“A SECURE FEDERATED INTRUSION DETECTION MODEL WITH BLOCKCHAIN AND DEEP BIDIRECTIONAL (LSTM)”

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Abstract: Several specialists have suggested using Machine Learning (ML) methods to create Intrusion Detection Systems (IDMs) in order to enhance the security of computing and network resources. Machine Learning replicates human cognitive skills by modeling deduction, inference, extrapolation, and synthesis. The use of this technology might be employed to construct Intrusion Detection Systems (IDMs), thereby facilitating accurate detection of harmful network traffic, resulting in a reduction in false positive alarms. Support Vector Machines (SVM), Decision Trees (DT), Bayesian Networks, and Naïve Bayes are often used machine learning techniques for creating Intrusion Detection Systems (IDMs). Nevertheless, the aforementioned conventional machine learning (ML) techniques prioritize the labor-intensive process of designing features and are less effective when confronted with vast amounts of data that need categorization in a real-world setting. As the amount of the dataset increases, the accuracy of many categorization jobs decreases. To address the difficulties in analyzing large amounts of data that classical machine learning (ML) algorithms face, deep learning (DL) methods are used to enhance the efficiency of intelligent data mining (IDM), particularly in situations involving many classes.

An intrusion refers to any illegal action that results in damage to a computer system or network, with the potential to jeopardize the confidentiality, integrity, or availability of information. Intrusion detection models are often integrated into software programs to monitor networks or computers for malicious activity in order to maintain system security [10]. As a proactive solution, IDM detects and halts possible risks to a system or network before they may do harm, including both hostile insiders and external hackers.

INTRODUCTION

Cloud computing has arisen as a solution to the need for computation services that can be accessed and used in a similar way to utilities such as electricity and water. Cloud computing enables the delivery of IT services to remote places over the Internet. In this method, individuals make use of the computing capabilities offered by Cloud Service Providers (CSP) and are charged based on their actual use, rather than paying a fixed amount in advance or entering into long-term agreements. By purchasing and using computational power on a pay-per-use basis, the fees associated with acquiring capital goods may be transformed into ongoing operating costs. Shared resources in the realm of cloud computing include processing and storage resources, software applications, operating systems, and network infrastructures. Businesses and consumers may access cloud services via many means such as social media, email, web application hosting, and more. Cloud storage systems such as AWS, Microsoft Azure Blobs, and Google Cloud Storage are extensively used by many cloud vendors and may be accessed from several devices. More than $1 trillion has already been allocated to cloud-based computing, either via active investment or passive funding. The advantages of cloud computing technology include scalability, allocation of resources according to demand, reduced administrative burden, a flexible pricing model (pay-as-you-go), and simplified application development and deployment. Establishing large data centers entails exorbitant initial costs. Smaller organizations may try to achieve a similar scale effect by forming federations of computing and storage services. Cloud federation supports three primary interoperability elements: resource migration, resource redundancy, and the aggregation of complementary resources or services. It involves aggregating services from several providers into a single pool [6]. The main cloud service types are Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS). IaaS offers virtualized resources for computing, storage, and networking. Platform-as-a-Service (PaaS) offers a framework for creating, developing, launching, and overseeing software applications. On the other hand, Software-as-a-Service (SaaS) allows end users to access programs without the need for physical installation on their machines. The numbers 2, 4, 7, and 8 are listed. With the progression of technology, there has been a noticeable increase in the frequency of hacking occurrences. The proliferation of security vulnerabilities has emerged as a significant obstacle in our intricate technological landscape. Cloud providers and consumers often report instances of attacks [9]. Identifying cyber risks in cloud computing is a costly and time-consuming process due to their growing complexity. Active Intrusion Detection Systems or Models (IDS/M) are crucial for preventing and securing Information Technology (IT) cloud infrastructure and operations [2].

Recently, blockchain technology has become prevalent in all aspects of Information and Communication Technology (ICT), and its use has grown. The rise in the value of cryptocurrencies and substantial venture capital investments in blockchain start-up firms have generated interest in the advancement of this technology [16], [17]. Blockchain primarily functions as a ledger, recording and sharing all transactions conducted by participating peers with all participants. As additional blocks are added over time, the size of this blockchain continues to grow. Commonly used cryptocurrency blockchains are accessible to the public, and transactions may be examined using online platforms like blockchain.com, enabling anybody to inquire about the blockchain transactions. Blockchain allows participants to engage in commercial transactions without the need for a trusted intermediary [17], [18].

