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A SURVEY ON CYBER SECURITY THREATS AND DEFENSE MECHANISMS

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Abstract

Cyber security has become a significant challenge in the digital era due to the rapid development of cloud computing, internet technologies, and Internet of Things (IoT) devices. This study offers a comprehensive review of a variety of cybersecurity threats and preventative measures. It covers traditional approaches as well as modern ones like those utilizing blockchain, deep learning (DL), and machine learning (ML). Furthermore, this study identifies important research gaps and proposes a multi-layered cyber defense mechanism for the purpose of identifying and mitigating threats in real time.

Index Terms - Cyber Security, AI, Blockchain, Malware, Phishing

1. Introduction

Cyber security includes the protection of data, computer systems, and networks from unauthorized access, threats, and harm. The rapid advancement of digital technologies and the widespread usage of the internet have made cyber threats more complex, frequent, and difficult to detect.

In today's digital world, a wide range of applications are critical to daily life, such as cloud computing, online banking, e-commerce platforms, and Internet of Things (IoT) systems. However, these advancements have also made systems more vulnerable to cyberattacks by expanding the attack surface.

Data breaches, financial fraud, and identity theft are just a few of the cybercrimes that have skyrocketed as a result of our growing reliance on digital infrastructure. Thus, it is imperative that rigorous cyber security procedures be in place to safeguard vital data and ensure system integrity.

2. Cyber Security Risks

Any malicious behavior aimed at endangering the confidentiality, integrity, and accessibility of data and systems is considered a cybersecurity threat. Some of the primary risks are listed below:

2.1 Malware

Malware (malicious software) seeks to infect, damage, or illegally gain access to computer systems. Examples of malware include viruses, Trojans, worms, and spyware. Malware can be distributed via email attachments, websites that have been compromised, or program downloads.

2.2 Phishing

In a phishing attempt, a sort of social engineering attack, the perpetrators impersonate a legitimate firm in an effort to get users to provide sensitive information, such as their usernames, passwords,

and credit card details. These assaults often use fake websites, SMS messages, and email correspondence.

2.3 Ransomware

A sort of malware known as ransomware encrypts the victim's data and demands a ransom in order to restore access. It has evolved into one of the most dangerous cyber threats affecting individuals, businesses, and governments.

2.4 DDoS (Distributed Denial of Service) Attacks

The objective of a DDoS attack is to overwhelm a server, network, or application with excessive traffic, making it unavailable to legitimate users. These attacks can cause significant financial losses and downtime.

2.5 Internal Risks

People inside an organization, such as workers or contractors, who possess insider knowledge of the organization pose insider threats.

2.6 Advanced Persistent Threats (APT)

Advanced Persistent Threats (APTs) are highly sophisticated and long-term cyber-attacks in which attackers gain unauthorized access to a system and remain undetected for an extended period. These attacks are usually targeted at high-value organizations such as government agencies, financial institutions, and large enterprises. The primary objective of APTs is to steal sensitive information, monitor activities, or disrupt operations without being discovered.

3. Defense Mechanisms

To protect systems from cyber threats, multiple defense mechanisms are implemented. These mechanisms focus on prevention, detection, and response to ensure overall system security.

Firewalls and Intrusion Detection Systems (IDS)

Firewalls act as a barrier between trusted and untrusted networks by filtering incoming and outgoing traffic based on predefined security rules. Intrusion Detection Systems (IDS) monitor network traffic to identify suspicious activities and potential threats in real time.

Encryption

Encryption is a technique used to convert sensitive data into an unreadable format to prevent unauthorized access. Only authorized users with the correct decryption key can access the original data, ensuring confidentiality and data protection.

Authentication Mechanisms

Authentication ensures that only authorized users can access a system. Common methods include passwords, biometric verification (such as fingerprint or facial recognition), and Multi-Factor Authentication (MFA), which provides an additional layer of security.

Anti-malware Tools

Anti-malware software is designed to detect, prevent, and remove malicious programs from computer systems. These tools continuously scan systems and update their databases to identify new and emerging threats.

AI & Machine Learning-Based Security

Artificial Intelligence (AI) and Machine Learning (ML) techniques are used to detect unknown threats by analyzing patterns and behaviors. These intelligent systems can adapt and improve over time, making them effective against evolving cyber attacks.

