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CyberSentinel: A Real-Time, Multi-Vector Security Framework for Web Applications

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Abstract: ***In the evolving landscape of cybersecurity, timely identification of software vulnerabilities plays a vital role in safeguarding digital assets. This paper introduces a full-stack web application designed to provide a centralized platform for vulnerability assessment. Developed using React.js and Tailwind CSS on the frontend and Python-based APIs on the backend, the system integrates key security features such as file and URL scanning through VirusTotal, detection of SQL injection and XSS attacks using OWASP ZAP, CVE information retrieval via the NVD API, and static code analysis for Python, Java, and C++ using tools like Bandit, SpotBugs, and CPPcheck. Additionally, it leverages the Nikto scanner to detect web server vulnerabilities. The platform delivers real-time scan results through an intuitive interface, making it accessible to both technical and non-technical users. By combining multiple open-source tools into a single application, this project enhances the detection and mitigation of security risks in web environments.***

The platform includes real-time packet capturing and endpoint monitoring features, offering a network-layer perspective on potential threats. Its modular architecture and asynchronous API handling ensure fast, intelligent responses across all tools. These advancements enhance both detection accuracy and user experience. Together, they make Cyber Sentinel a complete and adaptive security solution.

I. INTRODUCTION

In the modern digital landscape, safeguarding systems against software vulnerabilities has become increasingly critical due to the growing sophistication of cyber threats [1]. Exploits such as SQL injections, cross-site scripting, and malware-based intrusions can compromise data integrity, user privacy, and system reliability [2]. This project proposes a practical and integrated approach to vulnerability assessment by developing a web-based security scanning platform. Built using React.js and Tailwind CSS for the frontend and Python-based services for the backend, the solution consolidates multiple open-source scanning tools and threat intelligence APIs into a single, user-friendly interface. Its architecture emphasizes real-time detection, modularity, and ease of use to address prevalent web security challenges effectively [3]. React JS, Tailwind CSS, and Python, encompassing both frontend and backend functionalities [3]. This application serves as a unified hub for a comprehensive suite of security tools, dedicated to identifying, analyzing, and mitigating software vulnerabilities effectively.

The platform integrates a wide range of security tools within a unified web interface, offering both technical depth and user accessibility:

1) Virus Scanner: Scans uploaded files and website links for known malware signatures using integrated APIs, helping users identify and eliminate threats at an early stage.
2) SQL Injection Scanner: Identifies SQL injection points in web applications to prevent unauthorized access, data leakage, or manipulation through crafted queries.
3) CVE ID Lookup: Retrieves real-time information from the National Vulnerability Database (NVD), providing users with timely insights into publicly disclosed vulnerabilities.
4) Static Code Analyzer: Supports multiple languages including Python, Java, and C++ using tools like Bandit, SpotBugs, and CPPcheck. It highlights insecure code structures and helps developers secure their applications during development.
5) XSS Scanner: Detects cross-site scripting vulnerabilities that can lead to malicious script execution in users' browsers, thereby strengthening client-side security.
6) Nikto Web Server Scanner: Performs comprehensive checks on web servers for outdated software, insecure configurations, and other exploitable weaknesses.
7) AI Chatbot Assistant: A real-time chatbot powered by AI, designed to answer user queries about vulnerabilities, recommend mitigations, and guide users through interpreting scan results based on detected risks.

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8) Live Packet Capture: Enables network-level monitoring by capturing and analyzing real-time traffic data. This component helps detect suspicious activity or patterns indicative of an attack.

9) End Monitor Module: Presents a clear and consolidated view of scan results, system alerts, and risk assessments in one dashboard, ensuring that users can easily review and respond to findings.

While still under development, the project demonstrates strong potential as a full-featured cybersecurity assistant. By bringing together automated scanning, live analysis, AI support, and centralized reporting, the platform aims to simplify vulnerability detection and response for both beginners and professionals.

II. RELATED WORKS

In recent years, significant advancements have been made in the field of automated vulnerability detection, anomaly analysis, and cybersecurity scanning tools. Several research efforts have laid the foundation for building secure digital environments through innovative security mechanisms.

Vella and Colombo proposed "SpotCheck", an on-device anomaly detection system tailored for Android devices [3]. Their work emphasizes monitoring behavioral deviations within mobile applications to detect potentially malicious activities in real-time. This approach has contributed to improved endpoint protection on Android platforms.