LITERATURE REVIEW

Talaei Khoei and Kaabouch [11] devised an innovative approach focused on identifying outliers to detect zero-day intrusions. The main goal was to develop an advanced Intrusion Detection System (IDS) model capable of accurately detecting zero-day assaults with a high level of accuracy. The model's performance was assessed using the CICIDS2017 and NSL-KDD datasets, revealing detection accuracies of 90.01% for DoS (GoldenEye), 98.43% for DoS (Hulk), 90.01% for port scanning, and 99.67% for DDoS assaults. Sharafaldin et al. [38] introduced the Hierarchical Deep Learning System based on Big Data (BDHDLS). The BDHDLS utilizes behavioral and content features to understand the characteristics of network traffic and the information included in the payload. Each deep learning model in the Big Data High-Dimensional Learning System (BDHDLS) is designed to learn the unique data distribution inside a particular cluster. This technique enhances the detection rate of intrusive assaults in comparison to previous methods that used just one learning model. The model underwent training using the Information Centre of Excellence for Tech Innovation (ISCX) Intrusion Detection Assessment dataset (ISCXIDS2012) and obtained a remarkable accuracy rate of 99.5%. Lee et al. [39] created a framework for adaptive ensemble learning. The authors devised a multi-tree technique by adjusting the quantity of training data and creating many decision trees. The researchers used several fundamental classifiers, including Decision Trees, Random Forests, K-Nearest Neighbors (KNN), and Deep Neural Networks (DNN), in order to create an ensemble adaptive voting method that improves the overall detection performance. The authors used the NSL-KDD dataset to authenticate and verify the effectiveness of their suggested methodology. The multi-tree approach achieved an accuracy of 84.2%, whilst the adaptive voting system achieved an accuracy of 85.2% based on their results. The researchers in [40] introduced a network intrusion detection model that utilizes the Convolutional Neural Network (CNN) approach. The model autonomously extracts the salient features of incursion samples, enabling accurate categorization. It utilizes convolution and pooling methods to enhance the extraction of feature correlations within the data. The evaluation using the KDD99 datasets demonstrated that the suggested model attained a precision rate of 99.23%. Ring et al. [41] introduced a network intrusion detection model based on a CNN–IDS. The CNN model was used to automatically extract data characteristics that had been decreased in dimensionality. The authors used a standard KDD-CUP99 dataset to assess the performance of the CNN model. Based on the results, the CNN model achieved an accuracy of 94%, a Detection Rate of 93%, and a False Alarm Rate of 0.5%. The authors in [42] created a novel Intrusion Detection System (IDS) that combines different classifier methods using decision tree and rule-based algorithms. These algorithms include the Reduced Error Pruning (REP) tree, Repeated Incremental Pruning (RIP) algorithm, and Forest by Penalizing Attributes (Forest PA) algorithm. The purpose of this IDS is to detect and classify suspicious activity. The first and second algorithms were used to classify benign network traffic by using the dataset's attributes as inputs. The third classifier takes into account the characteristics of the original dataset and uses the outcomes of the first and second classifiers as inputs. The suggested Intrusion Detection System (IDS) model achieved an accuracy of 96.67%, a detection rate of 94.48%, and a false positive rate of 1.15% on the CICIDS2017 dataset. The model was trained for 195.5 seconds and tested for 2.27 seconds. Chattopadhyay et al. [43] introduced an Intrusion Detection System (IDS) that utilizes Core Vector Machines (CVM), which is a classifier based on data mining. When compared to Support Vector Machine (SVM) and ensemble classifiers, it exhibits a reduced false positive rate and requires less processing resources. The classifier underwent training and testing using the KDDCup'99 dataset. The evaluation findings indicate a detection rate of 99% and a false positive rate of 27%. Shen et al. [45] introduced a Genetic approach (GA) and Support Vector Machine (SVM) based approach for detecting intrusions in a human-controlled Intrusion Detection System (IDS). By using the crossover and mutation probabilities of GA as a baseline, the authors enhanced both the effectiveness of the population search and the capacity of people to exchange information. The algorithm's convergence time and SVM training speed were improved.