4. System Architecture

Proposed Workflow

User Activity → Data Collection → Preprocessing → Rule-Based Filtering → ML Detection → Response System

Figure 4.1 proposed workflow

Description

- **User Activity:** Generates input data based on user interactions.
- **Data Collection:** Logs and network traffic data are collected.
- **Preprocessing:** Data cleaning and normalization are performed.
- **Rule-Based Filtering:** Identifies known threats using predefined rules.
- **ML Detection:** Detects unknown or advanced threats using machine learning models.
- **Response System:** Generates alerts or blocks malicious activities.

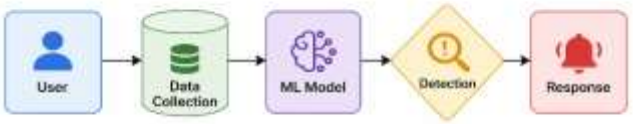

Figure 4.2 User activity

5. Data Flow Diagram (DFD)

Level 0

User → Cyber Security System → Output

Level 1

- Input Module
- Processing Module
- Detection Module
- Response Module

6. Machine Learning Model

Algorithms Used

- Random Forest
- Support Vector Machine (SVM)
- Neural Networks

Advantages

- High accuracy in threat detection
- Ability to identify unknown attacks
- Adaptive learning capability

1. Accuracy Comparison Graph

- Shows performance of:
  - Random Forest → **96%**
  - SVM → **92%**
  - Neural Network → **94%**

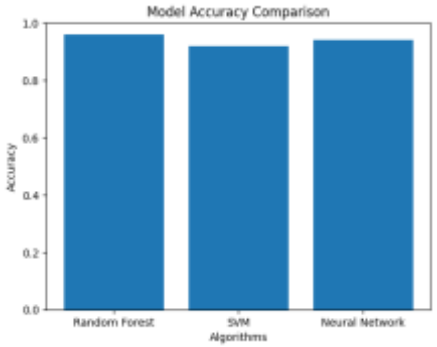

Figure 6.1 graph

2. Confusion Matrix

- Represents classification performance:
  - True Positives: **95**
  - True Negatives: **90**
  - False Positives: **10**
  - False Negatives: **5**

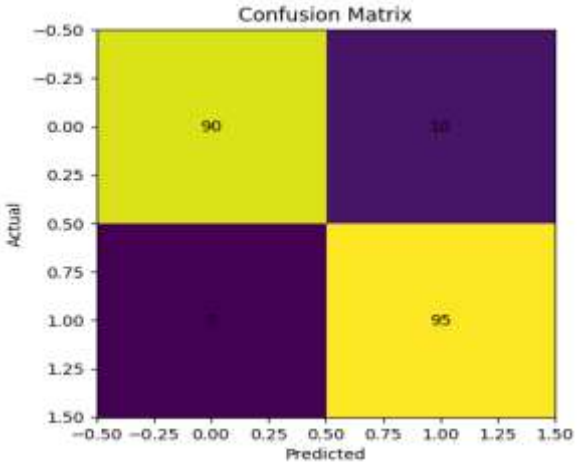

Figure 6.2 matrix

7. Literature Review

Cyber security has been extensively studied using both traditional and modern intelligent techniques. Recent research focuses on improving detection accuracy, reducing false positives, and enabling real-time threat identification.

Sarker et al. proposed a machine learning-based approach for fraud detection using algorithms

such as Logistic Regression, Decision Tree, Support Vector Machine (SVM), and Random Forest. Their findings indicated that Random Forest achieved the highest accuracy due to its ability to handle large datasets and complex patterns effectively.

Chatterjee et al. introduced a hybrid framework combining Federated Learning and Blockchain technology to enhance data privacy and security. This approach enables decentralized data processing while maintaining confidentiality, making it suitable for distributed cyber security environments.

Fahad presented an advanced model integrating Machine Learning and Blockchain for intrusion detection. The study demonstrated that hybrid models outperform traditional approaches by providing both high detection accuracy and improved security.

