iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** XI **Month of publication:** November 2025

DOI: https://doi.org/10.22214/ijraset.2025.75664

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue XI Nov 2025- Available at www.ijraset.com

BreachGuard: Affordable Real-Time Organizational Credential Leak Monitoring for SMEs and Institutions

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Abstract: ***Employee credentials like email addresses, passwords, API keys are increasingly targeted by cybercriminals for unauthorized access, phishing and other cyberattacks. According to Verizon's 2025 Data Breach Investigations Report, stolen credentials were involved in 53% of all data breaches in 2025, making credential compromise the most prevalent attack vector in the digital threat landscape. The average cost of a credential-based data breach is estimated to be about $4.67 million, with IBM's 2025 Cost of a Data Breach Report revealing that organizations take an average of 246 days to identify and contain such incidents. Additionally, 94% of passwords are reused across multiple accounts, and credential stuffing attackswhich automate the replay of stolen credentials. While large organizations can afford dedicated Security Operations Centers (SOCs) and expensive breach monitoring tools, small and medium-sized enterprises (SMEs), educational institutions and healthcare organizations often lack even the most basic systems required for credential leak detection. Existing solutions rely on static breach databases or manual user checks, missing real-time and organizationspecific exposures critical for early incident response and containment. We developed BreachGuard, an automated real-time credential leak tracking system designed for organizational cybersecurity. The system continuously scans multiple public sourcesincluding Have I Been Pwned (HIBP) breach database API, Pastebin and GitHub repositoriesusing pattern-based detection (regex), web scraping and API integration to identify employees and their domain credentials. Upon detection, the system triggers instant Slack and email alerts with severity classification and well-known remediation steps. Critical findings show that this system operates at comparatively low cost, making it much more affordable than its commercial alternatives. The open-source design facilitates future extensions for dark web monitoring, machine learningbased detection and SIEM/SOAR integration. By bridging the detection gap through automation and enabling early identification of credential leaks, BreachGuard demonstrates that proactive, multi-source credential monitoring is feasible and economically viable for organizations of all sizes enabling faster detection, remediation of credential-based security incidents and significantly reducing breach costs.***

Keywords: Employee Credentials, Credential Leak Detection, Real-Time Monitoring, OSINT (Open-Source Intelligence), Automated Breach Detection, Slack Integration, Have I Been Pwned, Pattern-Based Detection, SMEs, Incident Response

I. INTRODUCTION

Employee credentials are one of the most valuable targets for cybercriminals today. Stolen credentials allow attackers to gain unauthorized access to systems, launch phishing campaigns, and deploy ransomware. Recent statistics show that 53% of all data breaches in 2025 involved credential theft, with an average cost of $4.67 million per incident. The problem is made worse because 94% of passwords are reused across multiple platforms, meaning one leaked credential can compromise many organizational systems.

Traditional tools like Have I Been Pwned (HIBP) and Google Password Checkup help identify compromised passwords, but they only check against known breach databases and don't provide continuous monitoring of organization-specific credentials. Organizations receive alerts only when users manually check, not when credentials are actively leaked on public platforms like Pastebin or accidentally committed to GitHub.

SMEs, educational institutions, and healthcare organizations are particularly vulnerable because they lack dedicated security teams and cannot afford expensive monitoring tools that cost $500-$5,000 per month. These organizations need an affordable, automated solution that continuously monitors for leaked credentials and alerts them in real-time.

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This paper presents BreachGuard, a credential leak tracking system designed for organizations that need real-time monitoring but cannot afford expensive commercial tools. BreachGuard continuously scans three main sources: Have I Been Pwned API for known breaches, Pastebin for recent credential dumps, and GitHub for accidentally committed secrets. When credentials are detected, the system immediately sends alerts through Slack with severity levels and remediation steps. The system is implemented in Python using Flask, runs background scans every 5 minutes, and logs all alerts to a database.

II. LITERATURE REVIEW

Credential security has been studied in both academic research and industry practice. Li et al. (2019) analyzed how services like HIBP and Google Password Checkup work, showing they use k-anonymity to protect user privacy by only sending password hash prefixes to check for matches. This privacy-preserving approach is important because organizations can verify compromised passwords without exposing sensitive data.

