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SECURING THE CLOUD: AUTOMATING THREAT DETECTION WITH SIEM, ARTIFICIAL INTELLIGENCE & MACHINE LEARNING

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Abstract
While the role of DevOps in cyber security has emerged as a critical aspect in the modern world, practitioners must incorporate Security Information and Event Management (SIEM), Artificial Intelligence (AI), and Machine Learning (ML) to detect and combat threats in cloud infrastructures in real-time. This paper looks at how these technologies can merge to support security developments and optimize the occurrences of incidents. With the help of real-time collection and analysis through SIEM, pattern recognition through AI, and ML prediction, organizations can develop comprehensive and agile security features. This research work also concludes through the simulations that show how the integrated approach methodology can increase threat detectability, decrease response time, and increase data processing speed. Real-life convincing case studies demonstrate the dramatic enhancement of the efficiency of security processes and illustrate the problems and measures related to implementing this integrated security model. Hence, the present research emphasizes deploying an integrated model to protect organizations' cloud environments and prevent new threats.

Keywords: DevOps, Security, SIEM, Artificial Intelligence (AI), Machine Learning (ML), Continuous Threat Detection, Incident Response, Cloud Security, Real-Time Data Analysis, Anomaly Detection, Predictive Analytics, Cybersecurity, Security Operations, Threat Detection Accuracy, Adaptive Security Measures

Introduction
Regarding the current technological environment, one should note that, especially in modern developments, numerous changes have recently occurred in the cybersecurity domain. The adoption of cloud computing solutions is becoming widespread within IBS since decision-makers perceive this strategy as helpful in boosting the effectiveness and adaptability of their operations and making their solutions more accessible. However, with the move to the cloud, technological advancements have created other and even more complex threats that can neutralize conventional security. Regarding these changing threats, DevOps practices have become a necessity coupled with professional security technologies, including Security Information and Event Management (SIEM), Artificial Intelligence (AI), and Machine Learning (ML). This integration should develop a secure architecture that is resistant to new threats in the cloud computing environment, which will continue to detect and respond to them without being decommissioned.

DevSecOps combines DevOps and Security, emphasizing cooperation between development, operation, and security teams. This is mainly through integrating the SIEM systems because through these systems, organizations can collate large amounts of security-related data in real time so that any possible threats can be detected early. AI and ML, in particular, enhance the process by

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automating the detection of patterns, anomalies, and real-time prediction of threats, hence increasing the efficiency and effectiveness of threat detection. This integrated, practical approach is described in different simulation reports and real-world case scenarios, where this paper focuses on the enhancements of security operations and the realization process for a safe cloud environment.

Simulation Report

Introduction

Integrating SIEM, AI, and ML has made a revolutionary change in the global security domain to enhance the security scope of DevOps. This simulation report shows how this integrated approach may help detect threats and minimize the overall response time in cloud structures. The simulations were performed in the hybrid cloud environment; various security tools and technologies were used to analyze continuous security events.

Methodology

This was done because it is close to medium to large enterprise IT settings that incorporate the typical blend of private and public clouds. This arrangement ensured that the results' validity would always encompass a real-life scenario since it was the aim of the research. The environment included:

***Cloud Platforms*:** Amazon web service, Azure, and Google cloud platform.

SIEM Systems: Supply more than one resource, which will be more favourable than companies that depend only *on Splunk or companies that rely only on IBM QRadar*.

AI and ML Tools, Tensor Flow, Py Torque, and IBM Watson.

***Security Frameworks*:** policies including NIST and ISO/ IEC 27001 policies. They have been selected to define specific and widely used and have shown an aptitude for handling large quantities of information and protection issues.

Data Collection

Constant security logging and events were also part of the simulation process. The data was implemented from firewall logs, IDS logs, and application logs sources. Thus, all the potential security events were captured and examined when the simulation was completed. SIEM systems used for collecting and storing real-time security status data are Splunk and IBM QRadar [1].

Data Processing

This data was normalized and accumulated, and as a result, it was analyzed with the help of the SIEM systems. Normalization was because many data collection formats were brought to one format, making it easier to engage in the analysis. Integration was assembling information from different sources and then analyzing them to establish a correlation indicating signs of security threat. This step was vital as it brought the data to a format that could be processed by the AI and ML tools [2].

Threat Detection

Further, to identify possible threats, AI and ML methods were applied to the processed data. Tensorflow and Py-Torch are used to design models that are later trained to detect such odd behavior or signs of a security violation. Besides that, IBM Watson provided additional aspects of natural language processing and cognitive application that provided a superior function in threat identification. These technologies helped make the simulation detect high risks in real-time [3].

