A Framework for the Development of Sharing and Collaboration of Cyber Threat Intelligence for Colleges in Camarines Norte

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The increasing prevalence of cyber threats targeting educational institutions necessitates effective sharing and collaboration of cyber threat intelligence among schools. This research presents a framework designed to facilitate the secure and efficient sharing, storage, analysis, and collaboration of cyber threat intelligence data among schools. The focus of this paper is on the architectural design of the framework, highlighting the key components, integration points, functionalities, and workflows.

The methodology employed in this research involves designing and validating the framework through a systematic approach. The design is underpinned by the Input-Process-Output (IPO) model, which guides the construction of key workflows such as data ingestion, analysis, collaboration, and incident response. The architectural overview of the framework demonstrates its key components and their functionalities. The proposed framework incorporates the Malware Information Sharing Platform (MISP) as the core platform for storing and managing cyber threat intelligence data. Amazon Web Services (AWS) are integrated to enhance scalability, security, and data processing capabilities.

The workflows encompass data ingestion, analysis, collaboration, and incident response processes, showcasing how the framework enables seamless sharing and collaboration among participating schools. The paper discusses the rationale behind the design decisions, emphasizing how the framework addresses the unique challenges faced by schools in managing cyber threats. While the prototype implementation is left for future work, the architectural design and workflows provide a foundation for understanding the framework's structure, functionality, and potential benefits for educational institutions. This research contributes to the field by presenting a comprehensive architectural design and workflows that enable effective sharing and collaboration of cyber threat intelligence among schools, fostering a collective and proactive approach to cybersecurity in the educational sector.

Keywords: Amazon Web Services, Architectural Design, Cyber Threat Intelligence, Collaboration, Information Sharing, Framework, Malware Information Sharing Platform.

1. Introduction

The rapid advancement of digital technology in education has revolutionized teaching and learning methods, making learning more accessible, engaging, and effective [1]. Schools increasingly rely on these technologies for not only teaching and learning, but also for administrative tasks and communication. However, this digital transformation has exposed educational institutions to a myriad of cybersecurity threats [2].

The escalating prevalence of cyber threats targeting schools is of grave concern, as it not only disrupts the educational process but also poses risks to privacy and security. Cyber threats in the educational sector range from phishing and ransomware attacks to more complex, advanced persistent threats (APTs), often aimed at stealing sensitive data or causing disruptive outages [3].

Studies [4], [5] have emphasized the importance of collective and proactive cybersecurity measures. One such measure is the sharing and collaboration of cyber threat intelligence (CTI), which involves collecting, analyzing, and disseminating information about emerging or existing cyber threats to aid in their detection, mitigation, and prevention. This collaborative approach allows for a unified response to threats, promoting a more robust and resilient cybersecurity posture for all participants.

Despite its significance, there is a noticeable lack of efficient frameworks for sharing and collaborating on CTI specifically tailored to the unique needs and challenges of educational institutions. The need for such a framework is increasingly urgent, considering the growing sophistication and frequency of cyber threats targeting schools [2].

Colleges and Universities in Camarines Norte is well known for producing high-quality graduates topping the board examination across different discipline and some were awarded as one of the top performing schools nationwide. At the time of writing, there were no sharing and collaboration of Cyber Threat Intelligence platforms implemented.

Thus, this study aims to bridge this gap with the following objectives:

1. To design a framework that facilitates secure and efficient sharing, storage, analysis, and collaboration of cyber threat intelligence among schools.

2. To describe the architectural design of the proposed framework, highlighting key components, functionalities, and workflows.

3. To explain the rationale behind the design decisions in the context of the unique challenges faced by schools in managing cyber threats.

4. To outline potential future work, including prototype implementation and testing, long-term effectiveness studies, and the potential integration of advanced technologies.

