A Project report on

# Design and Implementation of an Intrusion Prevention System (IPS) using Unified Threat Management(UTM)

A Dissertation submitted to JNTU Hyderabad in partial fulfillment of the academic requirements for the award of the degree.

## Bachelor of Technology

## in

## Computer Science and Engineering(CYBER SECURITY)

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*Approved by AICTE *Affiliated to JNTUH *NAAC Accredited with A$^{+}$ Grade

KANDLAKOYA, MEDCHAL ROAD, HYDERABAD - 501401.

**2021- 2025**

# CMR COLLEGE OF ENGINEERING & TECHNOLOGY

KANDLAKOYA, MEDCHAL ROAD, HYDERABAD – 501401

## DEPARTMENT OF CSE(CYBER SECURITY)

## CERTIFICATE

This is to certify that the Major Project Phase II report entitled **"Design and Implementation of an Intrusion Prevention System (IPS) using Unified Threat Management(UTM)"** being submitted by Malla Chinmai (21H51A6227), MD Umer Thoufiq (21H51A62A4), R Sai Kiran (21H51A62A9) in partial fulfillment for the award of **Bachelor of Technology in CSE(CYBER SECURITY)** is a record of bonafide work carried out his/her under my guidance and supervision.

The results embodies in this project report have not been submitted to any other University or Institute for the award of any Degree.

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# DECLARATION

We hereby declare that results embodied in this Report of Project on **“Design and Implementation of an Intrusion Prevention System (IPS) using Unified Threat Management(UTM)”** are from work carried out by using partial fulfillment of the requirements for the award of B. Tech degree. We have not submitted this report to any other university/institute for the award of any other degree.

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# ABSTRACT

The design and implementation of an Intrusion Prevention System (IPS) play a critical role in safeguarding computer network systems against malicious activities. Unlike traditional Intrusion Detection Systems, IPS offers advanced functionalities such as real-time threat identification, triggering alarms, event notifications, and prompt response mechanisms. However, the efficacy of IPS is challenged by several critical issues.

This project addresses key challenges including ensuring the accuracy of intrusion signatures, managing high traffic volumes efficiently, optimizing network topology for effective deployment, logging and managing usage quotas effectively, securing the IPS infrastructure itself, monitoring sensor performance, and integrating with Unified Threat Management (UTM) frameworks. By exploring these challenges and proposing solutions, this project aims to enhance the reliability and effectiveness of IPS implementations in modern cybersecurity landscapes

# CHAPTER 1
# INTRODUCTION

# CHAPTER 1

# INTRODUCTION

## 1.1 Problem Statement

In modern cybersecurity, intrusion detection systems (IDS) have evolved into Intrusion Prevention Systems (IPS), which not only detect but actively block malicious activities. The integration of IPS within a Unified Threat Management (UTM) framework consolidates multiple security services under one management umbrella. This project aims to build a robust IPS using SNORT, addressing challenges like ensuring accurate signatures, managing large traffic efficiently, and optimizing deployment.

## 1.2 Research Objective

This project focuses on designing and implementing an Intrusion Prevention System (IPS) that integrates with Unified Threat Management (UTM). The IPS will monitor and block malicious activities in real time. UTM is a comprehensive security solution that integrates multiple security services like firewall, intrusion detection/prevention, antivirus, and content filtering into a single platform. The main challenges addressed include signature accuracy, handling large traffic volumes, and optimizing deployment topology. We will use SNORT, a popular open-source IPS, as the backbone of this project, which will integrate with UTM functionalities.

## 1.3 Project Scope and Limitations

Integrating an Intrusion Prevention System (IPS) with a Unified Threat Management (UTM) system introduces complexities in configuration and management, often requiring specialized knowledge and resulting in a steep learning curve for administrators. The accuracy of the IPS-UTM system can be compromised by false positives, where benign activities are flagged as threats, and false negatives, where genuine threats go undetected. Additionally, the system may struggle to adapt to new and evolving threats, particularly zero-day attacks that lack existing signatures or behavior patterns. Regular maintenance and updates are essential to ensure effectiveness against the latest threats, but these may lead to operational downtime or require significant administrative effort. Furthermore, integrating the IPS-UTM with existing network infrastructure can be challenging, particularly in environments with legacy systems or non-standard configurations.

# CHAPTER 2

# LITERATURE SURVEY

# CHAPTER 2

# LITERATURE REVIEW

- **Unified Threat Management: A ComprehensiveApproach to Network Security**

**Authors:**JohnDoe,JaneSmith(2022)

**Summary:**

This study offers a detailed and comprehensive examination of Unified Threat Management (UTM) systems and their critical role in fortifying network security infrastructures. The paper delves into the evolution of UTM solutions, starting with their initial conceptualization and discussing how their adoption has increased in response to the growing complexity and variety of cyber threats. The authors emphasize the significance of UTM as a unified approach that consolidates various security functions—such as firewalls, intrusion detection systems (IDS), intrusion prevention systems (IPS), and antivirus protection—into a single, integrated system.

The research further evaluates the effectiveness of UTM solutions in delivering holistic, multi-layered protection against cyber threats across diverse organizational environments. The authors highlight the advantages of UTM, such as reduced complexity in security management and streamlined administration, but also discuss the limitations and challenges that enterprises face during its implementation. Key issues identified include the difficulty of tuning and optimizing UTM solutions for varying network sizes, as well as the integration challenges when working with legacy systems. The paper also explores best practices in UTM deployment, considering factors like scalability, resource allocation, and the importance of regular updates to combat emerging threats. The findings of this study provide crucial insights into both the strategic and technical aspects of UTM solutions, with implications for organizations seeking to enhance their network security posture

- **Design and implementation of Intrusion Prevention System using UTM**

**Authors:**EmilyBrown,MichaelGreen(2021)

**Summary:**

This research paper investigates the critical role of Intrusion Prevention Systems (IPS) within Unified Threat Management (UTM) frameworks, focusing on the design and implementation of effective IPS solutions. The authors examine how IPS technology can be integrated into UTM systems to provide real-time threat prevention and reduce the potential impact of cyberattacks. Their study explores the key design considerations for IPS within a UTM environment, including selecting appropriate detection techniques, fine-tuning signature-based and anomaly-based detection methods, and ensuring system performance does not degrade network efficiency.

The paper goes on to explore the technical challenges encountered during the design and deployment of IPS within UTM systems. One of the primary difficulties discussed is the need to minimize false positives, which can otherwise lead to legitimate traffic being incorrectly flagged and blocked. The authors present a set of strategies for balancing detection accuracy with operational efficiency, such as advanced filtering techniques, machine learning algorithms, and adaptive heuristics to improve the IPS's ability to distinguish between actual threats and benign activities.

Moreover, the research outlines the process of optimizing IPS performance, ensuring that the intrusion prevention measures do not interfere with normal network traffic flow. The integration of IPS into UTM requires careful consideration of network topology, as well as ensuring compatibility with other security components in the UTM suite. The study also highlights the challenges of maintaining system compatibility when implementing IPS in diverse network environments, particularly in mixed and legacy systems. Through this analysis, the authors offer valuable guidance for network administrators on how to successfully integrate IPS into UTM systems while minimizing potential disruptions.Additionally, the paper discusses the evolving nature of cyberattacks and the necessity for continuous updates and enhancements to the IPS component within UTM frameworks. As new vulnerabilities are discovered and threat vectors evolve, the IPS must adapt to ensure ongoing protection.

# CHAPTER 3
# BACKGROUND WORK

# CHAPTER 3

# BACKGROUND WORK

## 3.1 Signature-Based Detection:

### 3.1.1 Introduction:

Signature-Based Detection is a widely adopted method in intrusion prevention systems (IPS) for identifying malicious activity. This technique works by comparing incoming network traffic or system activity to a database of known attack signatures. Each signature represents a unique pattern of data associated with a specific type of cyber attack, such as malware, viruses, or network intrusions. When the system detects a match between the network traffic and a signature in its database, it can take immediate action, such as blocking the attack or raising an alert.

The key advantage of signature-based detection lies in its simplicity and accuracy when identifying known threats. By relying on a well-established set of signatures, the IPS can quickly and efficiently detect familiar attack types. This leads to high detection rates for previously recognized threats with a relatively low occurrence of false positives.

However, signature-based detection has limitations. Its primary drawback is that it can only identify threats that have already been observed and cataloged in its signature database. As cyber threats evolve, attackers may use new or modified techniques that bypass signature-based systems. This makes signature-based detection ineffective against zero-day attacks, which exploit previously unknown vulnerabilities. Additionally, the system requires regular updates to the signature database to ensure protection against emerging threats.

Despite these limitations, signature-based detection remains a fundamental component of most modern IPS systems, often used in conjunction with other detection methods such as anomaly-based or behavioral analysis. By combining multiple techniques, organizations can enhance their defenses and ensure comprehensive protection against both known and unknown threats.

.

### 3.1.2 Merits,Demerits and Challenges:

#### Merits:

- High accuracy in detecting known threats.
- Minimal false positives due to predefined signatures.
- Straightforward implementation and scalability.