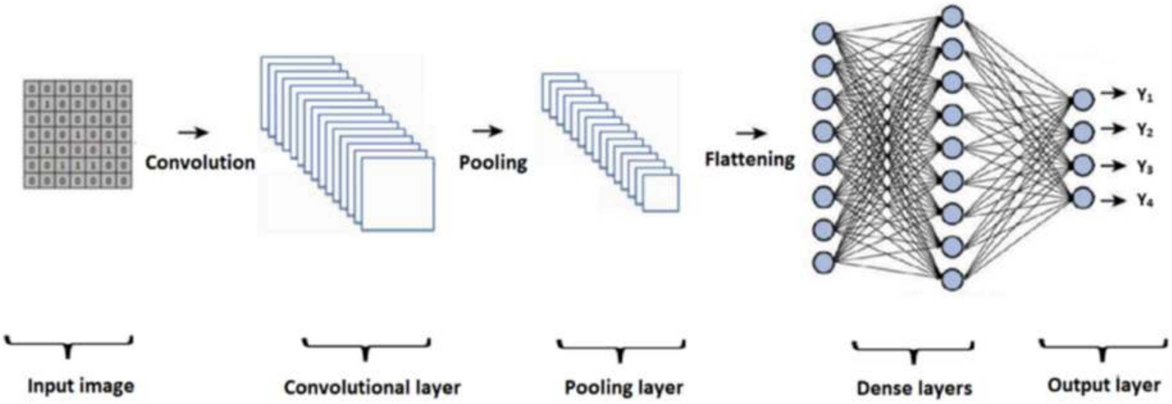
PROPOSED SYSTEM:

This project proposes a Secure Federated Intrusion Detection Model (SecFedIDM-V1). The model uses Bidirectional Long Short-Term Memory (LSTM), a deep learning algorithm, to detect and classify malicious activities on the network by monitoring incoming network packets. The details of the packets classified as malicious are stored in a blockchain ledger in a private network where only certified nodes can access it, and the ledger serves as a signature database.

CNN Architecture, Process & Inputs

Architecture:

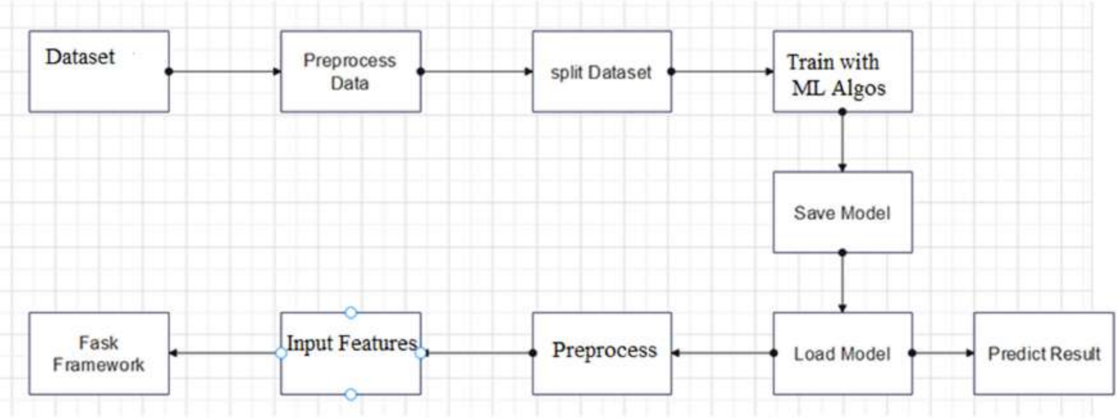
CNNs contain a combination of layers which transform an image into output the model can understand.