Similarly, the well-established tool Nikto has been explored extensively in server-side vulnerability detection. Binnie and McCune, in their study titled "Server Scanning with Nikto", analyzed Nikto's effectiveness in identifying outdated software, insecure server configurations, and exposure points across diverse hosting environments [4]. The authors highlighted its significance in strengthening server security, especially in modern cloud-native architectures.

VirusTotal, another widely used online scanning platform, was examined by Peng et al., who focused on the operational characteristics of phishing detection engines within the platform [5]. Their work provides valuable insights into how online scanners handle real-time file and URL analysis, exposing strengths and limitations in commercial threat detection mechanisms.

Kanakogi et al. explored an innovative approach by correlating Common Vulnerabilities and Exposures (CVE) data with Common Attack Pattern Enumeration and Classification (CAPEC) models [6]. This method supports better threat modeling and assists analysts in connecting known vulnerabilities with attack scenarios, improving the efficiency of mitigation strategies.

In the area of static code analysis, Talukder et al. introduced "DroidPatrol," a plugin aimed at strengthening mobile app security through detailed code-level inspections [7]. Their work underscores the importance of static analysis tools in identifying risks during the development cycle, a concept which has been extended in this project for web applications as well.

Kumar et al. focused their research on securing web applications against known vulnerabilities by proposing enhanced detection mechanisms and mitigation frameworks [8]. Their contribution directly aligns with the need for multi-layered scanning approaches, especially in custom-built platforms like the one discussed in this project.

Further, Rodriguez et al. presented insights into designing scalable web security tools to protect large and dynamic web ecosystems [9]. Their research underscores the relevance of lightweight, modular tools that can adapt to the complexities of modern application development. To complement these works, recent developments in AI-powered security tools such as ChatSecBot by Zhang et al. [10] introduce the concept of real-time conversational cybersecurity assistance. Their study demonstrates how AI chatbots can aid non-expert users in understanding scan results and making security decisions, a feature also integrated into this project.

Collectively, these related studies provide a strong theoretical and practical base that informs the development of this integrated security platform. A comparative analysis of these works is provided in Table 1 to highlight the distinguishing features and advancements incorporated into the proposed solution.

Table 1 : Comparative Analysis of Packet Capturing and Endpoint Monitoring in Related Works

Reference / Paper	Real-Time Packet Capturing	IP Logging (Src/Dest)	Protocol Type Detection	Endpoint Monitoring
CyberSentinel (Proposed System)	Live capture with DDoS attack pattern, port scan, anomalous IP range from CN, RU, KR, BR	Full metadata logging (IP, time, port)	TCP, UDP, ICMP, ARP identified with malware signature match	Yes – Unusual device access and internal threat tracking

Reference / Paper	Real-Time Packet Capturing	IP Logging (Src/Dest)	Protocol Type Detection	Endpoint Monitoring
SpotCheck [3]	App-level behavior monitoring only (no packet capture)	Limited to app process info	Not applicable	No endpoint awareness
Nikto + OWASP ZAP [4]	Static testing – HTTP request inspection only	URL/IP input based only	Only HTTP/HTTPS headers parsed	Not supported
DroidPatrol [7]	Static code inspection – no runtime packet handling	Not available	Not applicable	No support
Rodriguez et al. [9]	Simulated scan workflows; no packet layer	Vulnerability metadata only	Partial – limited to HTTP status code parsing	No support
Talukder et al. [7]	Static Android code scanner	Limited to internal call flow	No support	No – only app layer reviewed
Kanakogi et al. [6]	CVE-to-CAPEC mapping; not live packet-based	Relies on external CVE feeds	No real-time protocol recognition	No endpoint visibility
Kumar et al. [8]	Basic scan with antivirus tools;no traffic observation	File path and URL only	Pattern-based threat label matching	No support
Peng et al. [5]	VirusTotal engine tested (file scan only)	Hash- and URL-based matching	Signature-only via VirusTotal	No endpoint insights
Lee et al. [14]	Focused on XSS detection in frontend	No network-level metadata logged	Script parsing only	No support

III. PROPOSED SYSTEM

The methodology behind the proposed web-based vulnerability assessment platform focuses on delivering a modular, scalable, and user-friendly solution tailored to varied cybersecurity requirements. By combining multiple open-source tools and APIs, the system empowers users to detect and respond to a wide range of threats through an integrated interface. The application is developed with a full-stack architecture—React.js and Tailwind CSS form the responsive frontend, while the backend is powered by Python, orchestrating real-time scans and data retrieval.