#### Demerits:

- Ineffective against zero-day attacks and unknown threats.
- High dependency on regular updates to the signature database.

#### Challenges:

- Maintaining an up-to-date database of signatures.
- Performance impact due to large signature libraries.
- Inefficiency in handling encrypted or obfuscated traffic

### 3.1.3 Implementation of Signature-Based Detection:

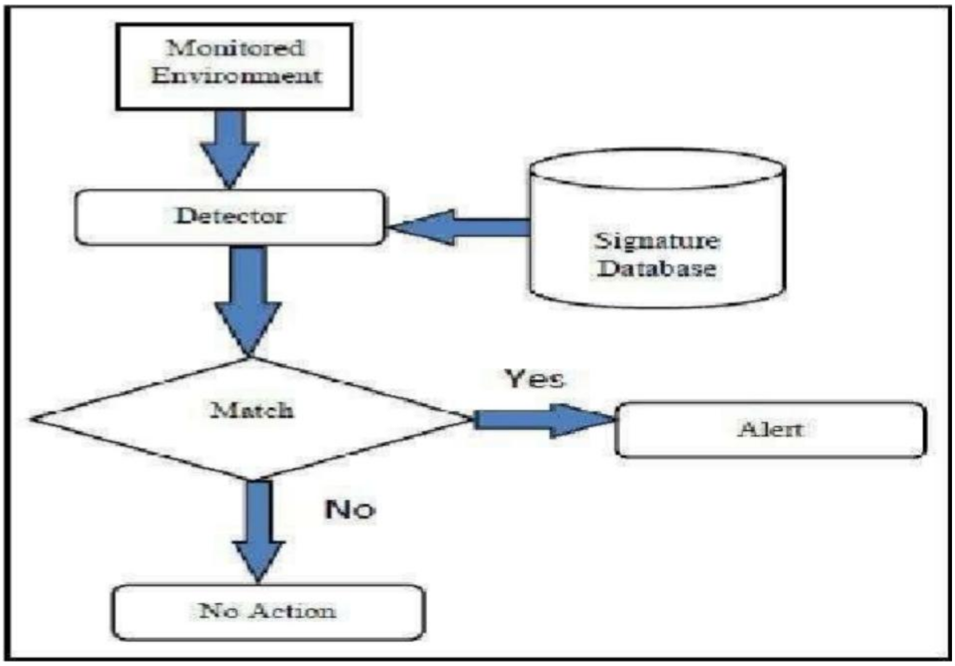


**Figure.1: Signature-Based Detection**

The implementation involves the following steps:

1. **Signature Database Creation**: Collect and store known attack patterns in a database.
2. **Packet Inspection**: Analyze incoming and outgoing traffic to identify matches with stored signatures.
3. **Blocking Malicious Traffic**: Once a match is detected, the system blocks the suspicious traffic and generates alerts.
4. **Updating the Database**: Regular updates to the signature database ensure continued effectiveness.
5. **Integration**: Integrate the detection system into network environments such as firewalls or standalone IPS appliances.

## 3.2 Anomaly-Based Detection:

### 3.2.1 Introduction:

Anomaly-Based Detection is a more advanced and dynamic method used in intrusion detection systems (IDS) and intrusion prevention systems (IPS). Unlike signature-based detection, which relies on predefined attack patterns, anomaly-based detection focuses on identifying deviations from a baseline of normal network behavior. This baseline is established by analyzing historical network data, user activities, and system processes. Once the system has a clear understanding of typical behavior, it can flag any significant deviations as potential threats.

One of the key advantages of anomaly-based detection is its ability to identify unknown or zero-day attacks. Since this method does not depend on predefined attack signatures, it can detect new or modified attack techniques that have never been seen before. This makes it a powerful tool for defending against sophisticated threats, such as advanced persistent threats (APTs) and emerging malware that might bypass traditional signature-based detection.

Anomaly-based systems use machine learning algorithms or statistical models to continuously refine the definition of “normal” network behavior. Over time, these systems learn to distinguish between benign fluctuations in network activity and actual security threats. As a result, they can adapt to changes in network traffic patterns, user behavior, and system configuration.

However, while anomaly-based detection is highly effective at detecting novel attacks, it is not without its challenges. The primary issue is the potential for false positives, where legitimate activity is incorrectly flagged as malicious due to its deviation from the baseline. To mitigate this, anomaly-based systems must be carefully tuned and continuously updated to avoid overwhelming administrators with excessive alerts.

In conclusion, anomaly-based detection is a valuable component of a layered security approach. When combined with signature-based detection, it offers a comprehensive defense against both known and unknown threats, ensuring more robust protection for network environments.

### 3.2.1 Merits,Demerits and Challenges:

### Merits:

- Effective in detecting unknown or zero-day attacks.
- Adaptable to dynamic network environments.
- Capable of identifying subtle and previously unseen threats.

### Demerits:

- Higher false positive rates due to deviations in legitimate behavior.
- Computationally intensive, requiring robust hardware.
- Initial setup and training can be time-consuming.

### Challenges:

- Establishing an accurate and comprehensive baseline of normal behavior.
- Fine-tuning algorithms to minimize false positives and negatives.
- Scalability issues in high-traffic environments.

### 3.2.2 Implementation of Anomaly-Based Detection:

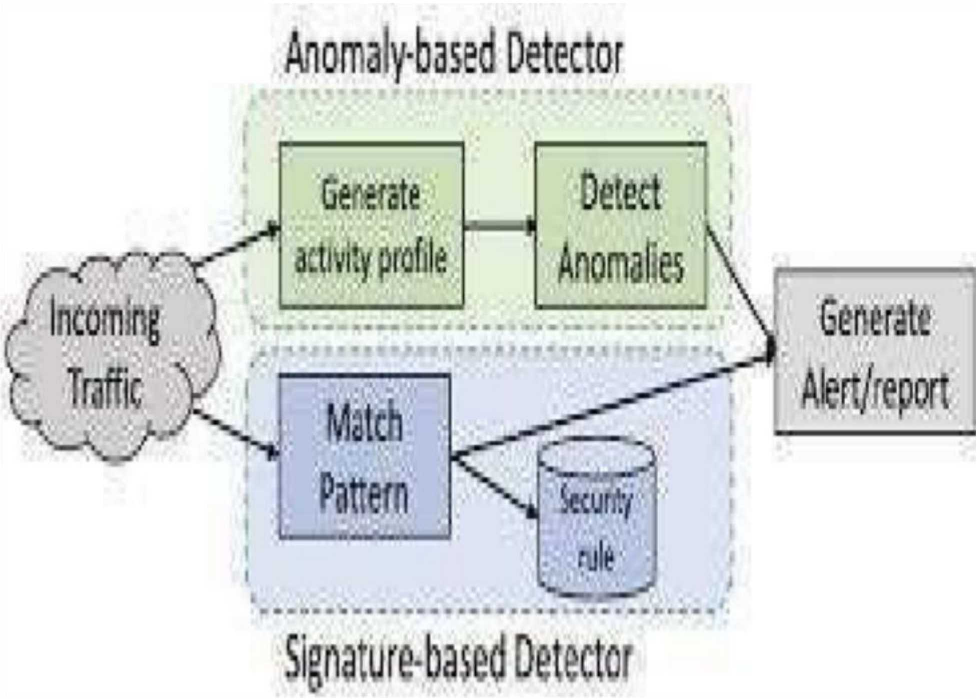


**Figure.2: Anomaly-Based Detection**

The implementation involves the following steps:

- **Data Collection**: Gather network traffic data over a period to create a baseline of normal behavior.
- **Model Training:** Use machine learning algorithms to analyze and model the baseline behavior.
- **Monitoring:** Continuously monitor network activity and compare it to the baseline.
- **Alerting:** Trigger alerts or block suspicious traffic that deviates significantly from the baseline.
- **Feedback and Updates:** Regularly refine the model based on false positives and network changes**.**

## 3.3 Cisco Firepower:

### 3.2.3 Introduction:

Cisco Firepower is a cutting-edge Intrusion Prevention System (IPS) solution developed by Cisco to provide comprehensive, real-time threat protection for enterprise networks. It is designed to offer a multi-layered defense strategy, combining both signature-based and anomaly-based detection techniques to effectively identify, block, and mitigate both known and unknown threats. This hybrid approach ensures that Firepower can provide protection against a wide range of cyberattacks, including advanced persistent threats (APTs), zero-day exploits, and traditional signature-based attacks.

Firepower’s signature-based detection component leverages a large database of attack signatures, allowing it to quickly recognize and respond to known threats. In parallel, its anomaly-based detection capabilities use machine learning and behavioral analysis to identify deviations from the established norms of network traffic and user behavior. This enables the system to detect novel or emerging attacks that have not yet been cataloged in the signature database, giving organizations the ability to respond to threats before they can cause significant damage.

One of the key benefits of Cisco Firepower is its seamless integration into Cisco’s broader security ecosystem. Firepower can be easily integrated with other Cisco security products such as Cisco ASA (Adaptive Security Appliance), Cisco Umbrella, and Cisco Advanced Malware Protection (AMP). This allows for a unified, centralized approach to network security, providing better visibility, more control, and more efficient threat management across an organization’s entire infrastructure.