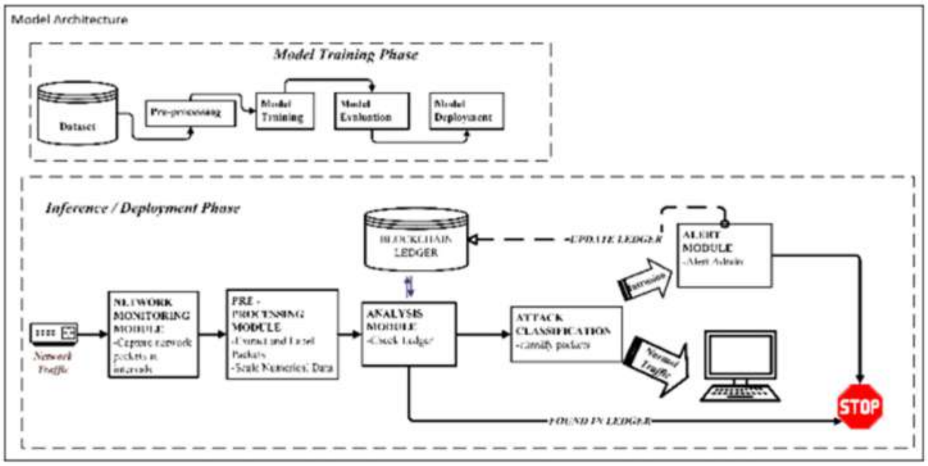


- Convolutional layer: creates a feature map by applying a filter that scans the image several pixels at a time
- Pooling layer: scales down the information generated by the convolutional layer to effectively store it
- Fully connected input layer: flattens the outputs into a single vector

SYSTEM ARCHITECTURE

A system architecture or systems architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system. Organized in a way that supports reasoning about the structures and behaviors of the system.


Dataset
Preprocess Data
split Dataset
Train with ML Algos
Save Model
Fask Framework
Input Features
Preprocess
Load Model
Predict Result


Model Architecture
Model Training Phase
Dataset
Pre-processing
Model Training
Model Evaluation
Model Deployment
Inference / Deployment Phase
Network Traffic
NETWORK MONITORING MODULE -Capture network packets at intervals
PRE - PROCESSING MODULE -Extract and Label Packets -Scale Numerical Data
BLOCKCHAIN LEDGER
ANALYSIS MODULE -Check Ledger
ATTACK CLASSIFICATION -classify packets
UPDATE LEDGER
ALERT MODULE -Alert Admin
Intrusion
Normal Traffic
FOUND IN LEDGER
STOP

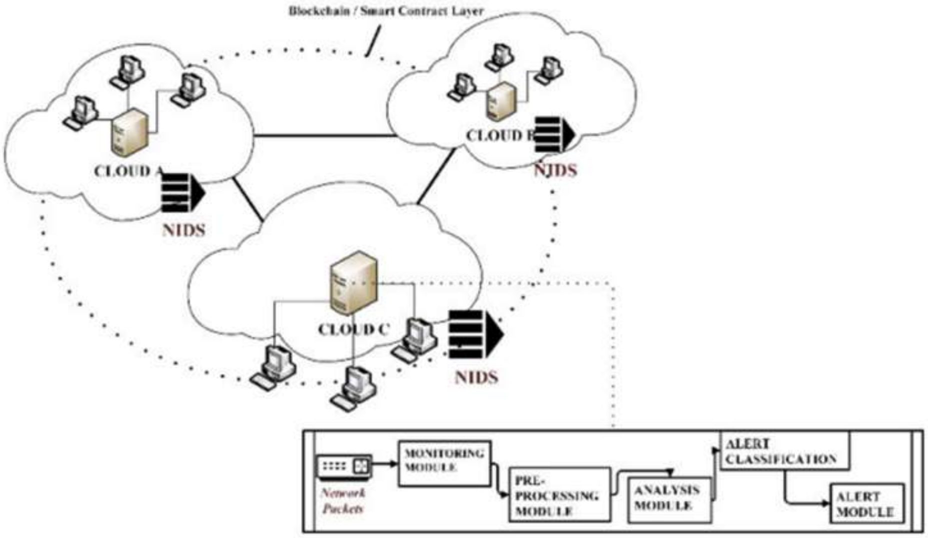
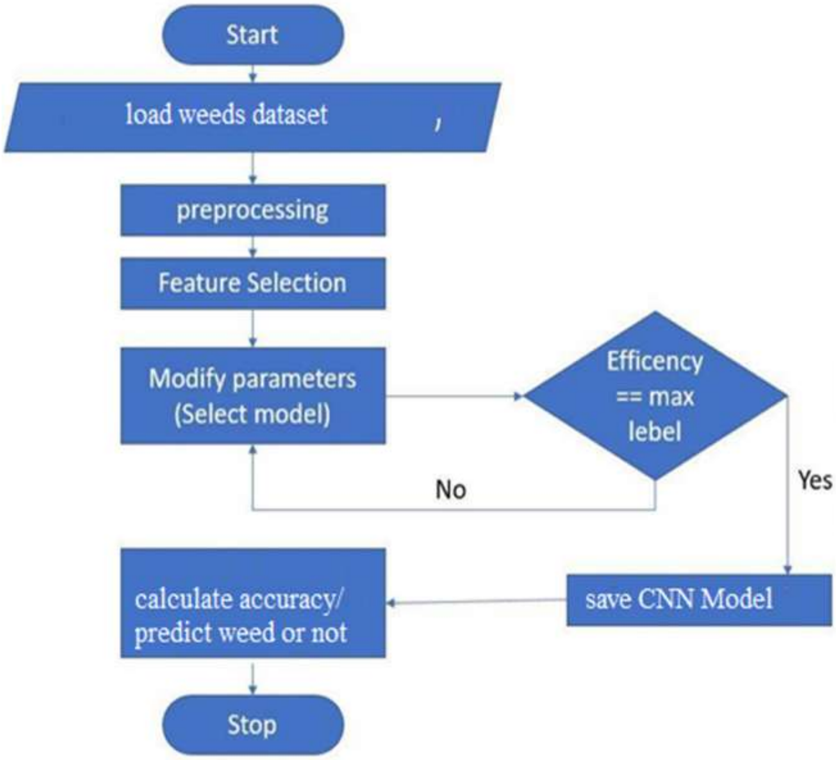