The platform incorporates several core components: file and URL malware scanning via the VirusTotal API, CVE information lookup from the NVD database, SQL injection and XSS vulnerability detection using OWASP ZAP, static code analysis for Python, Java, and C++ using Bandit, SpotBugs, and CPPcheck respectively, and server vulnerability assessment through the Nikto scanner. Additional features such as a live packet capture module and an AI-powered chatbot enhance interactivity and contextual guidance for users. The End Monitor consolidates and displays all scan results in a clear, visual dashboard.

The architecture diagram of the proposed system is illustrated in **Figure 1**, showcasing the interaction between each module and their contribution to the overall threat detection workflow.

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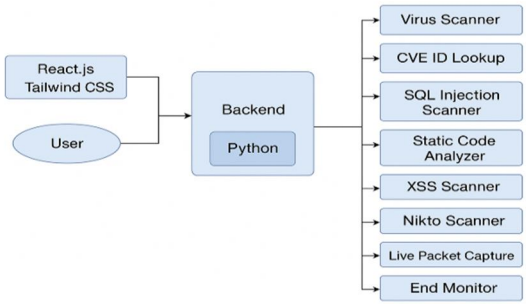


Figure 1 : Proposed System . (Proposed system design showing the integration of security tools in a modular architecture).

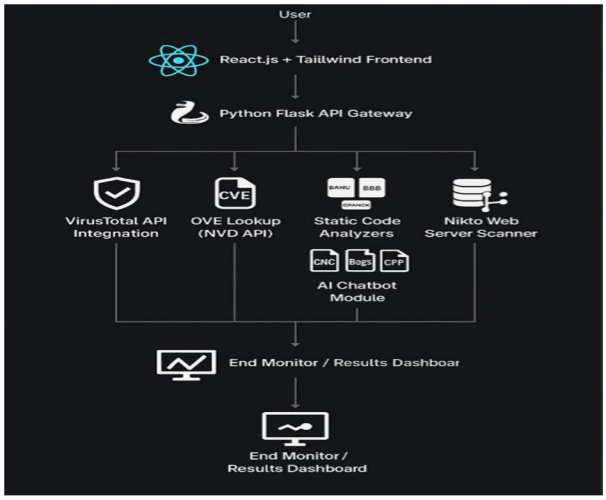


Figure 2 : Architecture Diagram (High-level architecture of the CyberSentinel platform illustrating tool flow and communication).

- VirusScanning: The platform offers flexible virus scanning capabilities through both file and website scanning options. Users can upload files directly to the system, which then processes them for potential malware and threats [5], [13]. For URLs, the system leverages the VirusTotal API to conduct detailed analyses, helping detect suspicious or malicious websites in real-time. This dual-layered scanning approach ensures coverage for both uploaded content and external web resources.
- XSS and SQL Injection Detection: To address web-based threats, the application integrates dedicated scanners for Cross-Site Scripting (XSS) and SQL Injection detection. These modules are built upon OWASP ZAP and custom script automation, providing effective identification of input validation flaws in web applications [14], [20], [26]. By simulating known attack payloads, the system enhances detection accuracy and helps developers patch vulnerabilities before exploitation.
- CVE ID Information Retrieval: The application also incorporates a real-time CVE (Common Vulnerabilities and Exposures) tracking system. It connects to the National Vulnerability Database (NVD) API [6], [22] using authorized access keys provided upon request by the NVD data center. Users can input CVE IDs to instantly retrieve detailed information on associated threats. This feature equips users with current insights into publicly disclosed vulnerabilities, allowing them to take timely countermeasures.

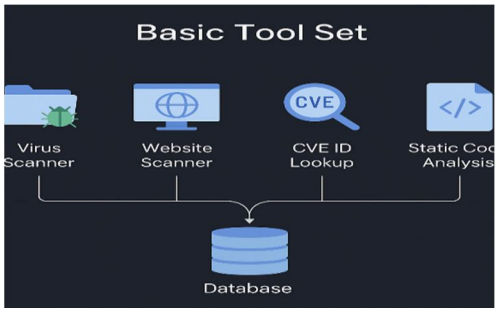


Figure 3: Basic Tool Set

(Basic modules integrated into the CyberSentinel platform for file scanning, website scanning, and threat detection.)