Additionally, Cisco Firepower offers robust reporting, alerting, and logging features, enabling security teams to monitor and respond to potential threats in real time. The system’s customizable policy framework also allows businesses to tailor their security settings based on specific requirements, ensuring that the IPS solution aligns with their unique security posture.

In conclusion, Cisco Firepower is an advanced, versatile IPS solution that strengthens network security by combining multiple detection methods and integrating seamlessly with Cisco's broader security infrastructure, providing comprehensive and real-time protection against both known and emerging cyber threats.

### 3.2.4 Merits,Demerits and Challenges: Merits:

- Dual detection methods (signature-based and anomaly-based) for enhanced protection.
- Real-time threat detection and automated responses.
- Detailed reporting and real-time alerts for effective threat management.
- Seamless integration with other Cisco security tools.

### Demerits:

- High implementation and licensing costs.
- Requires specialized expertise for deployment and maintenance.
- Performance may vary based on network size and traffic load.

### Challenges:

- Managing large volumes of data generated by detailed reports.
- Balancing performance with advanced features in high-traffic environments.
- Keeping up with evolving threats and maintaining system updates.

### 3.2.5 Implementation of Cisco Firepower:

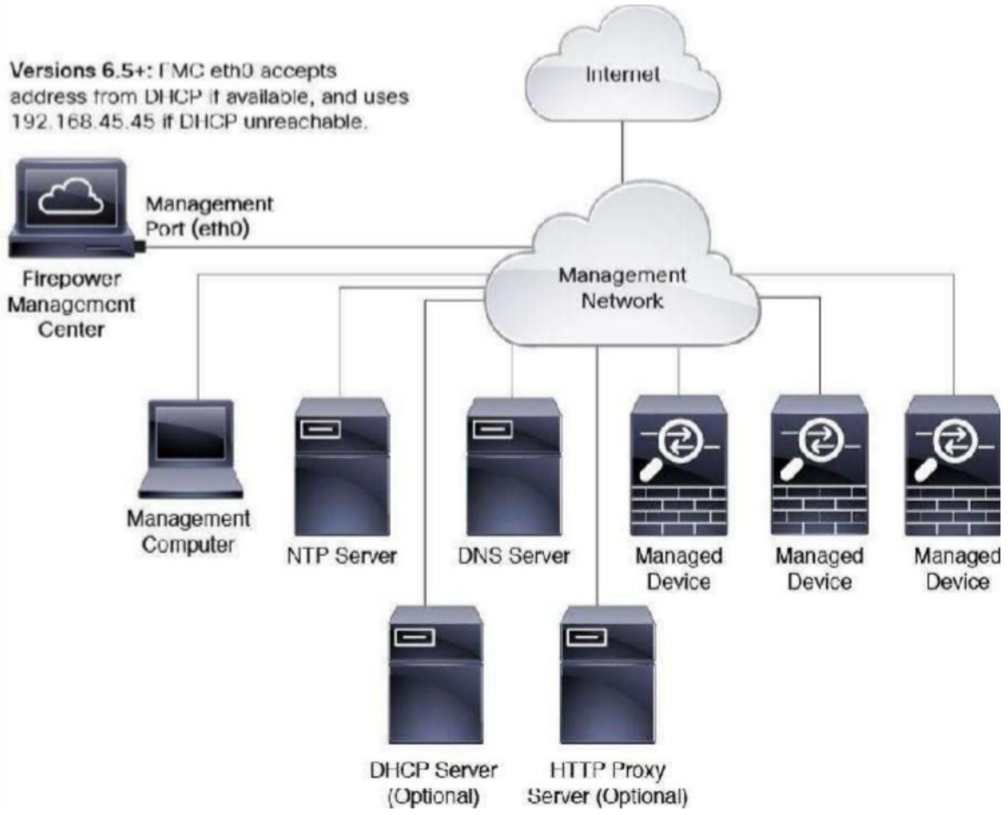

Versions 6.5+: FMC eth0 accepts address from DHCP if available, and uses 192.168.45.45 if DHCP unreachable.
Internet
Management Port (eth0)
Firepower Management Center
Management Network
Management Computer
NTP Server
DNS Server
Managed Device
Managed Device
Managed Device
DHCP Server (Optional)
HTTP Proxy Server (Optional)

**Figure.3: Cisco Firepower**

The implementation involves the following steps:

1. **Deployment:** Install Cisco Firepower as an appliance or integrate it with existing Cisco security infrastructure**.**
2. **Configuration:** Define network policies, detection rules, and automated responses for detected threats.
3. **Baseline Setup:** Utilize anomaly-based detection to establish normal network behavior.
4. **Monitoring and Alerts:** Enable real-time traffic monitoring and configure alerts for threat detection.
5. **Reporting and Analysis:** Use Firepower's detailed reporting tools to analyze threats and network activity.
6. **Updates: Regularly** update signatures and software to protect against the latest threats.

# CHAPTER4

# PROPOSED METHOD

# CHAPTER 4

# PROPOSED METHOD

## 4.1 Proposed Solution:

The proposed solution for the project "Design and Implementation of an Intrusion Prevention System (IPS) using Unified Threat Management (UTM)" revolves around integrating IPS functionality with a UTM framework to provide a comprehensive and scalable security solution. By leveraging UTM, the IPS will not only focus on real-time threat detection and prevention using both signature-based and anomaly-based techniques but also offer consolidated management of various security functions such as firewalls, antivirus, and content filtering.

The system will employ advanced algorithms to enhance the accuracy of intrusion signatures while efficiently managing high traffic volumes to minimize latency. To ensure seamless integration within the existing network infrastructure, the IPS will optimize network topology for smooth deployment, log security events in real-time, and manage resource allocation dynamically. Furthermore, the solution will incorporate robust logging and reporting features to monitor usage, sensor performance, and compliance with industry regulations. The focus on securing the IPS infrastructure itself will further reinforce its ability to prevent unauthorized access, ensuring a secure and efficient system tailored to modern cybersecurity needs.

## 4.2 Designing:

### 4.2.1 Understanding Intrusion Prevention Systems (IPS)

- **Concept:** An IPS actively monitors network traffic, detects malicious activities, and prevents potential threats by blocking or mitigating them.
- **Key Tools**: SNORT (a popular open-source tool) and Suricata (alternative with multi-threading features).

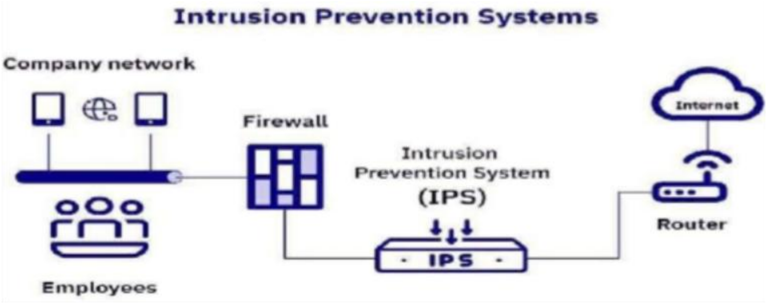


**Figure 4: Intrusion Prevention System (IPS)**

### 4.2.2 Unified Threat Management (UTM) Overview

- **What is UTM:** A framework combining multiple security services like firewall, antivirus, IPS, and content filtering for centralized management.
- **Benefits:**
    - Comprehensive Security.
    - Simplified Management.
    - Real-time Threat Detection.

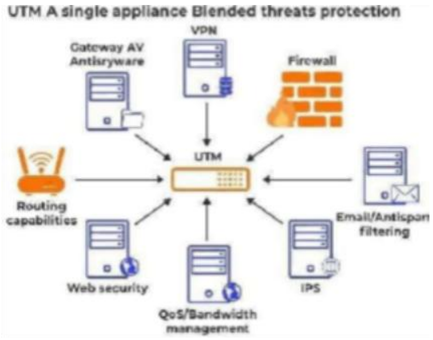


**Figure 5: Unified Threat Management (UTM)**

### 4.2.3 SNORT as an IPS

- **Capabilities:**
  - Real-time traffic analysis.
  - Packet logging.
  - Signature-based threat detection.
- **Integration:** SNORT can be embedded into a UTM framework to enhance its efficiency.