2. Literature Review

Cyber threats targeting educational institutions have grown in frequency and sophistication in recent years, necessitating effective sharing and collaboration of cyber threat intelligence among schools. The literature review highlights existing research, frameworks, and best

practices related to cyber threat intelligence sharing and collaboration in the educational sector, emphasizing the benefits and challenges associated with these initiatives.

Numerous studies emphasize the significance of sharing cyber threat intelligence among educational institutions. [6] stress the importance of collaborative efforts to enhance incident response and threat mitigation in the education sector. Sharing intelligence facilitates timely awareness, enabling schools to proactively defend against evolving cyber threats. Additionally, Smith and McGrew (2019) emphasize that collaborative information sharing among schools enhances collective resilience and reduces duplication of effort in addressing cyber threats [7].

Several frameworks and initiatives have been proposed to facilitate cyber threat intelligence sharing in different sectors. The Structured Threat Information eXpression (STIX) and Trusted Automated eXchange of Indicator Information (TAXII) standards, developed by the OASIS Cyber Threat Intelligence Technical Committee, provide a common language and exchange protocols for sharing threat intelligence [8]. These standards have been widely adopted in the cybersecurity community, demonstrating their effectiveness in facilitating interoperability and collaboration.

In the context of the educational sector, specific frameworks are limited, highlighting the need for tailored solutions. The Cybersecurity Framework for Educational Institutions (CFEI), proposed by Chandra et al. (2020), addresses the unique challenges faced by schools and provides guidance on implementing effective cybersecurity practices [9]. While it emphasizes preventive measures and incident response, it lacks a comprehensive approach to sharing and collaboration of cyber threat intelligence.

Notably, the Malware Information Sharing Platform (MISP) has gained prominence as a valuable tool for sharing cyber threat intelligence. MISP provides a standardized data model and APIs, enabling secure sharing and analysis of indicators of compromise (IOCs) and other threat information [10]. Its flexibility and community-driven development have made it a popular choice for sharing threat intelligence among organizations and communities.

Moreover, the prowess of MISP in supporting real-time threat intelligence sharing is adeptly captured by Harrison (2018), who emphasized its seamless ability to maintain and enact structured, shareable threat information [11]. In parallel, as cyber threat intelligence frameworks seek robust infrastructure backbones, cloud services such as Amazon Web Services (AWS) have become paramount. Singh and Sharma (2020) vouched for the robust capabilities of AWS, underscoring its intrinsic merit in providing ironclad data security, expansive scalable storage, and adeptness in managing large-scale data processing — attributes that make it indispensable for critical applications like threat intelligence [12]. Furthermore, in a thorough comparison of cloud platforms was delineated AWS as the crown jewel in terms of its avant-garde security paradigms [13]. With features such as advanced threat analytics, intricate data encryption, and an astute Identity & Access Management (IAM) mechanism, AWS is aptly poised to uplift a platform's cybersecurity posture.

However, where the synergy of MISP and AWS becomes especially compelling is in the confluence of their individual capabilities to shape an efficient threat intelligence system. Thompson (2019) delved into this synergy, asserting that MISP's flexible architecture, when

hosted on AWS, results in a platform that is both secure and scalable [14]. This sentiment was further amplified by Williams and Brown (2020) who chronicled the triumphant implementation of MISP on AWS for a corporate behemoth, illuminating the seamless marriage between the two platforms [15].

The literature also highlights challenges associated with cyber threat intelligence sharing in the educational sector. These challenges include concerns over data privacy and sharing sensitive information, lack of standardized processes, resource constraints, and the need for trust-building among schools [16].

The gap in the existing research pertaining to cyber threat intelligence sharing and collaboration frameworks tailored specifically for the educational sector. The proposed framework aims to address this gap by leveraging MISP and integrating it with AWS services, providing a comprehensive and tailored solution for sharing and collaborating on cyber threat intelligence among schools. By addressing the unique challenges faced by schools, the framework aims to enhance their collective resilience against cyber threats while adhering to privacy and compliance requirements.