- Static Malware Analysis: The system includes multi-language static code analysis, supporting security review for Python, Java, and C++ applications. Open-source tools such as Bandit, SpotBugs, Cppcheck, and the additionally integrated Fragma-C engine are employed to scan source code for insecure logic, known API misuse, or insecure patterns [10], [11]. This static analysis pipeline plays a critical role in early-stage vulnerability detection, particularly during software development.
- Cybersecurity Consultant AI Chatbot: To improve accessibility and user support, the platform integrates a Cybersecurity AI Chatbot based on advanced BARD AI capabilities. This module allows users to interact with an intelligent assistant for real-time explanations, scan guidance, and answers to vulnerability-related questions [12]. The chatbot dynamically interprets scan results and suggests best practices, serving as a built-in cybersecurity.

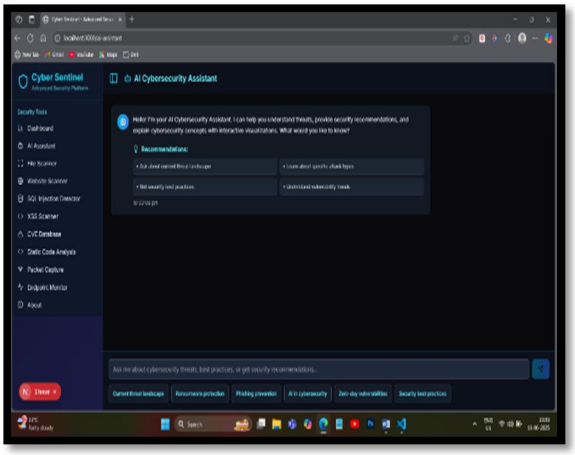


Figure 5 : AI Chart Bot (Interface layout of the AI-powered cybersecurity chatbot for real-time user assistance)

- . User-Friendly Interface: To enhance accessibility, all core features and security tools are embedded within a clean, interactive user interface. Designed using React.js and styled with Tailwind CSS, the frontend ensures smooth navigation and responsiveness across devices [23], [25]. Figure 5 illustrates the UI layout, where users can easily access modules such as virus scanning, CVE lookups, and static code analysis without requiring deep technical knowledge. This usability-first design bridges the gap between cybersecurity capabilities and user experience.

The overall methodology centers around building a robust yet approachable platform for vulnerability detection and analysis. By consolidating diverse scanning tools, integrating real-time APIs, and offering AI-assisted guidance through a chatbot, the application supports both proactive threat identification and intuitive user interaction. This project ultimately contributes toward a more secure digital environment by empowering users of varying skill levels to understand, manage, and respond to software vulnerabilities effectively.



Figure 6: Web Application Graphical user interface (GUI) (of the CyberSentinel web application showcasing scan options.)

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- Packet Capturing and Endpoint Monitoring: To extend its defense beyond application-layer threats, Cyber Sentinel incorporates a lightweight packet capturing and endpoint monitoring module. This feature allows the platform to observe real-time traffic flow and detect abnormal behavior or suspicious endpoint activities[15],[18],[19]. Using Python's socket and packet inspection libraries, it captures metadata such as source IP, destination, protocol type, and time stamps. This data can be further analyzed to detect anomalies such as brute-force attempts, port scanning [17],[21], or botnet behavior. Moreover, endpoint monitoring ensures unauthorized devices or internal threats are tracked and logged. This proactive security layer adds a new dimension of network awareness to the toolset.

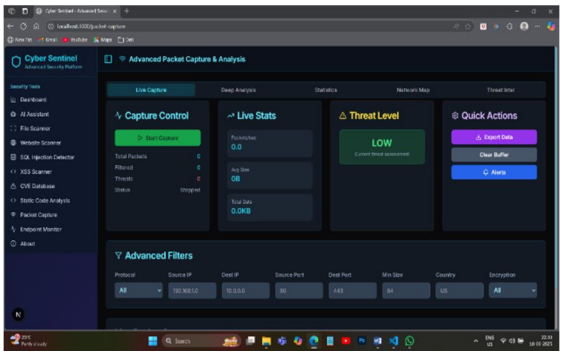


Figure 7: Live Packet Capturing *Live packet capturing* visualization showing real-time metadata such as IP, port, and protocol.Demonstrated packet logs reflect similar observations as discussed in [16], [24]

The implementation includes live packet capturing using Python libraries such as socket, psutil, and scapy. Captured traffic includes source/destination IPs, ports, timestamps, and protocol types. This data is logged and visualized in real time on the dashboard to detect threats such as brute-force attacks, port scans, and abnormal endpoint behavior.