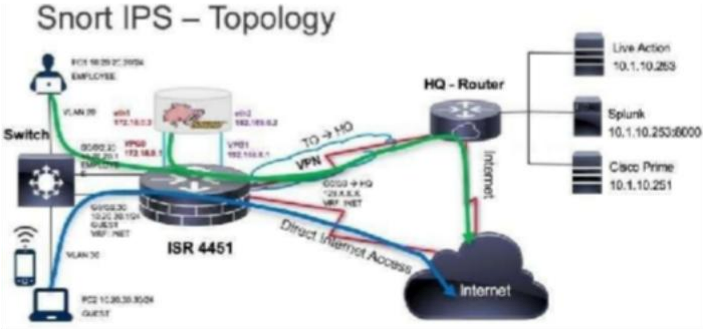


**Figure 6: Snort as an IPS**

1. Functionality & Purpose
   - Snort is an open-source Intrusion Detection and Prevention System (IDS/IPS) used for network security monitoring.
   - As an IPS, it actively blocks malicious traffic in real-time by dropping packets that match attack signatures or abnormal behavior.
2. Modes of Operation
   - Sniffer Mode: Captures and displays packets in real-time.
   - Packet Logger Mode: Logs packets for later analysis.
   - Network Intrusion Detection System (NIDS) Mode: Monitors and alerts on suspicious activity.
   - Intrusion Prevention System (IPS) Mode: Drops or blocks malicious packets inline (requires a firewall like pfSense).
3. Rule-Based Detection
   - Uses Snort rules to detect attacks (signature-based detection).
   - Can be configured with custom rules to meet specific security policies.
   - Rules define action (alert, drop, reject), protocol, source/destination IP, and port.
4. Inline Deployment with pfSense
   - In IPS mode, Snort works inline with pfSense firewall to block threats.
   - Requires enabling IPS mode in Snort and configuring blocking settings.
   - Uses Suricata-compatible Emerging Threats (ET) rules for enhanced detection

## 4.3 System Architecture

**Components:**

- UTM for routing and firewall.
- SNORT for traffic inspection.
- MySQL/ELK for logging and visualizing network traffic.

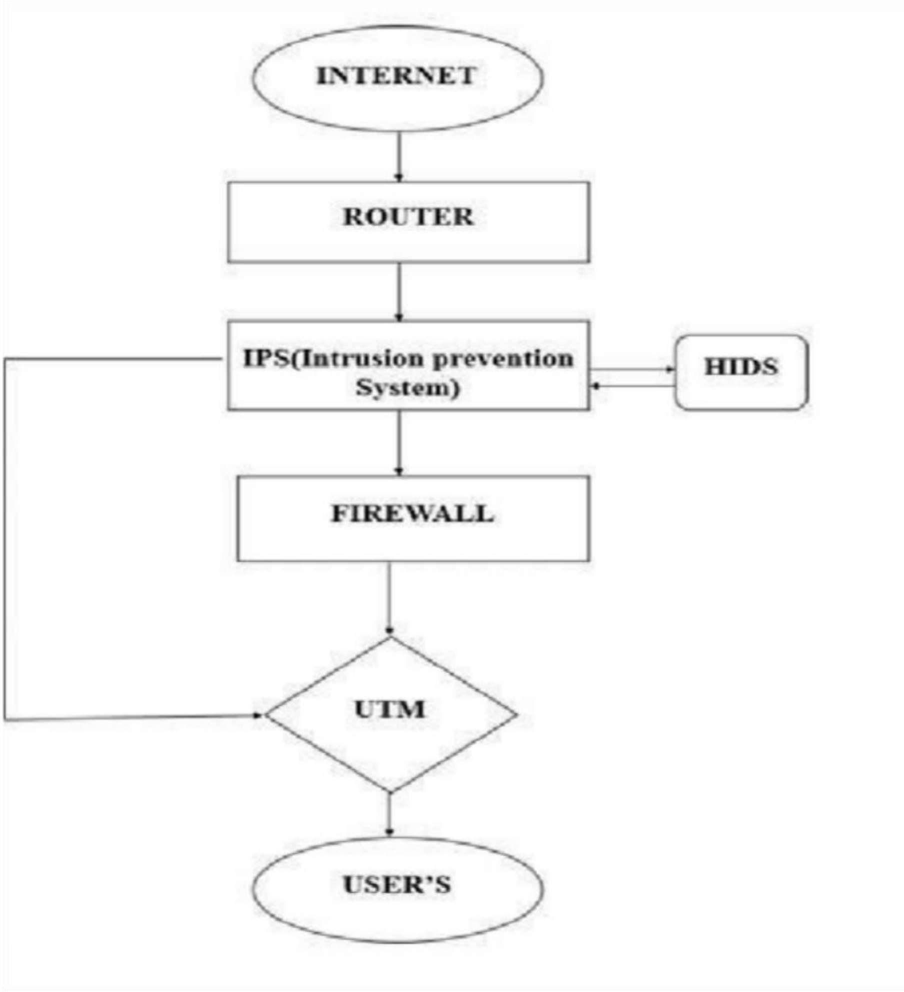
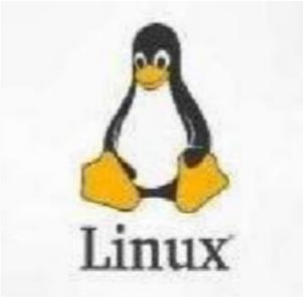


**Figure 7: System Architecture**

## 4.4 System Requirements:

**OperatingSystem:** Windows7 orlater, Linux, ormacOS.

- **Processor**:Intel Core i5 or equivalent.
- **Memory**:8GBRAM or more.
- **Storage:**500GB ormore.
- **NetworkAdapter**:Gigabit Ethernet
- **Software**:Snort
- **Vmware**:PfSense



```
pfSense

Welcome to pfSense
 1. Boot Multi User [Enter]
 2. Boot [S]ingle User
 3. [Esc]ape to loader prompt
 4. Reboot

 Options:
 5. [K]ernel: kernel (1 of 2)
 6. Configure Boot [O]ptions...
```

# CHAPTER 5
# METHODOLOGY

# CHAPTER 5

# METHODOLOGY

## 5.1 Implementation Steps

### Step 1: Install and Configure PfSense

- **Install PfSense in Vmware**

Download **pfSense ISO** from official website.

Create a **VM in VMware** with:

2CPUs, 4GB RAM, 20GB Storage

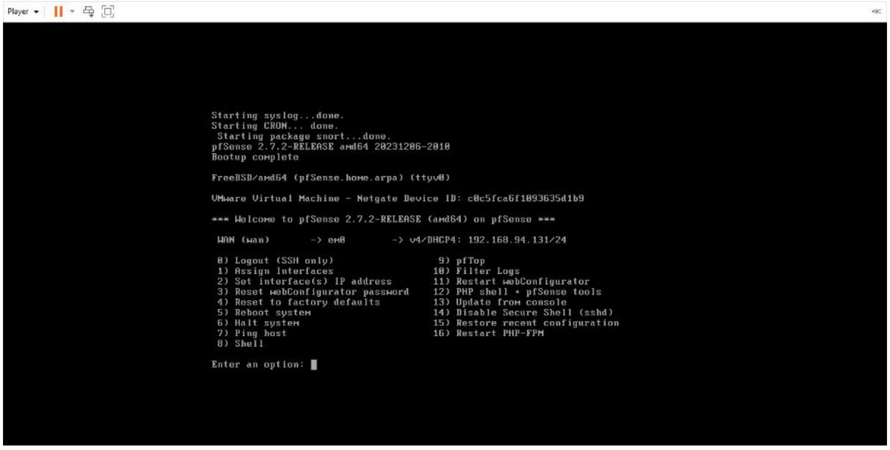
**Two network interfaces**:

**WAN** (Bridged/External Network)

**LAN (Optional for local testing)**

Boot and install pfSense.

Assign **WAN IP** (Dynamic/Static) as per network setup.



```
Starting syslog...done.
Starting CRON... done.
 Starting package snort...done.
pfSense 2.7.2-RELEASE amd64 20231206-2010
Bootup complete

FreeBSD/amd64 (pfSense.home.arpa) (ttyv0)

VMware Virtual Machine - Netgate Device ID: c0c5fca6f1093635d1b9

*** Welcome to pfSense 2.7.2-RELEASE (amd64) on pfSense ***

 WAN (wan)       -> em0        -> v4/DHCP4: 192.168.94.131/24

 0) Logout (SSH only)                  9) pfTop
 1) Assign Interfaces                 10) Filter Logs
 2) Set interface(s) IP address       11) Restart webConfigurator
 3) Reset webConfigurator password    12) PHP shell + pfSense tools
 4) Reset to factory defaults         13) Update from console
 5) Reboot system                     14) Disable Secure Shell (sshd)
 6) Halt system                       15) Restore recent configuration
 7) Ping host                         16) Restart PHP-FPM
 8) Shell

Enter an option: █
```

**Fig8:Pfsense Terminal**

### Step 2: Access pfSense Web GUI

Openbrowser and enterhttps://<pfSense_WAN_IP>

Login:

Username: admin

Password: pfsense (Change this after login

## Step 3: Install and Configure Snort

- **Install Snort on pfSense**

  **Navigate to:** System → Package Manager → Available Packages and search for snort and install.

- **Configure Snort on WAN Interface**

  Go to Services → Snort → Interfaces

  Click **Add** on WAN interface

  Enable Block Offenders mode

  Save and Apply settings

- **Enable Snort rules**

  Go to Snort → WAN → Categories

  Enable **Emerging Threats and Snort VRT Rules**

  Save and UpdatE

## Step 4:Define and Add IPS Custom Rules

- **Add Custom Snort Rules**

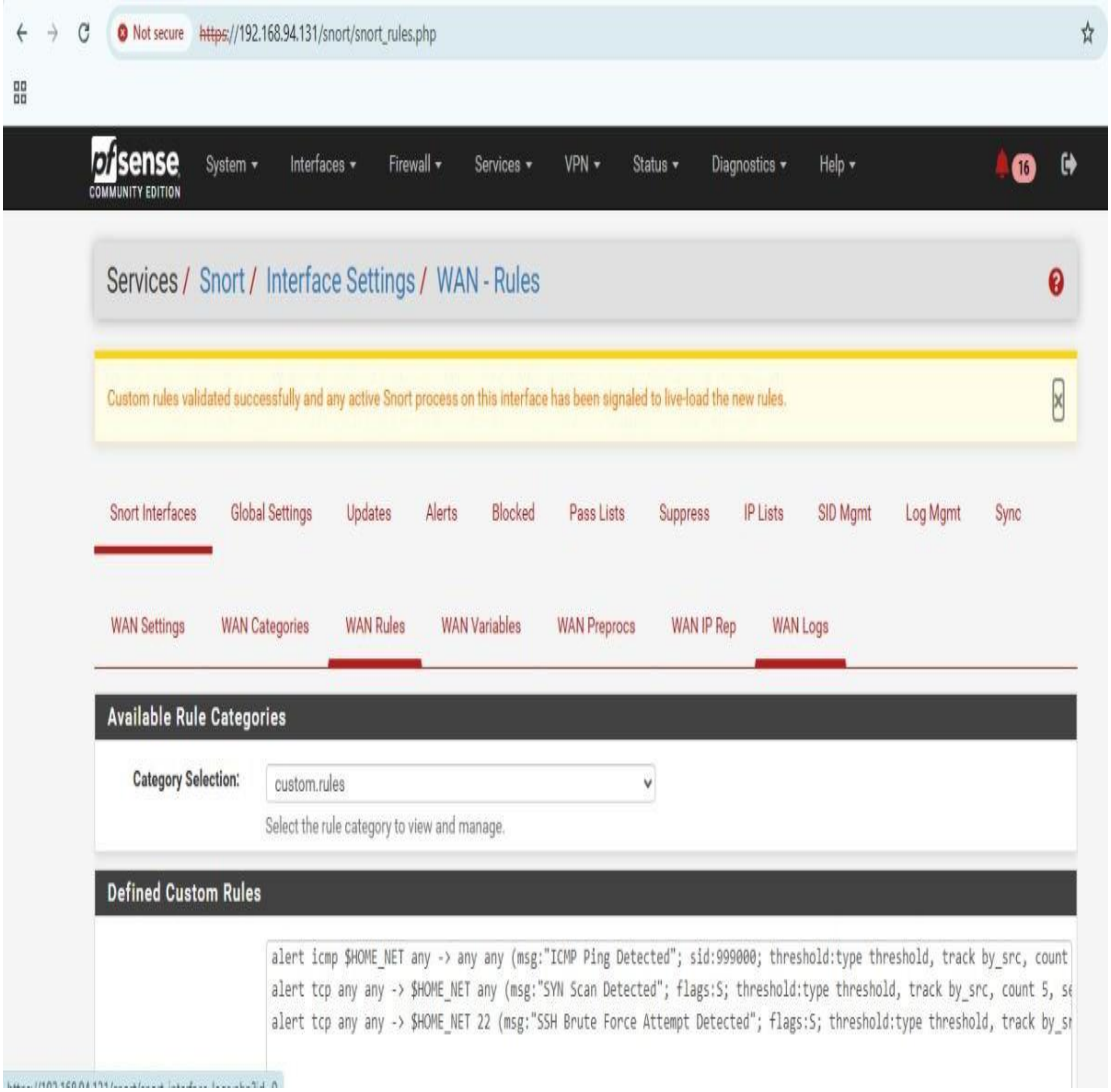
  Navigate to Snort → WAN → Custom Rules, and add the following:

```
alert icmp $HOME_NET any -> any any (msg:"ICMP Ping Detected"; sid:999000; threshold:type threshold, track by_src, count 5, seconds 30; rev:1;)

alert tcp any any -> $HOME_NET any (msg:"SYN Scan Detected"; flags:S; threshold:type threshold, track by_src, count 5, seconds 30; sid:1000002; rev:1;)

alert tcp any any -> $HOME_NET 22 (msg:"SSH Brute Force Attempt Detected"; flags:S; threshold:type threshold, track by_src, count 5, seconds 30; sid:1000001; rev:1;)
```

Save and restart Snort to apply changes.



Custom rules validated successfully and any active Snort process on this interface has been signaled to live-load the new rules.

Available Rule Categories

Category Selection: custom.rules

Select the rule category to view and manage.

Defined Custom Rules

```
alert icmp $HOME_NET any -> any any (msg:"ICMP Ping Detected"; sid:999000; threshold:type threshold, track by_src, count
alert tcp any any -> $HOME_NET any (msg:"SYN Scan Detected"; flags:S; threshold:type threshold, track by_src, count 5, se
alert tcp any any -> $HOME_NET 22 (msg:"SSH Brute Force Attempt Detected"; flags:S; threshold:type threshold, track by_sr
```

**Fig9:Custom Rules**

# CHAPTER 6

# TEST CASES
# &
# RESULTS

# CHAPTER 6

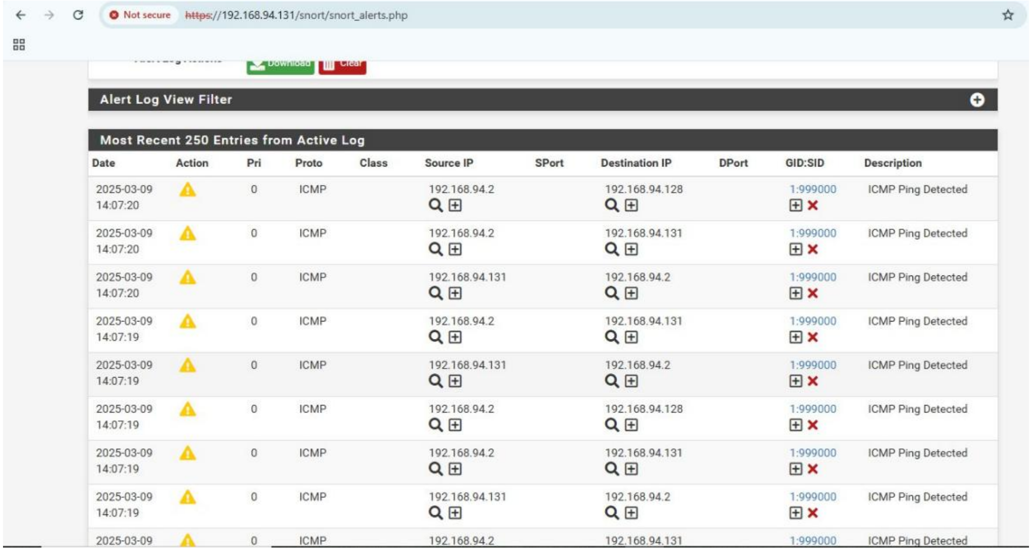
# TESTCASES & RESULT

## PERFORM ATTACKS AND ANALYZE ALERT

### 1. ICMP Ping Test

Execute the following from a Kali Linux or another test machine:

***ping -c 5 <pfSense_WAN_IP>***



Not secure ~~https~~://192.168.94.131/snort/snort_alerts.php

Most Recent 250 Entries from Active Log

| Date | Action | Pri | Proto | Class | Source IP | SPort | Destination IP | DPort | GID:SID | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| 2025-03-09<br>14:07:20 | ⚠ | 0 | ICMP | | 192.168.94.2<br>🔍 ⊞ | | 192.168.94.128<br>🔍 ⊞ | | 1:999000<br>⊞ ✕ | ICMP Ping Detected |
| 2025-03-09<br>14:07:20 | ⚠ | 0 | ICMP | | 192.168.94.2<br>🔍 ⊞ | | 192.168.94.131<br>🔍 ⊞ | | 1:999000<br>⊞ ✕ | ICMP Ping Detected |
| 2025-03-09<br>14:07:20 | ⚠ | 0 | ICMP | | 192.168.94.131<br>🔍 ⊞ | | 192.168.94.2<br>🔍 ⊞ | | 1:999000<br>⊞ ✕ | ICMP Ping Detected |
| 2025-03-09<br>14:07:19 | ⚠ | 0 | ICMP | | 192.168.94.2<br>🔍 ⊞ | | 192.168.94.131<br>🔍 ⊞ | | 1:999000<br>⊞ ✕ | ICMP Ping Detected |
| 2025-03-09<br>14:07:19 | ⚠ | 0 | ICMP | | 192.168.94.131<br>🔍 ⊞ | | 192.168.94.2<br>🔍 ⊞ | | 1:999000<br>⊞ ✕ | ICMP Ping Detected |
| 2025-03-09<br>14:07:19 | ⚠ | 0 | ICMP | | 192.168.94.2<br>🔍 ⊞ | | 192.168.94.128<br>🔍 ⊞ | | 1:999000<br>⊞ ✕ | ICMP Ping Detected |
| 2025-03-09<br>14:07:19 | ⚠ | 0 | ICMP | | 192.168.94.2<br>🔍 ⊞ | | 192.168.94.131<br>🔍 ⊞ | | 1:999000<br>⊞ ✕ | ICMP Ping Detected |
| 2025-03-09<br>14:07:19 | ⚠ | 0 | ICMP | | 192.168.94.131<br>🔍 ⊞ | | 192.168.94.2<br>🔍 ⊞ | | 1:999000<br>⊞ ✕ | ICMP Ping Detected |
| 2025-03-09 | ⚠ | 0 | ICMP | | 192.168.94.2 | | 192.168.94.131 | | 1:999000 | ICMP Ping Detected |