Figure 5. 1 System Architecture

3-Tier Architecture:

The three-tier software architecture (a three-layer architecture) emerged in the 1990s to overcome the limitations of the two-tier architecture. The third tier (middle tier server) is between the user interface (client) and the data management (server) components. This middle tier provides process management where business logic and rules are executed and can accommodate hundreds of users (as compared to only 100 users with the two tier architecture) by providing functions such as queuing, application execution, and database staging.

FLOW CHART:



A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

implementation

To conduct studies and analyses of an operational and technological nature, and To promote the exchange and development of methods and tools for operational analysis as applied to defense problems.

System testing

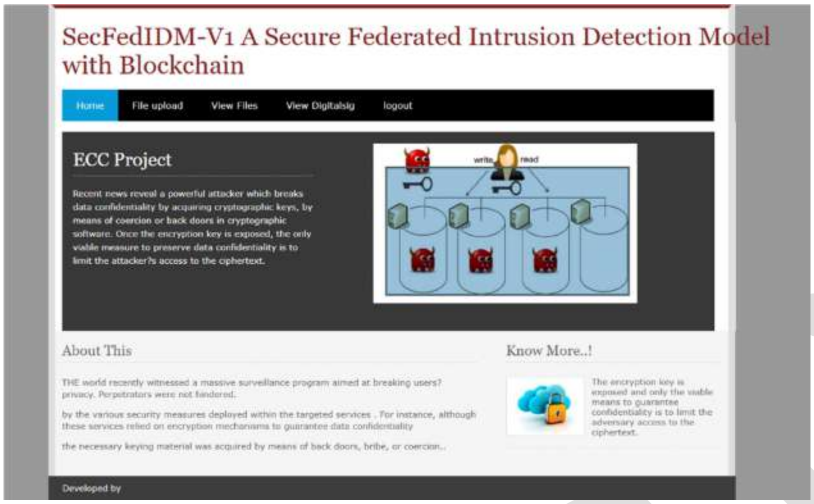
Testing is the debugging program is one of the most critical aspects of the computer programming triggers, without programming that works, the system would never produce an output of which it was designed. Testing is best performed when user development is asked to assist in identifying all errors and bugs. The sample data are used for testing. It is not quantity but quality of the data used the matters of testing. Testing is aimed at ensuring that the system was accurately an efficiently before live operation commands.

Testing objectives:

The main objective of testing is to uncover a host of errors, systematically and with minimum effort and time. Stating formally, we can say, testing is a process of executing a program with intent of finding an error.