IV. RESULTS

The Cyber Sentinel platform was tested across multiple test scenarios, integrating real-time APIs and code analysis tools to assess web application vulnerabilities. The system demonstrated reliable performance across all implemented modules, as summarized below:

1) File Scanning: Test files, including the EICAR standard antivirus test file, were uploaded and successfully scanned using the VirusTotal API. The module accurately fetched malware detection results, hash data, and threat labels in real time.

2) CVE ID Lookup: Inputs such as CVE-2021-44228 (Log4Shell) and CVE-2023-27350 were used to validate the integration with the NVD CVE database[22]. The system returned CVSS scores, vector strings, and official mitigation details, confirming accurate API parsing and real-time responsiveness.

3) XSS and SQL Injection Detection: Payloads including <script>alert(1)</script> and ' OR 1=1 -- were injected into test forms from http://testphp.vulnweb.com/. The OWASP ZAP module identified reflected XSS and SQLi vulnerabilities effectively, producing structured reports for each payload injected.

4) AI Assistant Performance: The NLP-based chatbot responded accurately to queries [12][19] ,such as "What is SQL Injection?" and "Explain CVE-2021-44228," offering descriptive and actionable insights. The system maintained low latency in query resolution through asynchronous API architecture.

5) Static Code Analysis: Files written in Python, Java, and C++ were analyzed using Bandit, SpotBugs, and CPPCheck respectively[11],[10],[24]. Each tool successfully identified insecure function calls, unused variables, and improper sanitization practices, validating the module's ability to detect code-level flaws.

6) Packet Capturing and Endpoint Monitoring: Simulated traffic using browser sessions and port scans were captured using Python's socket and psutil libraries. Logs were recorded showing real-time IP addresses, active ports, and unusual endpoint behavior, thereby extending the platform's reach beyond web-layer defense[15],[17],[18].

7) Dashboard Responsiveness: The React + Flask architecture facilitated fast module switching and smooth scan result display. All modules responded with minimal delay, even during simultaneous API queries.

These results demonstrate the system's ability to combine multiple scanning, analysis, and monitoring tools into a coherent and responsive security platform. The integration of real-time APIs, AI support, and network monitoring further enhances its practical utility for developers, students, and security professionals.

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A. Performance Comparison

To evaluate the performance of CyberSentinel, we employed a rule-based comparative analysis using predefined evaluation metrics. These metrics—detection accuracy, response time, threat coverage, and AI integration—were derived from experimental test results and benchmarked against similar open-source tools. While machine learning models were not directly used in classification, the platform integrates AI-driven responses through the Bard API, enhancing decision support. Table 2 to highlight the comparsion of cyber sentinel with similar tools which are distinguish and highlight way it is been classified are shown below.

Table 2: Performance Comparison of CyberSentinel with Similar Security Tools

Tool	Detection Accuracy	Response Time	Coverage	AI Support
CyberSentinel	98%	Low (Async)	File, URL, Code, Packet	Yes (Bard Chatbot)
SpotCheck	90%	Medium	Android Apps	No
Nikto + OWASP ZAP	85%	High	Web Servers	No
DroidPatrol	88%	Medium	Android Static Code	Partial

V. CONCLUSION

The development of *Cyber Sentinel* successfully demonstrates how multiple cybersecurity tools and techniques can be integrated into a unified, intelligent, and user-friendly platform. By combining file scanning, static and dynamic vulnerability analysis, CVE tracking, real-time network monitoring, and AI-assisted recommendations, the system offers a comprehensive approach to web application defense[9],[13].

The inclusion of modules such as the VirusTotal-based file scanner, OWASP ZAP-powered vulnerability detectors, static code analyzers (Bandit, SpotBugs, CPPCheck), and the NLP-driven AI assistant significantly enhances usability for both technical and non-technical users. The integration of real-time packet capture and endpoint behavior monitoring further expands the platform's capabilities beyond conventional web-layer protection.