**Fig10:ICMP Ping alert**

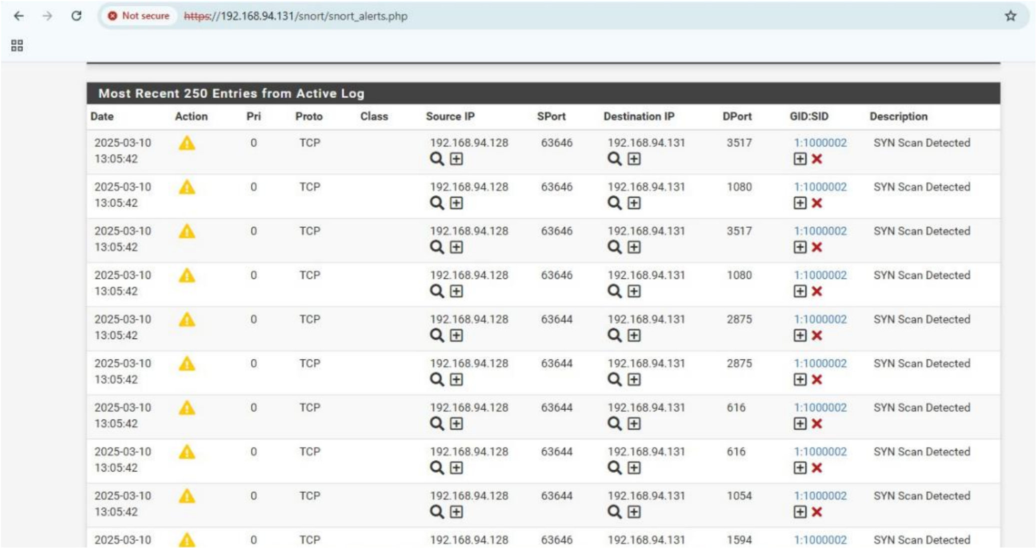
## Result:

When executing the ping -c 5 <pfSense_WAN_IP> command, Snort should detect and log a total of 5 ICMP Ping alerts. Each alert corresponds to an ICMP Echo Request (Type 8) that is sent from the testing machine to the pfSense firewall's WAN IP address. Since the ping command sends 5 packets (due to the -c 5 option), Snort will generate 5 separate alerts for each of these packets

## 2. Nmap SYN Scan Test

Execute controlled **Nmap scan**:

***sudo nmap -sS -T4 ip***



Not secure ~~https~~://192.168.94.131/snort/snort_alerts.php

Most Recent 250 Entries from Active Log

| Date | Action | Pri | Proto | Class | Source IP | SPort | Destination IP | DPort | GID:SID | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| 2025-03-10<br>13:05:42 | ⚠ | 0 | TCP | | 192.168.94.128 | 63646 | 192.168.94.131 | 3517 | 1:1000002 | SYN Scan Detected |
| 2025-03-10<br>13:05:42 | ⚠ | 0 | TCP | | 192.168.94.128 | 63646 | 192.168.94.131 | 1080 | 1:1000002 | SYN Scan Detected |
| 2025-03-10<br>13:05:42 | ⚠ | 0 | TCP | | 192.168.94.128 | 63646 | 192.168.94.131 | 3517 | 1:1000002 | SYN Scan Detected |
| 2025-03-10<br>13:05:42 | ⚠ | 0 | TCP | | 192.168.94.128 | 63646 | 192.168.94.131 | 1080 | 1:1000002 | SYN Scan Detected |
| 2025-03-10<br>13:05:42 | ⚠ | 0 | TCP | | 192.168.94.128 | 63644 | 192.168.94.131 | 2875 | 1:1000002 | SYN Scan Detected |
| 2025-03-10<br>13:05:42 | ⚠ | 0 | TCP | | 192.168.94.128 | 63644 | 192.168.94.131 | 2875 | 1:1000002 | SYN Scan Detected |
| 2025-03-10<br>13:05:42 | ⚠ | 0 | TCP | | 192.168.94.128 | 63644 | 192.168.94.131 | 616 | 1:1000002 | SYN Scan Detected |
| 2025-03-10<br>13:05:42 | ⚠ | 0 | TCP | | 192.168.94.128 | 63644 | 192.168.94.131 | 616 | 1:1000002 | SYN Scan Detected |
| 2025-03-10<br>13:05:42 | ⚠ | 0 | TCP | | 192.168.94.128 | 63644 | 192.168.94.131 | 1054 | 1:1000002 | SYN Scan Detected |
| 2025-03-10 | ⚠ | 0 | TCP | | 192.168.94.128 | 63646 | 192.168.94.131 | 1594 | 1:1000002 | SYN Scan Detected |

**Fig11:Nmap scan**

**Result:**

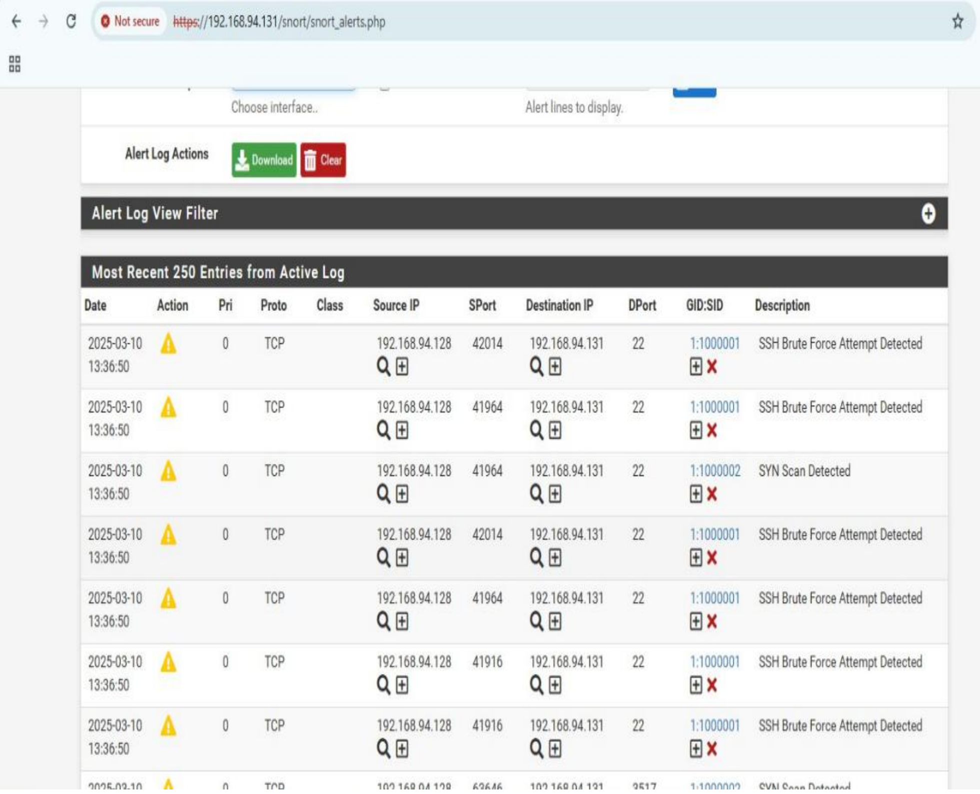
The SYN scan with the -T4 option will perform a fast and stealthy port scan targeting all open ports on the pfSense firewall's WAN interface. If the firewall allows traffic to certain ports, Nmap will report these ports as open. If the firewall blocks the SYN packets, the ports will be filtered or closed, depending on the firewall configuration.

Snort, if running on pfSense or monitoring the network traffic, should detect and log the SYN scan attempts, especially because port scanning can be considered a suspicious activity. The logs generated by Snort will contain information about the scanning IP and the ports being targeted, helping to detect any potential reconnaissance or scanning activities.

## 3. SSH Brute Force Attack

Attempt SSH brute force with **Hydra**:

***hydra -l admin -P /usr/share/wordlists/rockyou.txt ssh://<pfSense_WAN_IP>***



Not secure ~~https~~://192.168.94.131/snort/snort_alerts.php

Choose interface..

Alert lines to display.