Output Screens

9.1 PROGRAM EXECUTION OUTPUT SCREEN



SecFedIDM-V1 A Secure Federated Intrusion Detection Model with Blockchain

ECC Project

Recent news reveal a powerful attacker which breaks data confidentiality by acquiring cryptographic keys, by means of coercion or back doors in cryptographic software. Once the encryption key is exposed, the only viable measure to preserve data confidentiality is to limit the attacker?s access to the ciphertext.

About This

THE world recently witnessed a massive surveillance program aimed at breaking users? privacy. Perpetrators were not hindered.

by the various security measures deployed within the targeted services . For instance, although these services relied on encryption mechanisms to guarantee data confidentiality

the necessary keying material was acquired by means of back doors, bribe, or coercion..

Know More..!

The encryption key is exposed and only the viable means to guarantee confidentiality is to limit the adversary access to the ciphertext.

Developed by

9.2 PACKET TRACKING INTERFACE

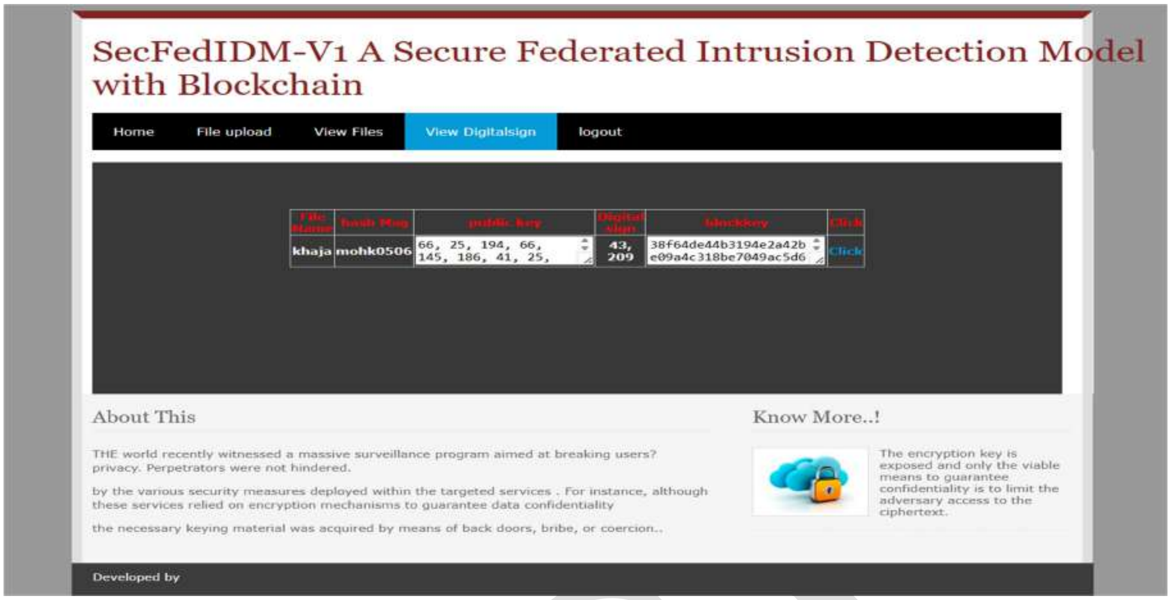
Packet Tracking Using Machine Learning Packet tracking is a critical component of network security, particularly in the context of intrusion detection systems (IDS). The objective of packet tracking is to monitor network traffic, analyze the packets transmitted over the network, and detect any anomalies or malicious activities. Leveraging machine learning for packet tracking enhances the ability to identify sophisticated and evolving cyber threats. Here, we outline the theoretical foundation of using machine learning for packet tracking

1. Introduction to Packet Tracking

Packet tracking involves capturing and analyzing the data packets that travel across a network. Each packet contains metadata and payload information, which can provide insights into the nature of the traffic and potential security threats. In traditional systems, rule-based methods are used to detect known threats, but these systems often fail to identify novel or evolving attacks.