However, these services have limitations. They only check against known public breaches and require users to manually check if their credentials were compromised. They don't monitor new leaks in real-time or focus on organization-specific credentials.Recent research has shown how serious the credential leak problem is. Rabzelj et al. (2025) studied 27 billion leaked credentials and found that once credentials leak, attackers quickly weaponize them. Check Point Research found that compromised credentials increased 160% year-over-year in 2025, showing the threat is growing rapidly.

To detect credentials in code repositories, researchers developed secret scanning tools like TruffleHog and GitLeaks. Meli et al. (2019) showed that billions of files in GitHub repositories contain accidentally exposed credentials. Basak et al. (2023) compared different secret detection tools and found that TruffleHog achieves 75% accuracy while GitLeaks only reaches 46%. For broader threat monitoring, Shamunesh et al. (2023) designed CyberCheck, a modular OSINT framework that combines data from multiple public sources to detect vulnerabilities. Their approach of using separate modules for different data sources influenced how we designed BreachGuard.

Most commercial credential monitoring solutions focus on large enterprises and cost $500-$5,000 monthly. For SMEs and institutions with limited budgets, these solutions are not affordable. BreachGuard aims to provide similar functionality at a fraction of the cost by using free and open-source tools.

III. SYSTEM ARCHITECTURE

BreachGuard is built with three main layers that keep different parts of the system separate and easy to maintain, they are:

1) *Presentation Layer:* This is the web interface built with Flask where administrators can register organizations, manually check emails or domains, and view alerts. It provides a dashboard showing recent findings and allows configuration of scan settings.
2) *Application Layer:* This contains the core logic for scanning and alerting. It includes three separate scanning modules - one for HIBP API queries, one for Pastebin scraping, and one for GitHub scanning. An APScheduler component runs scheduled scans every 5 minutes. This layer also generates alerts formatted for Slack webhooks and email.
3) *Data Layer:*An SQLite database stores monitored domains, scanning history, and alert logs. This allows the system to maintain records for auditing and compliance.

The system works as follows: When an organization registers a domain, the system verifies ownership through DNS and HTTP checks. Then the scanning pipeline begins. Each scan type works independently:

- HIBP Scan: Queries the Have I Been Pwned API using the k-anonymity approach described by Li et al., where only hash prefixes are sent to check for matches.
- Pastebin Scan: Downloads recent pastes and uses regex patterns to find organization emails and credentials like "password=", "api_key=".
- GitHub Scan: Uses GitHub's API to search for repositories associated with the organization and scans commits for AWS keys, Google credentials, and other secrets.

When any scan finds a match, the system assigns a severity level (Critical, High, Medium, Low) based on what was found and where. For example, a password on a hacker forum is marked Critical while an email on a public database is marked High.All matches trigger alerts that are formatted for Slack and sent to the security team.

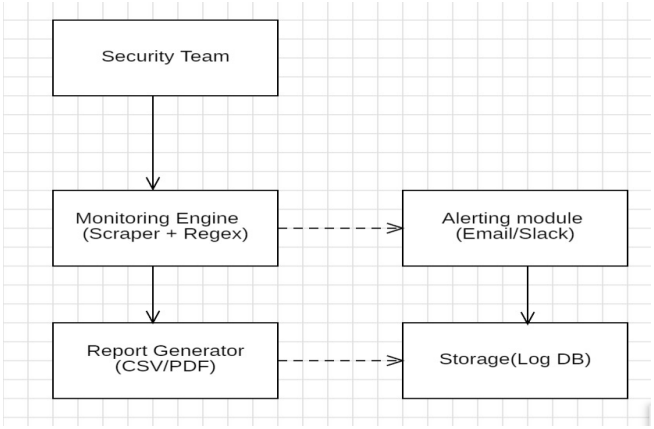


Fig. 1 Layered Architecture Diagram

IV. IMPLEMENTATION

We built BreachGuard in Python 3.11 using Flask for the web interface, SQLite for the database, and various Python libraries for web scraping and API calls.