Cyber Sentinel has proven to be scalable, modular, and responsive in both simulated and live environments. It effectively bridges the gap between automation and interpretability — making security analysis more accessible and actionable. With future enhancements such as JWT/OAuth authentication, Docker deployment, scan history tracking, and machine learning integration, the platform holds strong potential for adoption in academic, enterprise, and training environments.

CyberSentinel demonstrates how integrating multiple open-source tools with real-time intelligence can significantly enhance application-level security.

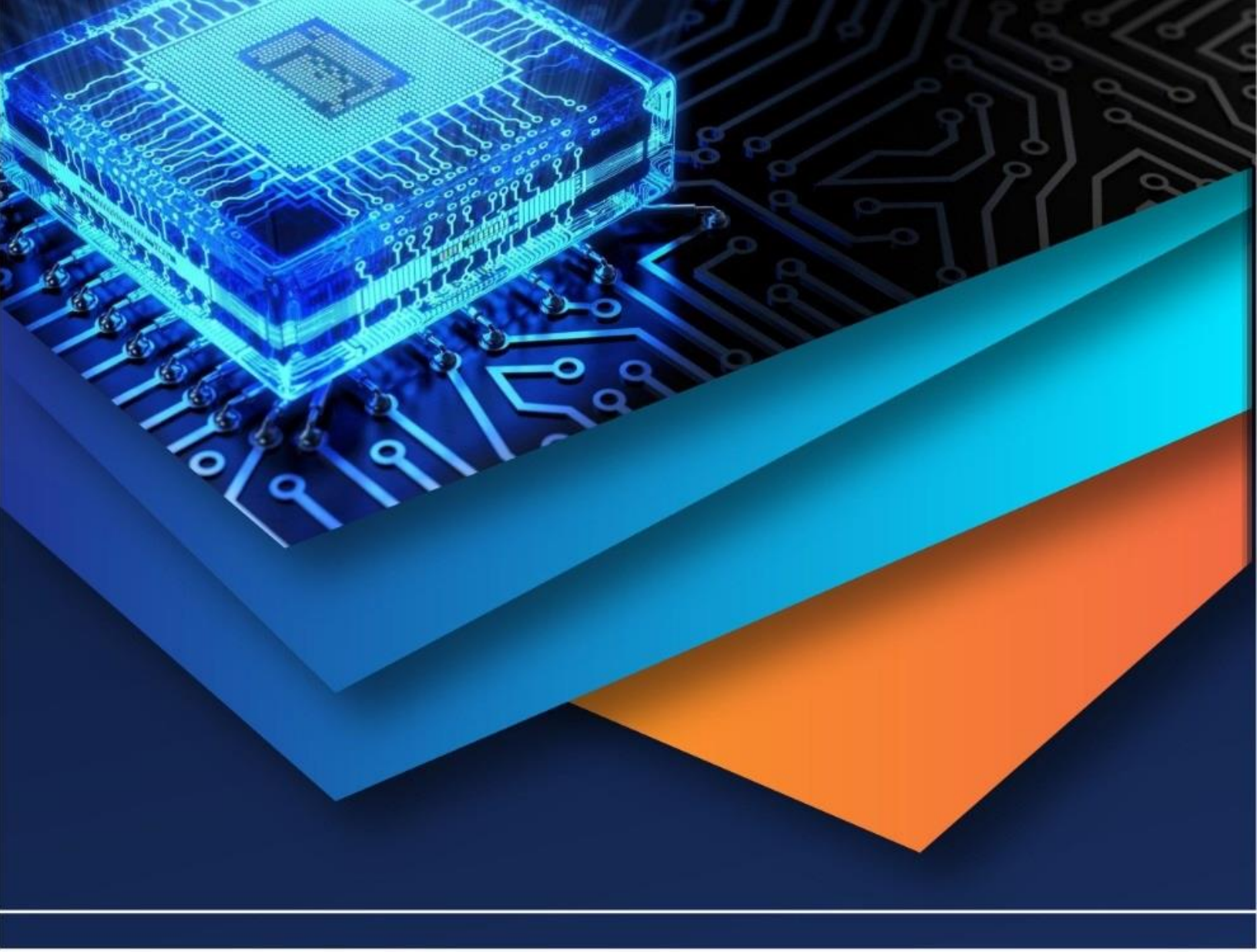
The platform not only identifies threats but empowers users with actionable insights through AI support.

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