1. **Machine Learning for Anomaly Detection**

Machine learning algorithms are well-suited for identifying patterns and anomalies in large datasets. In the context of packet tracking, machine learning can be employed to: Detect unusual patterns: By analyzing packet headers and payloads, machine learning models can identify deviations from normal traffic patterns, indicating potential intrusions.Classify packets: Supervised learning techniques can be used to classify packets as benign or malicious based on labeled training data.Predict future attacks: By learning from historical data, machine learning models can predict and preemptively identify potential future threats


SecFedIDM-V1 A Secure Federated Intrusion Detection Model with Blockchain

File Name	hash Msg	public key	Digital sign	blockkey	Click
khaja	mohk0506	66, 25, 194, 66, 145, 186, 41, 25,	43, 209	38f64de44b3194e2a42b e09a4c318be7049ac5d6	Click

About This

THE world recently witnessed a massive surveillance program aimed at breaking users? privacy. Perpetrators were not hindered.

by the various security measures deployed within the targeted services . For instance, although these services relied on encryption mechanisms to guarantee data confidentiality

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Know More..!

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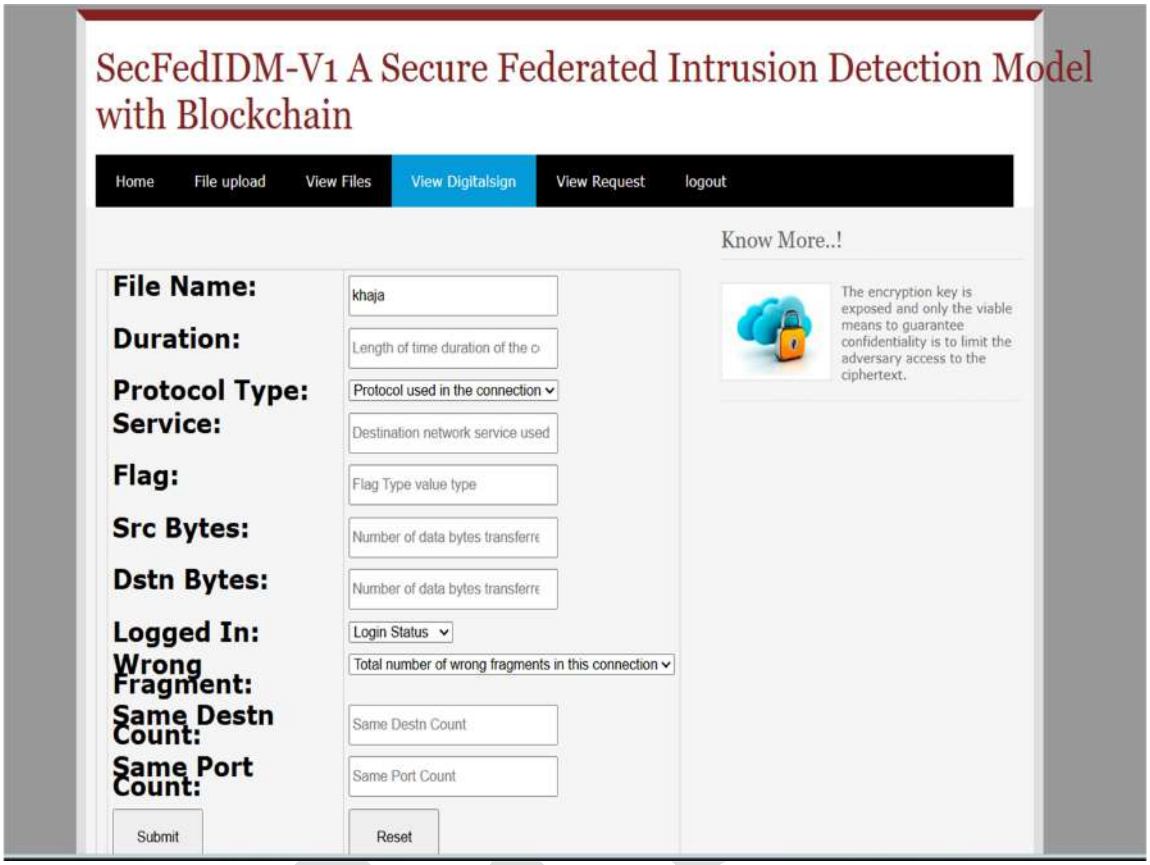
In modern network security, Intrusion Detection Systems (IDS) are crucial for identifying and mitigating unauthorized access and attacks. Traditional IDS methods often fall short in addressing the complexity and sophistication of contemporary cyber threats. This project presents an advanced approach by integrating machine learning, specifically