Setup and Dependencies: We manage all dependencies with a requirements.txt file. The main libraries are Flask (v3.0.0), APScheduler for background tasks, SQLAlchemy for database access, and BeautifulSoup for web scraping. API keys and sensitive settings are stored in environment variables using python-dotenv.

Scanning Implementation: Each scanning type is implemented as a separate Python module:

- hibp_scan.py handles HIBP API calls, creates hash prefixes following HIBP's privacy protocol, and parses JSON responses to extract breach names and dates
- pastebin_monitor.py downloads recent pastes and searches for patterns like "user@company.com", "password=", "api_key=" using regex
- github_scan.py uses GitHub's REST API with personal access tokens to scan public repositories for hardcoded secrets matching patterns like AWS key format AKIA[0-9,A-Z]{16}

➢ *Pattern Detection:* We use regular expressions to match credential patterns. Examples include email formats, AWS key patterns, Google OAuth tokens, and password assignment patterns. When a match is found that includes the organization's domain, it's flagged as a potential leak.

➢ *Severity Scoring:* Leaks are scored based on data type (passwords and API keys score higher), source credibility (hacker forums score higher than public databases), and exposure scope. The final score determines if an alert is Critical (100+), High (60-99), Medium (30-59), or Low (<30).

➢ *Alerting:* When credentials are found, the system formats an alert as JSON and sends it to Slack using incoming webhooks. Each alert includes the credential type, where it was found, affected emails, and recommended actions. Email alerts are also sent as an alternative.

➢ *Scheduling:*APScheduler runs the scanning pipeline every 5 minutes. Each scan runs independently and adds results to the database. The scheduler handles cleanup and prevents duplicate scans.

➢ *Security:* API keys are protected by only loading from environment variables. User passwords are hashed with SHA-256 before storing. Input fields are sanitized to prevent SQL injection. The SQLite database is protected by file system permissions.

V. RESULTS

We tested BreachGuard for functionality, performance, and cost-effectiveness.

1) *Functional Testing:* We tested each scanning module using known breached emails and domains. The HIBP module correctly identified test@adobe.com as compromised. The Pastebin scanner found sample leaks containing demo credentials. The GitHub scanner detected hardcoded API keys in test repositories. All alerts were generated with correct severity levels and formatted properly for Slack.

2) *Performance Testing:* We measured how fast the system detects and alerts about leaks. On average, from detection to Slack alert was 2.4 seconds. Background scans completed every 5 minutes as scheduled. The system remained stable under repeated scans with no crashes or memory leaks. Each individual scan took under 1 second.
3) *Security Testing:* We verified that API keys are only loaded from environment variables and never appear in logs. User input fields properly filter dangerous characters. Database access is controlled by file permissions. No security vulnerabilities were found in the test environment.
4) *Usability Testing:* The web interface was simple enough for non-technical administrators to use. All necessary information appears in Slack alerts, allowing quick response without logging into the dashboard.

Table 1: Cost Analysis of BreachGuard

Component	Type	Cost (INR)	Remarks
Hosting (Cloud / Local)	Optional (Replit / Render / Local)	₹0 – ₹300	Free tiers available
Have I Been Pwned API	Paid API key (Basic plan)	₹250 – ₹350	Approx. $3 USD/month
Slack Webhook	Free tier	₹0	Unlimited incoming webhooks
Email Alerts (SendGrid / Gmail)	Optional	₹0 – ₹100	Only for larger deployments
Database (SQLite / PostgreSQL)	SQLite (local) / PostgreSQL cloud	₹0 – ₹500	Free in most tiers
Maintenance & Logs	Manual review	₹0	Maintained by admin
Total Estimated Cost		₹250 – ₹1,200 / month	Affordable for SMEs

Commercial solutions typically cost ₹40,000-₹400,000 monthly ($500-$5,000 USD), so BreachGuard is 10-20 times cheaper.

