasticsearch is a distributed, open-source search and analytics engine known for its scalability and real-time search capabilities. It efficiently stores and indexes large volumes of data, accommodating complex queries and full-text searches. Widely utilized in applications such as log analytics, monitoring, and enterprise search, Elasticsearch enables centralized monitoring. By integrating a monitoring system with Elasticsearch, data from diverse machines are collected and combined in a centralized repository, enhancing the overall efficiency of analysis and insights.

5. Security Infrastructure Integration:

- **MITRE ATT&CK:**
  MITRE ATT&CK (Adversarial Tactics, Techniques, and Common Knowledge) serves as a knowledge base, providing a comprehensive framework to comprehend the tactics and techniques employed by cyber adversaries. It categorizes and describes diverse attack methods, empowering cybersecurity professionals to strengthen threat detection, analysis, and response strategies. Integrating generated logs with MITRE ATT&CK provides valuable insights into hacker tactics, techniques, and procedures, enhancing the understanding of potential security threats.

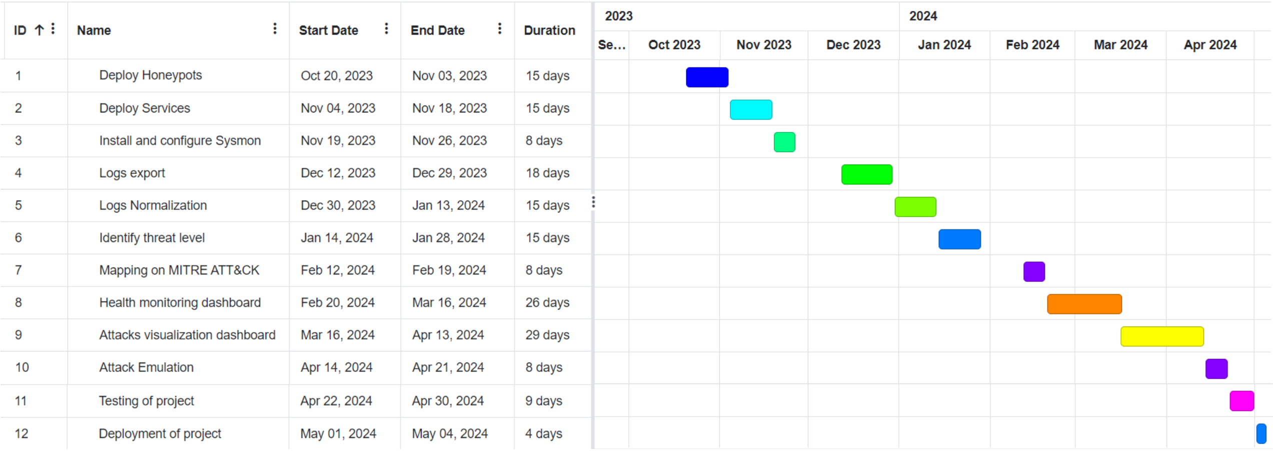
6. Visualization:

- Develop a dashboard with React.js for a dynamic front end. Utilize Python and Flask for a robust backend, handling data requests and facilitating seamless communication.

7. Attack Emulation:

- **Atomic Red Team and Caldera:**
  Atomic Red Team, an open-source framework for security testing, offers a library of small, modular tests to evaluate and enhance detection capabilities. Caldera, a threat emulation platform, leverages Atomic Red Team's tests to create a controlled environment for assessing how well honeypots detect and respond to cybersecurity threats. Both Atomic Red Team and Caldera are frameworks that assist security teams in testing their detection capabilities by simulating real-world attacks.

8. Project Timeline (Gantt chart)



ID	Name	Start Date	End Date	Duration
1	Deploy Honeypots	Oct 20, 2023	Nov 03, 2023	15 days
2	Deploy Services	Nov 04, 2023	Nov 18, 2023	15 days
3	Install and configure Sysmon	Nov 19, 2023	Nov 26, 2023	8 days
4	Logs export	Dec 12, 2023	Dec 29, 2023	18 days
5	Logs Normalization	Dec 30, 2023	Jan 13, 2024	15 days
6	Identify threat level	Jan 14, 2024	Jan 28, 2024	15 days
7	Mapping on MITRE ATT&CK	Feb 12, 2024	Feb 19, 2024	8 days
8	Health monitoring dashboard	Feb 20, 2024	Mar 16, 2024	26 days
9	Attacks visualization dashboard	Mar 16, 2024	Apr 13, 2024	29 days
10	Attack Emulation	Apr 14, 2024	Apr 21, 2024	8 days
11	Testing of project	Apr 22, 2024	Apr 30, 2024	9 days
12	Deployment of project	May 01, 2024	May 04, 2024	4 days

Figure 6: Gantt chart

9. References

[1] Team Acalvio. (2017). DECEPTION 1.0: HONEYPOTS ARE DEAD! In *Acalvio Deception Cyberdefense Manual* (pp. 8-15). Acalvio Technologies.

[2] Team Acalvio. (2017). DECEPTION 2.0: LONG LIVE HONEYPOTS! In *Acalvio Deception Cyberdefense Manual* (pp. 24-33). Acalvio Technologies.