Deep Bidirectional Long Short-Term Memory (BiLSTM) networks, with blockchain technology in a federated learning environment to enhance intrusion detection capabilities.Packet tracking is a key component of network monitoring and security. It involves the continuous monitoring and analysis of data packets transmitted over a network to identify anomalies and potential security threats. Each data packet carries essential information such as source and destination addresses, protocol types, payload data, and timestamps. Analyzing these packets can reveal suspicious activities and potential intrusions.Machine learning, especially deep learning, offers powerful tools for recognizing patterns and detecting anomalies in large datasets.

In this project, a BiLSTM network is utilized for its superior ability to handle sequential data and capture temporal dependencies, which is crucial for analyzing network packets. Unlike standard Recurrent Neural Networks (RNNs), BiLSTMs process input data in both forward and backward directions, allowing the model to consider both past and future context in its predictions. This dual perspective enhances the model’s capability to detect complex patterns and anomalies within packet data.



SecFedIDM-V1 A Secure Federated Intrusion Detection Model with Blockchain

File Name:	khaja
Duration:	Length of time duration of the c
Protocol Type:	Protocol used in the connection
Service:	Destination network service used
Flag:	Flag Type value type
Src Bytes:	Number of data bytes transferre
Dstn Bytes:	Number of data bytes transferre
Logged In:	Login Status
Wrong Fragment:	Total number of wrong fragments in this connection
Same Destn Count:	Same Destn Count
Same Port Count:	Same Port Count

Know More..!

The encryption key is exposed and only the viable means to guarantee confidentiality is to limit the adversary access to the ciphertext.

Federated learning is employed to enable the training of machine learning models across multiple decentralized devices without requiring the transfer of raw data to a central server. This approach significantly enhances privacy and security, as sensitive data remains local and only model updates are shared. Federated learning allows multiple organizations to collaboratively improve the intrusion detection model while maintaining data privacy and security.to ensure the integrity and security of the federated learning process, blockchain technology is integrated.

Blockchain provides a transparent and tamper-proof ledger where each model update is recorded. This integration addresses potential trust and reliability issues in federated learning environments, ensuring that the collaborative learning process remains secure and trustworthy.the packet tracking interface is a critical element of the ids in this project.

It provides a real-time view of network traffic and highlights detected anomalies. The interface tracks and displays key packet attributes, including packet size, time intervals, protocol types, source and destination addresses, and payload data. These attributes are essential for analyzing network traffic and identifying potential threats.the anomaly detection process involves the continuous analysis of incoming packets using the bilstm model, which has been trained through federated learning. The process includes data preprocessing to extract relevant features and normalize the data, feature extraction to identify key attributes from each packet, and model inference where the bilstm network processes the extracted features.

The model compares these features to learned patterns of normal and malicious traffic, identifying packets that significantly deviate from normal patterns as potential threats. Detected anomalies trigger alerts, prompting further investigation or automated mitigation actions

CONCLUSION

In modern times, cloud federation has gained usage among Cloud Service Providers (CSP) as a means of sharing computational resources for better service delivery. However, with the increase in malicious activities and cyber-attacks, the need for secure transactions and communication between federated entities becomes critical. This study presents a BiLSTM-based IDS model for a federated cloud platform named SecFedIDM-V1. Firstly, we developed a cloud federation testbed using openstack. Secondly, we experimentally evolved an IDS model using CIDDS dataset with BiLSTM RNN giving the best performance metrics for intrusion traffic detection on an OpenStack-based federated cloud testbed. Thirdly, in order to enhance the security of the proposed architecture, we integrated a blockchain to serve as a secure datastore for intrusion signatures. In order to make the model usable for cloud system administrators, we developed a cloud native web application that incorporates the proposed BiLSTM IDS model. As a proof of concept, we illustrated how different classes of malicious traffic could be detected with high precision from the cloud application. The web app could be deployed on other experimental or production-federated cloud platforms to detect malicious intrusions.

Future scope:

In the future, we hope to extend the architecture as well as the web application by covering novel and higher number of network attack classes..

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