Incident Response

When the threats, usually prescribed by the organization and the analyst, are detected, the simulation uses automatic and manual response actions to counter the threats and realize the overall objectives. Automated responses blocked the IP addresses, terminating all the suspicious sessions and

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alerting the security team. Yes, it should be noted that manual responses based on the results of the work of security analysts called for further examination of further threats associated with confirmation and neutralization activity. This twofold procedure provided appropriate foundations for the harmonious and proper bifacete incident response strategy [4].

Reporting and Analysis

The last process aimed to escalate the specific report, which concerned the combined security model's performance and efficiency, and build the graphs. For that reason, while preparing the reports, the focus was shifted to parameters that defined the quality, namely the rate of threat identification, response time, and data transfer rate. Different graphical representations that depicted the improvement of the situation about the implementation of SIEM, AI, and ML in DevOps were provided. It was crucial in stabilizing the definition of the impacts of the introduced security framework and searching for new sources for development [1].

Objectives of Each Simulation

1. Threat Detection Accuracy

Objective: The study aims to determine the use of AI and ML alongside the SIEM systems in identifying security threats.

Description: This simulation is primarily solely focused at a basic level on determining how much of a difference exists in the threat identification capability of the two models with the inclusion of AI and ML. Since it is regarding the detection rates, the idea here is to analyze how developed technologies may improve detection for signs connected to breaches.

Expected Outcome: Enhancement in threat identification that shows the effectiveness of AI and ML-enabled SIEM systems over conventional ones.

2. Response Times

Objective: For the management to evaluate the findings of leads regarding the amount of time it takes for the automated mechanisms of the Incident response to respond to threats.

Description: This simulation is based on the response to incidents comparing the time spent on the whole process, if done manually, to the time if done automatically. This means the goal is to understand the AI-based automated responses related to threat mitigation and the potential for performance improvement.

Expected Outcome: This presented a marked reduction in time in dealing with those incidents, proving that the automatic incident handling systems are efficient in escalating threats while responding to them almost immediately.

3. Data Processing Rates

Objective: To assess to what extent the SIEM systems perform in real-time analysis of numerous security event data.

Description: Besides the event processing rates and the system latency of SIEM systems, this simulation examines the following. The objective is to define a testing model of how these systems operate in terms of performing normalization, aggregation, and real-time analytics and timely shutdown of the threats.

Expected Outcome: Event processing rates and system latency have proved that SIEM systems can process and analyze high rates of security data in the continuously growing cloud habitat.

Results

Several of these findings were presented in the simulation results, which proved that artificial intelligence, machine learning, and an SIEM solution within DevOps practices provide a continuous protection mechanism in a cloud infrastructure.

Improved Threat Detection Accuracy

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It was noted that the integration of AI and ML with SIEM was observed to help significantly improve the ability of SIEM to detect threats. Of 100 per cent efficiency, the machine learning algorithms and artificial intelligence used in the system succeeded in identifying the irregularities and patterns pointing towards the security breach with an efficiency of 95 percent. The accuracy of the proposed method in the previous sections, without the use of AI and ML, was 85%. This improvement is attributed to getting AIML techniques that can recognize patterns and detect anomalies from the vast amount of data that cannot be done manually [1, 3].

Reduced Response Time

AI, when applied in the automation of the incident response procedures, also enjoys minimal average reaction time to the incidents the system notices. The provided simulation results displayed that the response time of the manual work was equal to 15 minutes. The time taken for the automated responses, including the use of AI, was, on average, 9 minutes. This has been observed to be a forty percent improvement in the response time. The following conclusion can be deduced from the above information: This is because of its attributes, which can quickly analyze threats within the system and implement hard-wired response operations that assist in avoiding penetrations and such violations [2].

Enhanced Data Processing Efficiency

The programs utilized in setting up SIEM systems for normalization and aggregation of data improved data collection and processing by a great deal and enabled the real-time monitoring of security events. When you execute the simulation in the system, the number of events per second handled is 10000, while the system response time is less than 2 seconds. The high throughput and low latency were attributed to the capabilities of the robust SIEM systems that have high throughput identification of critical information security information [3].

Scalability and Flexibility

The hybrid cloud configuration showed that the total elasticity was very high because the same system could quickly adapt itself to types of workloads and security levels without necessarily compromising on the throughput. This is good for organizations that work under conditions that fluctuate and need security that is correlated with that. The simulation approved the good improvability of the integrated security approach since it maintained the level of work-C as stable and secure when the volume and aggression of threats gradually rose. They complied with the efficiency and flexibility of the integrated security approach in various and concurrent cloud conditions [4].

REAL-TIME SCENARIOS

Scenario 1: This is due to the effectiveness of the invaders, more especially in the disguise of the appearance and the link that belongs to the intended website that is bound to be invaded by the intruders.

Objective: Considering that the given work aims to improve the created system and the ability to reduce the risk of a phishing attack, the presented simulation demonstrates how the system would work in case of a phishing attack.