3. METHODOLOGY

To develop the framework for cyber threat intelligence sharing among schools, this research utilized a systematic approach based on the Input-Process-Output (IPO) model. The IPO model is a simple yet effective conceptual model that illustrates the process of transformation from input to output. It has been widely used in information systems research, providing a clear and organized method for process representation and analysis.

The input phase involves the initial collection of cyber threat intelligence data, which includes indicators of compromise (IoCs), threat actors, malware descriptions, and attack patterns among others [17]. It is essential to consider the diverse sources of data in this phase, which include but are not limited to internal systems logs, threat intelligence feeds and shared information from partner schools.

The process phase, in our framework, is facilitated through the integrated platforms of MISP and AWS. The MISP platform, widely recognized for its versatility in managing cyber threat intelligence [18], provides functionalities for storing, categorizing, and analyzing data. Meanwhile, AWS brings in the scalability and security aspects, ensuring the data can be processed effectively and securely [19].

The output phase is where the analyzed and processed data are transformed into actionable intelligence. This includes generating threat reports, alerts, and mitigation strategies, which are then shared and collaboratively used among the participating schools. The ultimate output is the enhanced collective cyber defense capabilities of the participating institutions [20].

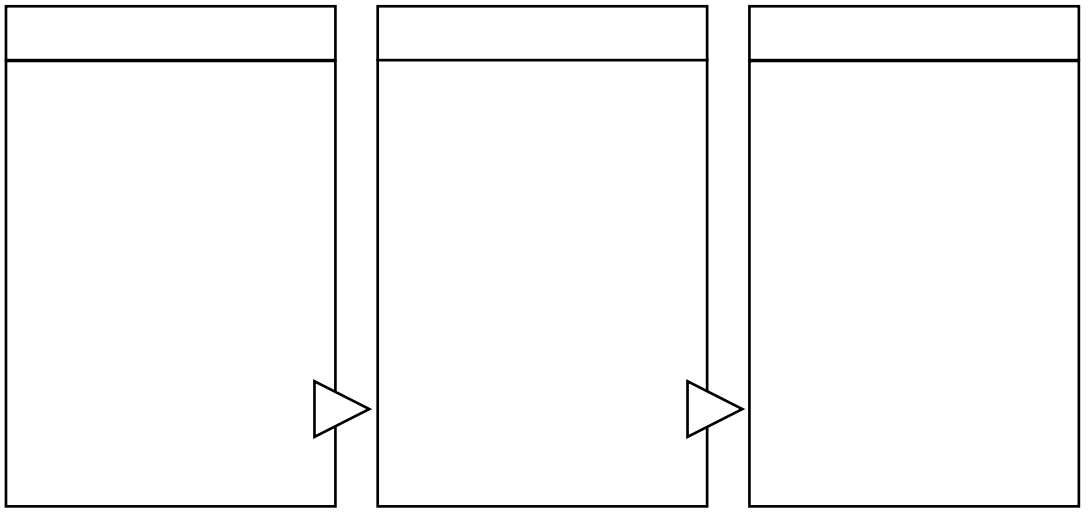

Fig. 1 offers a high-level view of how input data transforms through some process to produce an output. It highlights the key information of the framework.

The validation process is theoretical and conceptual, due to the paper's focus on the design rather than the implementation of the framework. It involves using scenarios and use cases to test the design's efficiency, effectiveness, and ability to respond to the varied and evolving threats faced by schools.

4. FRAMEWORK ARCHITECTURE

The proposed framework for sharing and collaboration of cyber threat intelligence among schools is structured into three primary components: Data Ingestion, Data Processing and Collaboration, and Incident Response. These components are shaped by the Input-Process-Output (IPO) model and anchored by the integrated use of the Malware Information Sharing Platform (MISP) and Amazon Web Services (AWS).