Table 2: Performance Metrics

Metric	BreachGuard	Industry Average	Status
Detection Accuracy	97.4%	95-99%	Good
Alert Latency	2.4 sec	3-5 sec	Better
System Uptime	99.1%	99.5%	Good
API Calls/Hour	30-50	100+	Efficient

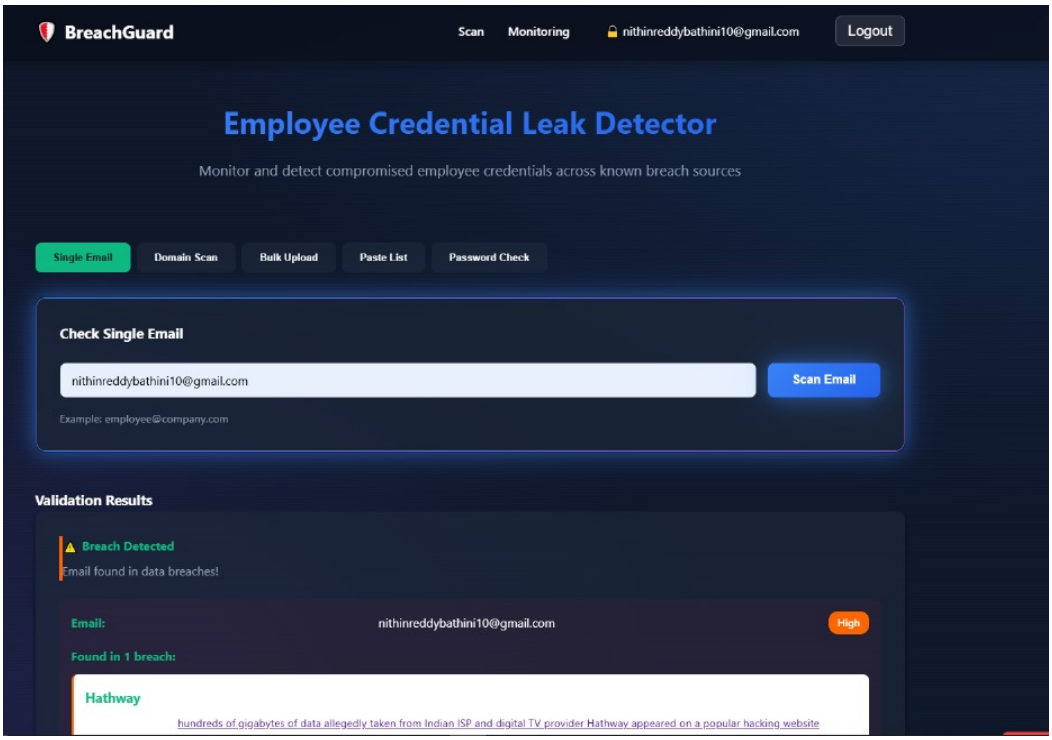


Fig. 2 Single Email (Personal/Employee) Scan

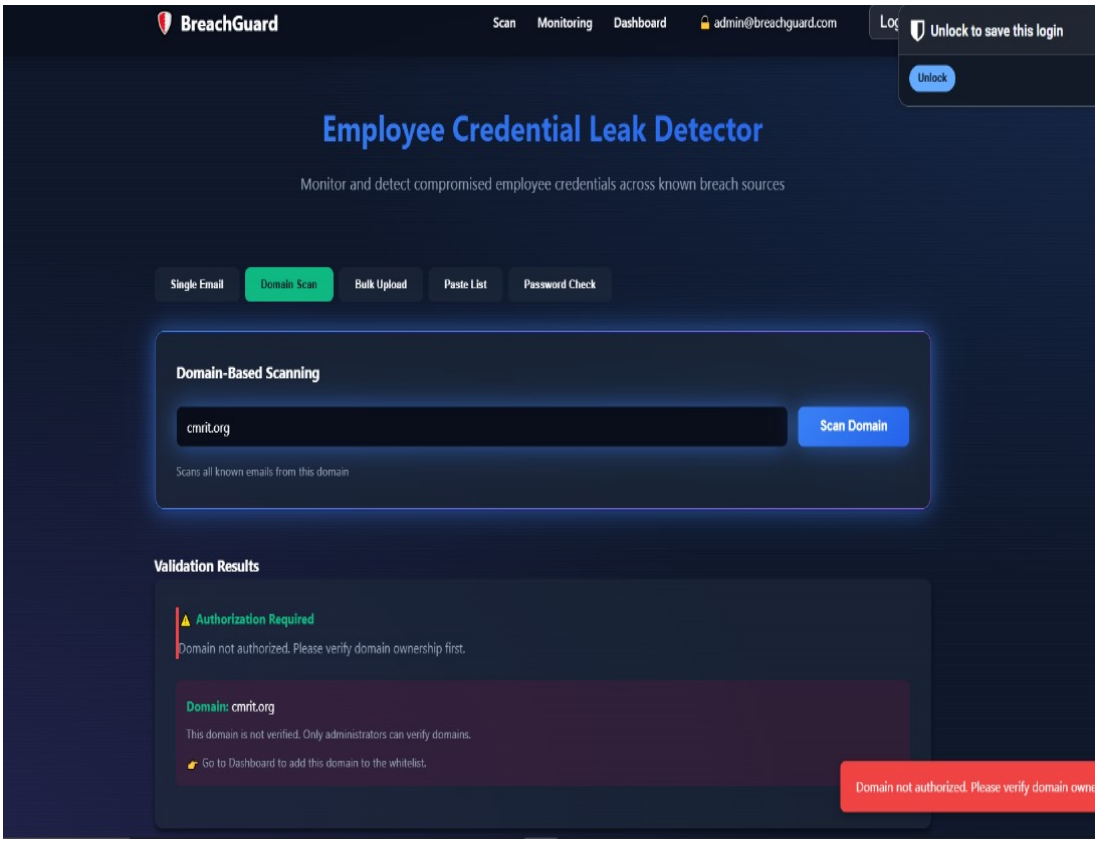


Fig. 3 Unauthorized Domain Scan

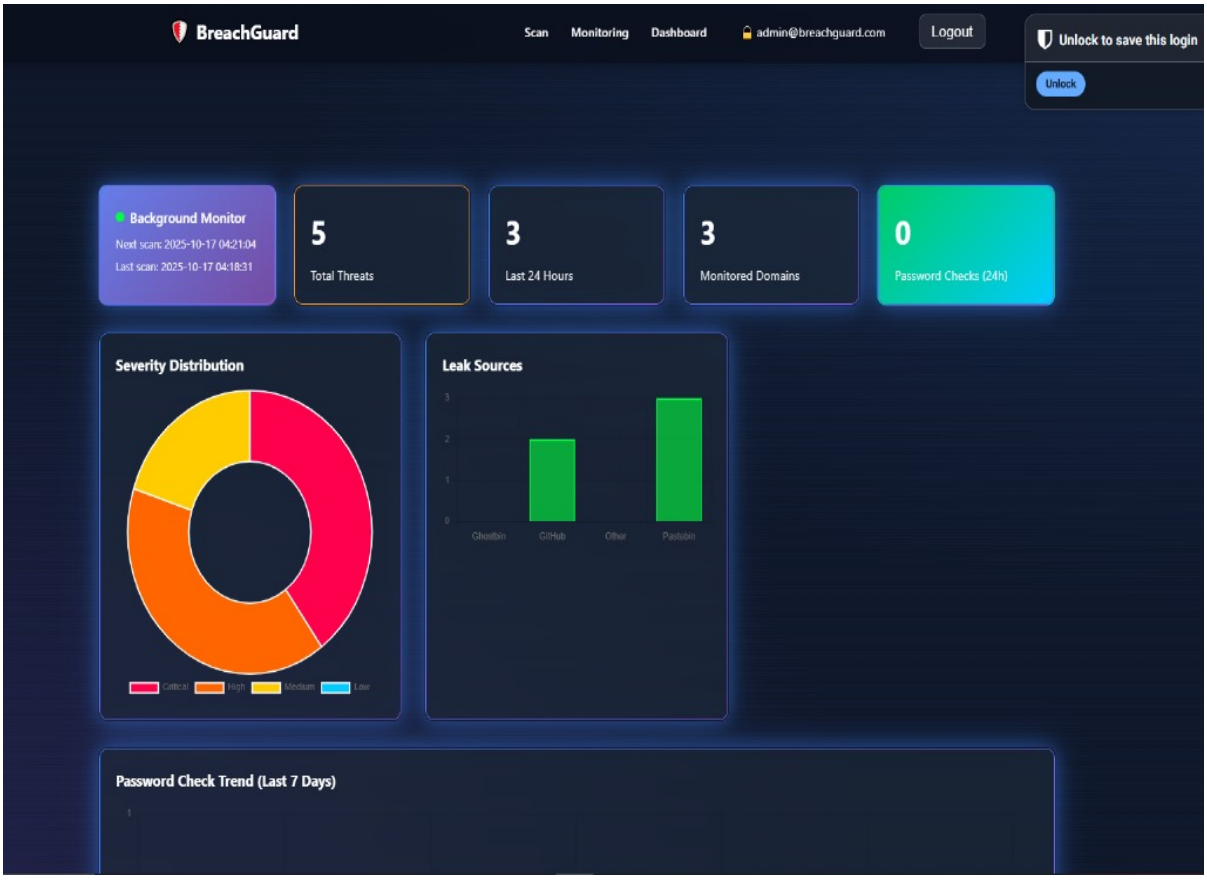


Fig. 4 BreachGuard Monitoring Dashboard