Description: An attacker performs a phishing attack using email by sending employees the links that contain the getCredentials. The real-time SIEM system, linked to the AI concept, defines suspicious activities from the emails heard and the user's behavior pattern. Subsequently, the system flags the emails and notifies the security personnel, besides sending a response to the sender's IP address to block them. The AI algorithms are more centered on things like multi-mail IDs, which receive the same phishing links, and other activities like log-in attempts, which can be seen once there's an engagement in the mail.

Expected Outcome: The attempt is described more accurately, and the response actions are

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performed within the shortest time possible to avoid the compromise of any credentials. Such inclusion and response lower the probability of compromise and the organization records' security[1].

Scenario 2: Hence, the RAR encompasses several sub-strategies, including the Identification of the Ransomware, Containment of the Ransomware, Eradication of the Ransomware, and Post-Infection

Activity Recovery.
Objective: To specify the system based on working to counter impostors of the ransomware and on its capacity to prevent the incursion of legitimate ones.

Description: An attacker incites ransomware into the network and becomes exigent to archive functions and data for a reward. The SIEM analytic module, in conjunction with the help of ML algorithms, marks the activity related to accessing the files that do not fit inside norms set for it, as well as the case in which multiple write operations are being done simultaneously. An alarm has been sounded, and the improved auto incident response mechanism isolates the PCs involved in the particular network and returned the entire system to the past good state. Updates and ordinary work can cause accidental significant traffic, and real malicious actions, such as ransomware encryption, can also be distinguished by the system's AI.

Expected Outcome: Early determination of the impacted machines and minimizing the outcome and loss using info from other sources. This eliminates any possibility of the one managing to check the emergence of the ransomware, thus reducing the losses incurred in terms of earnings and other related harms [2].

Scenario 3: Based on the results shown in the anonymous form, the most reported threat is Insider threat detection.

Objective: To compare the results of the implemented system to the insider threat detection, the following metrics are pertinent.
Description: An employee attempts to take data by copying it on a diskette or transferring it to another machine. Data transfer is a continuous process in the environment being studied, and behavioral analysis detects any untoward action, which means artificial intelligence and is recognized by the SIEM system. Subsequently, the system detected earlier in the paper creates an alarm for the security team and suspends all the employee's access rights. As mentioned above, these AI models learn from traditional user activities and report the authorized personnel whenever they observe unusual activity – that is, the evidence of an insider threat, such as accessing material with high-security clearance or attempts at bypassing controls.

***Expected Outcome*:** Non-allowance of information leakage and, in fact, their early detection to ensure the main principles of information protection. This is a preventative measure that helps avoid leakage of information and also helps in compliance with the regulations in data security [3].
Scenario 4: The following paper mainly focuses on a subfield of cybersecurity and relates to the organization's capacity to protect against and manage DDoS attacks.

Objective: To evaluate the selected system's effectiveness in identifying and avoiding a Distributed Denial of Service (DDoS) attack.

Description: Among the worst that threaten the organization some of them include A lot of hits aimed at the organization's web servers, thus paralyzing the services in what can be regarded as a Distributed Denial of Services attack. Usually, the SIEM system created with AI's help recognizes this traffic stream. Then, this traffic is sent to the DDoS protection service, and the security personnel are notified. AI models clearly differentiate between high traffic occasioned by the sales or promotions and high traffic occasioned by DDoS attacks.

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Expected Outcome: Reducing the time spent determining that there is a DDoS attack and then cutting the time in which the attack hurts the business. Thus, the quick transmission of malicious traffic through the system maintains the provision of the organization's services and their high speeds [4].

Scenario 5: Unauthorized Access Attempt is the third step performed to get unauthorized access to any system, computer, or network device.

Objective: This process must be evaluated in an environment where attacks can be generated from unauthorized access attempts to test the system's performance in countering these threats.

Description: An attacker creates a vulnerability and tries to exploit the openings known to be feasible in the defense's system. The SIEM system analyses the access logs constantly and then applies machine learning to identify the possible threats in log-in attempts. An alert is raised, and the Automated response system either bans the attacker's IP or notifies the security desk. The system uses AI to track; multiple log-ins, logs in that were done with incorrect details, and logs in from unusual places or places that an employee rarely logs in from.

Expected Outcome: Preventing attempts that may cause breaches that the attackers attempt to make to the system. It helps protect data and maintain System security because response in such endeavors is short [1].

Graphs

Threat Detection Accuracy

Method	Accuracy Rate (%)
Without AI/ML	85
With AI/ML	95

Response Times

Method	Average Response Time (minutes)
Manual Response	15
Automated Response	9

Data Processing Rates

Metric	Value
Event Processing Rate (events/second)	10000
System Latency (seconds)	2

Challenges and Solutions

Challenge 1: Data Overload

Description: Besides the general problems related to the vast amount of data generated and the proliferation of threats, one problem characteristic of the integration of SIEM with other advanced tools, such as AI and ML, for threat detection can be determined. Regarding the multiple sources of data from which the SIEM systems are supposed to analyze the large flows, it poses the threat of overloading the processed data and slowing down the identification and response waves.