Thanner et al. focused on anomaly detection techniques for identifying unknown cyber threats. Their research highlighted that anomaly-based

TABLE 1. COMPARATIVE STUDY

Ref. no.	Dataset	Method	Features	Strengths	Performance	Limitation
[1]	KDD Cup 99	Random Forest	Network traffic features	High accuracy, robust	~95% accuracy	Outdated dataset
[2]	NSL-KDD	SVM	Statistical features	Good classification	~92% accuracy	Slow training.
[3]	CICIDS2017	Deep Learning (CNN)	Packet-level features	Detects complex patterns	~97% accuracy	High computation cost

[4]	UNSW-NB15	Decision Tree	Flow-based features	Easy to interpret	~90% accuracy	Overfitting issue.
[5]	Credit Card Dataset	Logistic Regression	Transaction features	Fast & simple	~91% accuracy	Lower accuracy
[6]	IoT Dataset	ANN	Behavioral features	Adaptive learning	~94% accuracy	Needs large data
[7]	Blockchain Dataset	ML + Blockchain	Secure transaction features	High security & transparency	Accuracy: 96%	Complexity

8. Research Gap

Despite significant advancements in cyber security technologies, several limitations still exist in current systems. One of the major gaps is the lack of real-time threat detection, as many existing solutions rely on offline analysis. This makes them less effective against rapidly evolving cyber attacks.

Another critical issue is the limited integration of advanced Artificial Intelligence (AI) and Machine Learning (ML) techniques. Although some systems utilize basic ML models, they often fail to incorporate deep learning approaches capable of detecting complex and previously unseen attack patterns.

Scalability also remains a major concern. Traditional security systems often struggle to handle the massive volume of data generated by cloud computing, Internet of Things (IoT) devices, and big data environments. This limitation leads to performance degradation and delayed response times.

Furthermore, many existing solutions rely on single-layer security mechanisms, which are insufficient to defend against multi-stage and sophisticated attacks. These challenges highlight the need for a robust, scalable, and multi-layered cyber security framework.

9. Problem Statement

Existing cyber security systems face several challenges that limit their effectiveness in modern digital environments. One key issue is the inability to detect threats in real time, allowing attackers to exploit vulnerabilities before detection mechanisms are activated.

Another major problem is the difficulty in handling large-scale and high-velocity data, especially in cloud-based and IoT-driven systems. This results in inefficient processing and missed detection opportunities.

Additionally, many systems lack adaptability and are unable to identify new or unknown threats (zero-day attacks) due to their reliance on predefined rules and signature-based detection techniques.

Therefore, there is a need for an intelligent cyber security system that can:

- Detect threats in real time
- Efficiently process large-scale data
- Adapt to evolving attack patterns
- Provide automated and rapid responses

10. Proposed Work

To address the limitations of existing systems, this study proposes a multi-layered cyber security framework that integrates both traditional and intelligent techniques.

The proposed system consists of the following components:

Rule-Based Detection Layer

This layer identifies known threats using predefined rules and signature-based techniques, enabling fast and reliable detection of common attacks.

Machine Learning-Based Detection Layer

This layer employs advanced machine learning algorithms such as Random Forest, Support Vector Machine (SVM), and Neural Networks to detect unknown and anomalous activities.

Real-Time Monitoring System

A continuous monitoring mechanism that analyzes network traffic and user activities in real time to detect suspicious behavior instantly.

Automated Response Mechanism

This component automatically initiates actions such as generating alerts, blocking malicious IP addresses, and isolating compromised systems to minimize damage.

The integration of these layers enhances detection accuracy, scalability, and adaptability, making the system highly effective against modern cyber threats.

11. Future Scope

The proposed framework can be further improved by incorporating emerging technologies and expanding its capabilities. Future research directions include:

- **AI-Based Autonomous Security Systems:**
  Development of self-learning systems capable of independently detecting and responding to cyber threats without human intervention.
- **Blockchain Integration:**
  Utilizing blockchain technology to ensure data integrity, transparency, and secure information sharing in distributed environments.
- **IoT Security Enhancement:**
  Extending the framework to protect IoT devices, which are particularly vulnerable due to limited built-in security features.
- **Big Data Analytics:**
  Leveraging big data tools and techniques to analyze large volumes of security data and improve threat detection accuracy.

12. Conclusion

This study presents a comparative analysis of existing cyber security approaches and proposes an intelligent hybrid framework to address current limitations.

Cyber threats continue to evolve rapidly, posing significant challenges to traditional security systems. Conventional rule-based approaches alone are no longer sufficient to detect and prevent complex and dynamic cyber-attacks.

The findings emphasize the importance of adopting a multi-layered cyber defense strategy that integrates Artificial Intelligence and Machine Learning techniques. Such systems offer enhanced capabilities in real-time detection, scalability, and adaptability.

In conclusion, future cyber security solutions must be intelligent, automated, and capable of handling large-scale dynamic environments to effectively combat emerging threats.

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