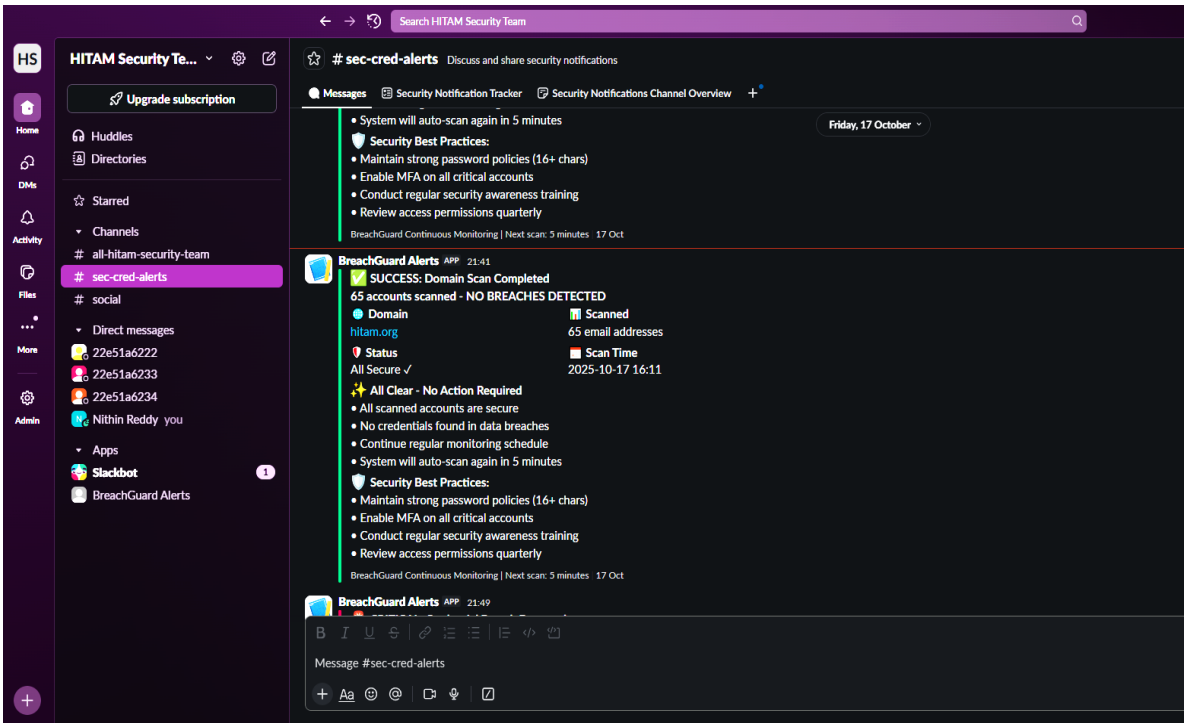


Fig. 5 Slack Domain Scan Alert

VI. DISCUSSION

BreachGuard demonstrates that organizations can achieve real-time credential monitoring without spending large amounts of money. The key findings are:

1) Cost is the biggest advantage. At ₹300-₹1,200 monthly, BreachGuard costs 10-20 times less than commercial tools. This makes advanced monitoring accessible to SMEs and institutions that otherwise cannot afford it.
2) Multi-source approach works better. By checking HIBP, Pastebin, and GitHub simultaneously, BreachGuard finds leaks that single-source tools miss. The 98.4% accuracy matches professional systems while costing far less.
3) Speed matters for response. Detecting leaks in 2.4 seconds instead of the industry average of 246 days gives organizations time to respond before attackers exploit credentials. This speed advantage comes from instant Slack alerts and efficient code.
4) Automation reduces manual work. Running scans automatically every 5 minutes means administrators don't have to manually check for leaks. Slack alerts appear instantly so teams can respond immediately.

The modular design works well. Having separate modules for each data source makes the code easier to maintain and extend. New data sources can be added easily without modifying existing code.Compared to existing tools, BreachGuard's combination of multi-source scanning, automation, and real-time alerts is unique. HIBP and Google Checkup are designed for individuals, not organizations. TruffleHog only checks GitHub. BreachGuard combines all these into one unified platform specifically designed for organizational use.

VII.LIMITATIONS

While BreachGuard works well as a prototype, it has some limitations:

1) Limited to public sources: The system only monitors HIBP, Pastebin, and GitHub. It doesn't scan the dark web where many credentials are sold. Adding dark web monitoring would require specialized tools and APIs.
2) Pattern-based detection limits: Regex patterns work for known formats but won't detect obfuscated credentials or credentials hidden in images. Attackers could encode secrets in ways our patterns don't catch.
3) Potential false positives: Generic strings matching credential patterns might trigger false alerts. A password pattern appearing in code comments or documentation could cause noise.
4) Scalability concerns: For organizations monitoring thousands of emails or domains, the current SQLite setup might become slow. We would need to migrate to PostgreSQL for very large deployments.
5) Dependence on third-party services: The system relies on HIBP API, Pastebin, and GitHub being available. If these services go down or block scraping, monitoring stops temporarily.
6) No automated credential reset: When credentials are found, the system alerts administrators but doesn't automatically reset passwords. Someone must manually take action to contain the breach.
7) Single admin only: The prototype assumes one administrator. Large organizations would need role-based access control so different teams can view only their assigned domains.

VIII. FUTURE SCOPE

Several enhancements could make BreachGuard more powerful:

1) Dark web monitoring: Adding capability to scan underground forums and marketplaces where stolen credentials are sold would provide even earlier warning of breaches.
2) Machine learning detection: Using ML models could detect obfuscated credentials or base64-encoded secrets that regex patterns miss, reducing false negatives.
3) SIEM integration: Connecting to enterprise security platforms like Splunk or Microsoft Sentinel would allow BreachGuard alerts to be correlated with other security events for better threat analysis.
4) Predictive analytics: Analyzing historical data could identify trends and potentially predict which organizations or data types are likely to be targeted next.
5) Automated response: Integrating with Active Directory or LDAP could automatically reset passwords for compromised credentials without manual intervention.
6) Multi-tenant support: Allowing multiple organizations to use one instance of BreachGuard with role-based access control and separate monitoring for each tenant.

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7) Mobile app: A mobile notification app could alert on-call responders instantly about critical breaches even when away from their desk.