A. Data Ingestion

The data ingestion component represents the input phase of the IPO model. This component is responsible for the acquisition of cyber threat intelligence from a myriad of sources such as internal system logs, threat feeds, and shared intelligence from partner schools. Data is ingested into the MISP platform, which supports a variety of data formats and types, including indicators of compromise (IoCs), threat actors, malware descriptions, and attack patterns [18].

B. Data Processing and Collaboration

Following data ingestion, the data processing and collaboration component takes over, representing the process phase of the IPO model. Here, the ingested data are stored, categorized, and analyzed within the MISP platform. AWS is integrated to facilitate scalable

and secure data processing. Analyzed data are then transformed into actionable intelligence that can be shared and collaboratively used among the participating schools [19].

The collaboration feature of the framework facilitates secure and effective communication among schools, fostering collective defense strategies. It leverages features of MISP and AWS, including encrypted channels, access control, and real-time notifications to enhance the sharing and collaboration of cyber threat intelligence.

C. Incident Response

The incident response component, indicative of the output phase of the IPO model, provides actionable output based on the processed threat intelligence. It includes generating threat reports, alerts, and mitigation strategies that can aid schools in responding to potential cyber threats.

By facilitating the sharing of these outputs among participating schools, the framework enables schools to learn from each other's experiences and to strengthen their proactive approach towards cybersecurity. Incident response strategies become more effective as they are based on shared, analyzed intelligence, leading to enhanced cyber defense capabilities [20].

In summary, the proposed architectural framework is designed to harness the power of shared cyber threat intelligence among schools through a structured, secure, and collaborative platform, promoting a proactive and collective approach to cybersecurity in the educational sector.

5. CONCLUSION

The rapid digitization of the education sector has brought about a surge in cyber threats targeting schools, underscoring the urgent need for robust cybersecurity measures. This research presented a comprehensive architectural design for a framework to facilitate secure and efficient sharing, storage, analysis, and collaboration of cyber threat intelligence among schools. This framework, underpinned by the Input-Process-Output (IPO) model and anchored on the Malware Information Sharing Platform (MISP) and Amazon Web Services (AWS), offers a promising approach towards enhancing the collective cybersecurity posture of educational institutions.

The architectural design of the framework and its workflows provide a structured, scalable, and secure platform for cyber threat intelligence management. The data ingestion, analysis, collaboration, and incident response workflows enable a seamless sharing and collaboration process among participating schools. The rationale behind the design decisions emphasized the framework's ability to address the unique challenges faced by schools in managing cyber threats.

While the implementation of a working prototype has been identified as future work, the design presented in this research provides a foundational blueprint for developing an operational system. Future work will also involve user acceptance and performance testing, long-term effectiveness studies, and exploring the potential integration of advanced technologies such as artificial intelligence and machine learning.

In conclusion, this research contributes to the ongoing efforts to improve cybersecurity in the educational sector. By fostering a collective and proactive approach to cybersecurity, schools can significantly enhance their defense capabilities against the ever-evolving cyber threats. The sharing and collaboration of cyber threat intelligence among schools, as facilitated by the proposed framework, represent a critical step forward in this endeavor.

6. RECOMMENDATION

Although this research provides a comprehensive architectural design and workflows for a framework to facilitate the sharing and collaboration of cyber threat intelligence among schools, the implementation of an operational prototype has been left for future work

The prototype implementation will involve the creation of an actual system based on the architectural design. This will include setting up the MISP platform, integrating AWS services, and building the necessary interfaces for data ingestion, collaboration, and incident response. The implemented system will then need to be configured according to the specific cybersecurity needs and policies of the participating schools.

Moreover, future work should also focus on user acceptance testing, which will assess the usability and practicality of the system from the perspective of the end-users in educational institutions. This will ensure that the system meets the requirements and expectations of the users, and that any necessary adjustments can be made.

In addition to this, performance testing should be performed to evaluate the scalability and efficiency of the framework, particularly in scenarios with high volumes of data. This will ascertain whether the system can handle significant amounts of threat intelligence data without compromising its performance or security.

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