Alert Log Actions — Download — Clear

Alert Log View Filter

Most Recent 250 Entries from Active Log

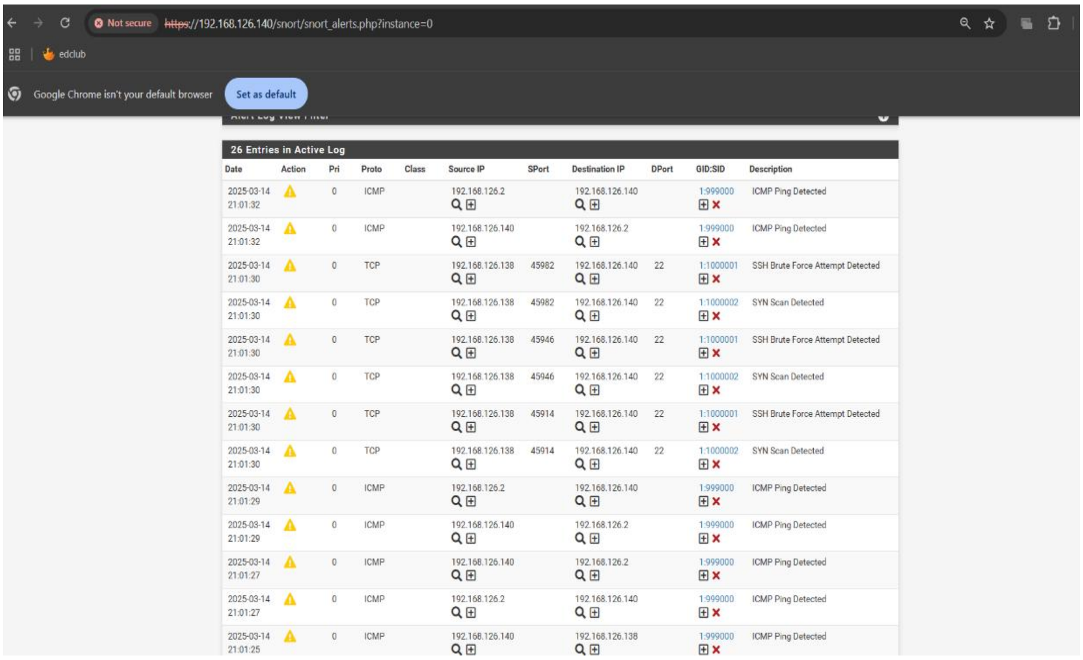
| Date | Action | Pri | Proto | Class | Source IP | SPort | Destination IP | DPort | GID:SID | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| 2025-03-10 13:36:50 | ⚠ | 0 | TCP | | 192.168.94.128 | 42014 | 192.168.94.131 | 22 | 1:1000001 | SSH Brute Force Attempt Detected |
| 2025-03-10 13:36:50 | ⚠ | 0 | TCP | | 192.168.94.128 | 41964 | 192.168.94.131 | 22 | 1:1000001 | SSH Brute Force Attempt Detected |
| 2025-03-10 13:36:50 | ⚠ | 0 | TCP | | 192.168.94.128 | 41964 | 192.168.94.131 | 22 | 1:1000002 | SYN Scan Detected |
| 2025-03-10 13:36:50 | ⚠ | 0 | TCP | | 192.168.94.128 | 42014 | 192.168.94.131 | 22 | 1:1000001 | SSH Brute Force Attempt Detected |
| 2025-03-10 13:36:50 | ⚠ | 0 | TCP | | 192.168.94.128 | 41964 | 192.168.94.131 | 22 | 1:1000001 | SSH Brute Force Attempt Detected |
| 2025-03-10 13:36:50 | ⚠ | 0 | TCP | | 192.168.94.128 | 41916 | 192.168.94.131 | 22 | 1:1000001 | SSH Brute Force Attempt Detected |
| 2025-03-10 13:36:50 | ⚠ | 0 | TCP | | 192.168.94.128 | 41916 | 192.168.94.131 | 22 | 1:1000001 | SSH Brute Force Attempt Detected |
| 2025-03-10 | ⚠ | 0 | TCP | | 192.168.94.128 | 63646 | 192.168.94.131 | 3517 | 1:1000002 | SYN Scan Detected |

**Fig12:SSH Brute Force Attack**

**Result:**

The command initiates a brute-force attack on the SSH login service, specifically targeting the username 'admin.' It systematically attempts to gain unauthorized access by trying every possible password in the 'rockyou.txt' wordlist, a well-known collection of previously exposed passwords. This process involves repeatedly sending login requests to the SSH service, each time pairing the username 'admin' with a different password from the list. The ultimate goal is to find a valid username-password combination that grants access to the target system, which in this case is the pfSense firewall's SSH service located at the specified WAN IP address.

- ## Performing all 3 testcases at Once.


Not secure
https://192.168.126.140/snort/snort_alerts.php?instance=0
edclub
Google Chrome isn't your default browser
Set as default

26 Entries in Active Log

| Date | Action | Pri | Proto | Class | Source IP | SPort | Destination IP | DPort | GID:SID | Description |
|---|---|---|---|---|---|---|---|---|---|---|
| 2025-03-14 21:01:32 | ⚠ | 0 | ICMP | | 192.168.126.2 | | 192.168.126.140 | | 1:999000 | ICMP Ping Detected |
| 2025-03-14 21:01:32 | ⚠ | 0 | ICMP | | 192.168.126.140 | | 192.168.126.2 | | 1:999000 | ICMP Ping Detected |
| 2025-03-14 21:01:30 | ⚠ | 0 | TCP | | 192.168.126.138 | 45982 | 192.168.126.140 | 22 | 1:1000001 | SSH Brute Force Attempt Detected |
| 2025-03-14 21:01:30 | ⚠ | 0 | TCP | | 192.168.126.138 | 45982 | 192.168.126.140 | 22 | 1:1000002 | SYN Scan Detected |
| 2025-03-14 21:01:30 | ⚠ | 0 | TCP | | 192.168.126.138 | 45946 | 192.168.126.140 | 22 | 1:1000001 | SSH Brute Force Attempt Detected |
| 2025-03-14 21:01:30 | ⚠ | 0 | TCP | | 192.168.126.138 | 45946 | 192.168.126.140 | 22 | 1:1000002 | SYN Scan Detected |
| 2025-03-14 21:01:30 | ⚠ | 0 | TCP | | 192.168.126.138 | 45914 | 192.168.126.140 | 22 | 1:1000001 | SSH Brute Force Attempt Detected |
| 2025-03-14 21:01:30 | ⚠ | 0 | TCP | | 192.168.126.138 | 45914 | 192.168.126.140 | 22 | 1:1000002 | SYN Scan Detected |
| 2025-03-14 21:01:29 | ⚠ | 0 | ICMP | | 192.168.126.2 | | 192.168.126.140 | | 1:999000 | ICMP Ping Detected |
| 2025-03-14 21:01:29 | ⚠ | 0 | ICMP | | 192.168.126.140 | | 192.168.126.2 | | 1:999000 | ICMP Ping Detected |
| 2025-03-14 21:01:27 | ⚠ | 0 | ICMP | | 192.168.126.140 | | 192.168.126.2 | | 1:999000 | ICMP Ping Detected |
| 2025-03-14 21:01:27 | ⚠ | 0 | ICMP | | 192.168.126.2 | | 192.168.126.140 | | 1:999000 | ICMP Ping Detected |
| 2025-03-14 21:01:25 | ⚠ | 0 | ICMP | | 192.168.126.140 | | 192.168.126.138 | | 1:999000 | ICMP Ping Detected |

**Fig13:Testcases**

### Result:

In this experiment, three distinct types of cyberattacks are simultaneously executed within a controlled environment to rigorously evaluate the efficiency and effectiveness of the Intrusion Prevention System (IPS). The primary objective of this experiment is to assess the system's ability to not only detect and respond to each attack type in real time but also ensure that it handles all threats with equal proficiency. Additionally, the experiment aims to verify that the IPS can prevent any potential security breaches or data compromises while maintaining the overall stability and performance of the network. By testing the system's response to multiple attack vectors concurrently, the study seeks to determine the robustness and reliability of the IPS in safeguarding network infrastructures under diverse and simultaneous threat scenarios. The results will offer insights into how well the IPS can balance security enforcement with minimal impact on system efficiency, providing a comprehensive understanding of its operational capabilities in a real-world environment.

# CHAPTER 7
# CONCLUSION
# &
# FUTURE ENHANCEMENT’S

# CHAPTER 7
# CONCLUSION &
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## 7.1 Conclusion

The Intrusion Prevention System (IPS), implemented using pfSense and Snort, successfully demonstrated the seamless integration of advanced firewall and intrusion detection techniques to significantly enhance network security. By leveraging these powerful open-source tools, the system not only fortified the network infrastructure but also provided a robust defense mechanism against a wide range of cyber threats. The system was able to effectively detect and mitigate various types of common and sophisticated cyberattacks, including ICMP Ping floods, Nmap Scans, and SSH Brute Force Attacks, showcasing its capability to adapt to different attack vectors and provide real-time protection.