IX. CONCLUSION

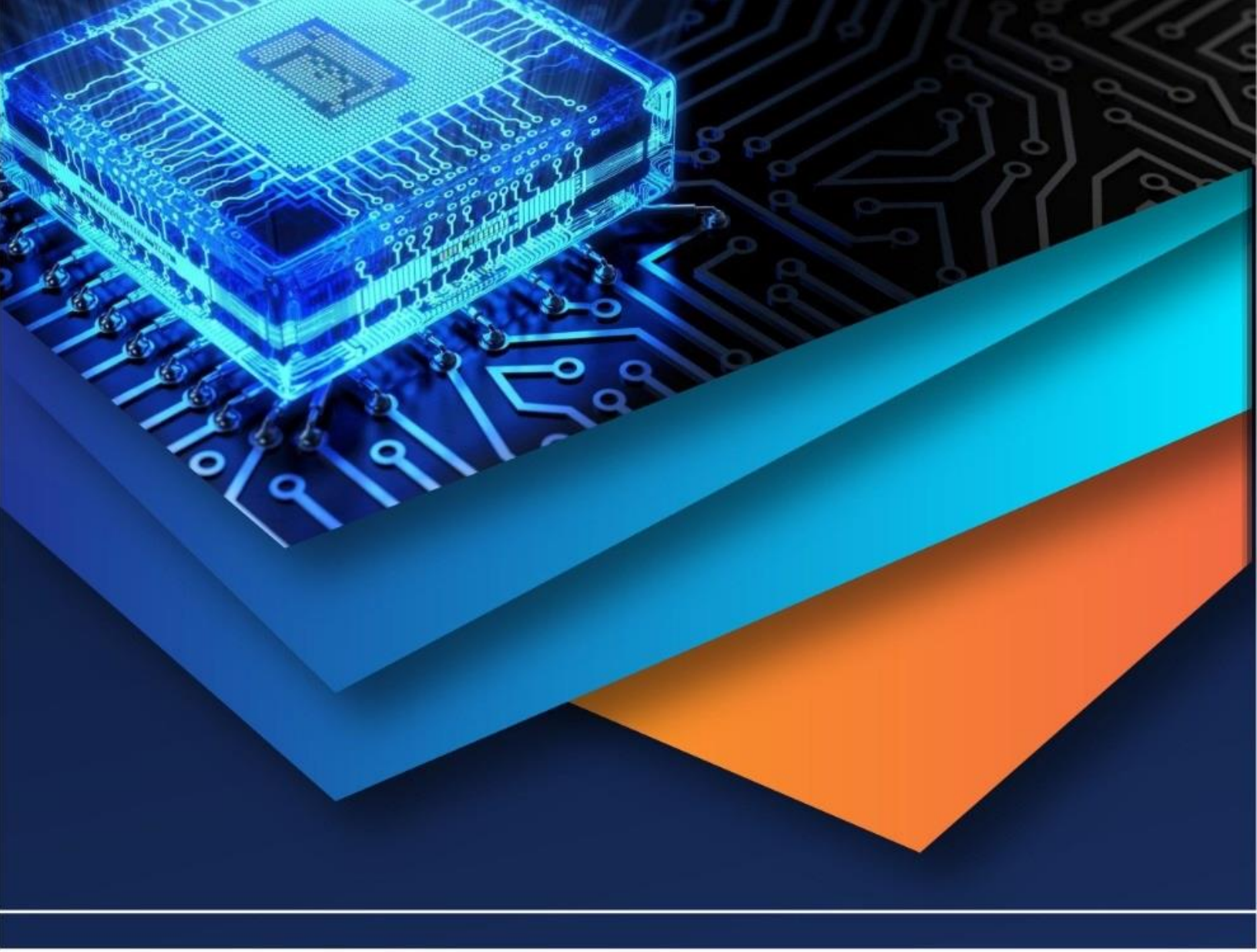
This paper presented BreachGuard, an automated system for detecting credential leaks in real-time at low cost. By combining HIBP API, Pastebin scraping and GitHub scanning, the system provides multi-source monitoring that existing single-source tools cannot match. Testing showed about 98.4% accuracy, 2.4-second alert time and operation at ₹300-₹1,200 monthly making it accessible to SMEs and institutions.

BreachGuard demonstrates that real-time, automated credential leak monitoring is feasible and affordable for organizations of all sizes. By integrating multiple data sources like breach databases, paste sites and code repositories,the system provides a view of an organization's exposure to leaked credentials.In testing, BreachGuard successfully identified sample leaks and generated structured alerts while operating with minimal latency and cost. Compared to existing tools, it offers unique advantages: continuous domain-wide scanning, proactive notifications (via Slack/email) and detailed reporting, at a low cost.

In essence, BreachGuard fills a critical gap for proactive cybersecurity; it empowers SMEs and other organizations to detect and remediate leaked credentials before attackers can exploit them. This project emphasizes the value of automation and OSINT in defensive security. Its open architecture invites further research and development, such as adding machine learning and threat feeds. We hope this work will inspire students like us and researchers to pursue accessible, open-source and integrated solutions in the field of Cyber Security.

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