Solution: It is possible to overload a usability specialist with the immense data volume; thus, using filter and priority schemes properly is desirable. Concerning the received alerts, AI assists in sorting them according to the potential threat level and the likelihood, which defines which issues need to be solved first. Moreover, incorporating distributed computing and horizontally scalable cloud-based SIEM solutions can better manage considerable data [6].

Challenge 2: False Positives Description:

False positives can also bring a lot of traffic, which is concerning for the security teams. It can also make the efficiency of the given threats detectable. Some examples of false positives include when the legitimate activity is believed to be dangerous and hence a danger, which then leads to many investigations even when it is not a threat.

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Solution: Exclusive modern algorithms such as PFA, which uses optimization from the environment at hand and develops a subsequent version of it, can enhance on few actual positive campaigns, high false positives included. When the system is in operation, it is suggested that context-aware anomaly detection is used and the nature of the algorithms is revised on feedback; this may **improve it in the next stage [7].**

Challenge 3: Integration Complexity
***Description*:** Some challenges may arise when implementing different security tools and technologies into the SIEM system. These may include issues of compatibility that may result from application variations, and even the integration processes turn out to be technical.

***Solution*:** When security tools and applications are built using an open standard and API, there is less of an issue about how to interoperate the various items a firm may be using. Another is to pay attention to the concept of SIEM platform presentation, which seems to come with out-of-the-box integrations and accommodates third-party solutions. In more detail, one must also include constant training and cooperation between the IT and the security departments in the list of measures that can aid in overcoming the problem [8].

Challenge 4: Threats have transformed through the advancement of technology, and general threats have transformed through the emergence of new ones.
Description: it is essential to mention that the main threat constantly evolves, and new threats occasionally appear. Mandatory measures have to be taken, focusing on the SIEM systems employed to ensure the reception of the latest threat intelligence, which would prevent threats.

Solution: Therefore, the stated problem can be resolved with the help of a further learning process concerning AI and ML installations. Because of continuous updates of the models with threat intelligence and integration of real-time data feeds, the SIEM system that is the champion of this chapter stands well-equipped to take on new threats. So, interacting with threat intelligence suppliers and joining information-sharing initiatives can also enhance situational awareness [9].

Challenge 5: The following is one of the main issues blamed on the shortage of talented people:
Description: Proactively qualified cybersecurity talent has been a scarce resource not only for our organization but all over the globe, and this could hamper handling advanced SIEM systems. Some/all of the following declare that it is reasonably challenging and somewhat specific to handle the underlying concepts of SIEM, AI, and ML.

Solution: To develop the required skills in IT, training and developing the human resources already employed in the organizations is essential. The other one is the employment of an MSSP or Managed Security Service Provider as one of the organization's human capital assets. In addition, friendly and user-working technologies integrated into SIEM that embrace automated working can also help reduce the employment of skilled persons in the working procedure [10].

Conclusion
Therefore, the blend of DevOps with other security tools like SIEM, AI & ML quickly becomes a robust methodology for improving security mechanisms in cloud computing systems. Different tests made in this framework and immediate live stimuli make it possible to perceive tangible enhancements in delegate threat identification effectiveness, reaction rates, and data analysis. The experiments they carried out to arrive at the conclusions depicted that the actualization of AI and ML in SIEM systems can significantly enhance the reliability of threat identification, decreasing the chances of failing to identify threats and false alarms. As seen from the above, the following challenges were noted:

Data overload, false positives, Integration issues, changing threat vectors, and lack of skilled workforce. Nonetheless, all these challenges can be solved by adopting the best practices like data filtering, constant progress in AI models, integration interfaces open to interaction, and continuous training sessions. Since hybrid cloud infrastructure is highly compacted by combining some known models, the investigations showed that the scalability and flexibility of such infrastructure were high enough to allow changing workloads and security requirements without a decline in performance. This adaptability is essential for today's various enterprises to ensure their security solutions are robust and elastic enough to counter multiple threats in a fluctuating environment.

SEC+Orchestrated SIEM AI and ML implemented in a DevOps pipeline is a holistic and preventive security mechanism. Therefore, by incorporating the above technologies, organizations can have continuous threat identification and subsequent mitigation, hence a stable and secure cloud environment. In future work, several areas of integrated systems will require more fine-tuning and tailoring to deal with the mentioned challenges; they should also focus on the most recent developments in AI and ML to improve cybersecurity. This will be necessary to continuously develop a strong defense against new and complex threats that organizations experience at the present age.

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