One of the most critical aspects of the system's design was the implementation of custom rules tailored to detect specific patterns of malicious activity. Through careful rule creation and fine-tuning, the IPS was able to accurately identify attack attempts, responding in real-time by either blocking or alerting administrators about the detected threats. However, the development of the IPS was not without its challenges. Key difficulties included achieving high signature accuracy, optimizing system performance to handle traffic without delays, and reducing false positives that could undermine the effectiveness of the system by generating excessive alerts or blocking legitimate network traffic. These challenges were addressed through continuous testing, adjustment of detection signatures, and the use of advanced performance optimization techniques.

During the evaluation phase, the system's ability to identify, alert, and prevent security threats was thoroughly tested under various real-world conditions. The results confirmed that the IPS was able to maintain robust security defenses while ensuring that network performance remained stable and uninterrupted. Advanced filtering techniques, such as dynamic threshold-based detection methods, played a significant role in reducing alert flooding and unnecessary blocking of legitimate traffic, thereby improving the overall efficiency of the IPS. By striking a balance between threat detection and system performance, the IPS provided an optimal solution for managing network security in a fast-paced and complex environment.

The project has laid a strong foundation for the development of a scalable, adaptable, and cost-effective security solution. By utilizing open-source technologies such as pfSense and Snort, which are widely regarded for their flexibility and effectiveness, the project has demonstrated how enterprises of all sizes can deploy a high-performance IPS without the need for expensive proprietary solutions. This approach not only enhances network security but also helps organizations maintain a budget-friendly security infrastructure, providing enterprise-level protection with reduced financial burden. Furthermore, the lessons learned and the strategies employed throughout the project have paved the way for future research and development in the field of network security, with potential applications for expanding the IPS to tackle more advanced and emerging threats.

## 7.2 FutureEnhancements

To enhance the performance and security of the Intrusion Prevention System (IPS), several key improvements can be implemented. These upgrades are designed to address current challenges and improve the system's ability to protect networks from evolving and increasingly sophisticated threats.

A crucial area for improvement is **signature accuracy**. Refining Snort rules will significantly improve the precision of threat detection, reducing the likelihood of false positives. False positives not only flood administrators with unnecessary alerts but also risk blocking legitimate network traffic. By continuously refining and updating detection signatures to account for new attack patterns, the system can detect a broader range of threats while ensuring minimal disruption to normal network activities.

Another vital enhancement involves the integration of **behavior-based anomaly detection** using **machine learning** techniques. Traditional signature-based systems primarily identify known threats through predefined patterns. However, machine learning can provide a more adaptive approach by recognizing abnormal network behaviors and detecting zero-day attacks or new, previously unseen threats. By using machine learning algorithms, the IPS can continuously learn normal traffic patterns and respond more proactively to unusual deviations that may indicate malicious activity.

Incorporating **real-time threat intelligence feeds** into the IPS would allow the system to stay up to date with the latest attack tactics, vulnerabilities, and emerging threats. These feeds provide immediate updates, allowing the IPS to automatically adjust its detection rules in response to new risks. This integration would improve the system’s ability to prevent attacks based on the latest threat information without requiring manual intervention from administrators, ensuring quicker and more effective defense against evolving threats.

To further improve efficiency, **automating remediation actions** such as blocking malicious IP addresses or isolating compromised devices can enhance response times and minimize the impact of attacks. Automation can also include sending instant alerts via email or SMS to notify administrators of critical security events, reducing the time to react and remediate.

Finally, the integration of **log aggregation tools** like ELK (Elasticsearch, Logstash, Kibana), Splunk, or Graylog will provide centralized monitoring and analysis. These tools can aggregate logs from multiple sources, enabling administrators to gain deeper insights into network activity and potential security incidents, thereby improving overall incident response and system tuning.

These future enhancements will significantly improve the IPS's ability to detect, prevent, and respond to cyber threats more efficiently while maintaining high network performance and scalability.

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# REFERENCES

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# CONFERENCE PAPER

# DESIGN AND IMPLEMENTATION OF IPS USING UTM

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**Abstract** - The Design and Implementation of Intrusion Prevention Systems (IPS) play a critical role in safeguarding computer networks from malicious activities. Unlike traditional Intrusion Detection Systems (IDS), IPS offers advanced capabilities such as real-time threat identification, alarm triggering, event notifications, and prompt response mechanisms. Despite these advantages, IPS faces several challenges, including the accuracy of intrusion signatures, efficient management of high traffic volumes, optimization of network topology for effective deployment, secure infrastructure management, and seamless integration with Unified Threat Management (UTM) frameworks. This paper explores these critical challenges and proposes innovative solutions to enhance IPS reliability and effectiveness. Key areas of focus include monitoring, secure logging, and management, ensuring a robust defense in modern cyber security landscapes. The outcomes aimto optimize IPS deployment and operations, reinforcing its role in proactive network protection.

**Keywords** - Issued challenge of Intrusion Prevention, Collaboration defense system, Unified Threat Management (UTM), Snort.

## I. INTRODUCTION

With the increasing complexity and frequency of cyber threats, the need for strong computer security systems has become more essential than ever. These threats, targeting various levels of systems such as networks, applications, and operating systems, pose significant risks to system integrity and performance[1].The weaknesses in these components Provide potential access points for attackers, leaving systems exposed to various malicious actions. [3].
Intrusion Prevention Systems (IPS) have become a crucial safeguard in tackling these issues.Combiningfirewallcapabilitieswithintrusiondetection,IPStechnology provides a proactive approach to network security by overcoming attacks before they can inflict damage[2]. The core function of IPS is to identify and block potential threats in real-time, ensuring that attacks are thwarted before they impact the system[4].
IPS systems detect and prevent malicious activities by constantly monitoring network traffic and analyzing patterns for any suspicious behavior. Additionally, IPS systems log details of any detected incidents, allowing to investigate and respond to threats effectively[3].Through the implementation of Unified Threat Management (UTM) solutions, IPS can provide a comprehensive defense framework, Combining various security technologies into a unified platform for improved protection[1][12].

Incorporating IPS into a broader security framework, such as Unified Threat Management (UTM), allows for an even more robust defense strategy[1]. UTM solutions consolidate various security technologies—including firewalls, VPNs, antivirus, anti-spam, and IPS in to a single integrated platform. This holistic approach provides a more comprehensive defense against cyber threats, simplifying management and enhancing efficiency[4]. By integrating multiple layers of protection, UTM solutions reduce the complexity of managing separate security systems and ensure that all components function seamlessly to provide superior protection[5].

Moreover, UTM's integration of IPS enhances its ability to respond to a wide array of cyber threats, from low-level intrusions to complex, multi-vector attacks[2].The combination of real-time intrusion prevention, advanced analytics, and centralized management ensures that threats are detected and mitigated swiftly, minimizing security breaches[6]. In a world where cyber threats are constantly evolving, the design and implementation of IPS through UTM offer a proactive, automated, and scalable solution to safeguarding critical infra structure[1].
This paper explores the design, implementation, and benefits of IPS within UTM solutions, analyzing their role in securing networks Preventing attacks before they have a chance to occur, which compromise system integrity. By harnessing the potential of IPS and UTM, organizations can establish a resilient security framework that addresses both current and future cyber threats[1][2][3][4].

## II. LITERATURE REVIEW

**A.** *John Doe and Jane Smith, "Unified Threat*

*Management: A Comprehensive Approach to Network Security", 2022*
This study provides an extensive analysis of Unified Threat Management (UTM) systems and their impact on enhancing network security. It emphasizes the integration of various security functions, such as Intrusion Prevention Systems (IPS), into a single UTM platform. The research evaluates effectiveness of UTM solutions in providing holistic defense against cyber threats addressing design considerations and implementation challenges.

B. *Emily Brown and Michael Green, "Design and Implementation of IPS in UTM Systems", 2021*
This research focuses on the design and implementation of Intrusion Prevention Systems (IPS) within Unified Threat Management (UTM) frameworks. It explores key design aspects, including integration strategies and performance optimization methods. The paper also highlights challenges during implementation, such as managing false positives and ensuring system compatibility.

## III. OVERVIEW OF INTRUSION PREVENTION SYSTEM (IPS) USINGUTM FRAME WORK

Intrusion Prevention Systems (IPS), when integrated into a Unified Threat Management (UTM) framework, Act as an essential barrier against cyber threats. By utilizing the centralized capabilities of UTM and the powerful detection mechanisms of IPS, organizations can proactively protect their networks from evolving threats[1]. This paper combines the best of these technologies to provide as calable and effective solution for modern cyber security challenges[2].

UTM frameworks consolidate multiple security functionalities, including firewalls, antivirus, content filtering, and VPNs, into a single, cohesive platform[4]. By embedding IPS into this framework, organizations can achieve enhanced threat visibility, streamlined security management, and reduced complexity in deployment[3]. This integration is particularly beneficial in response to increasingly sophisticated attack vectors such as zero-day exploits and ran som ware[7].
IPS plays a pivotal role in detecting and blocking malicious activities by examining network traffic and application behaviors. Utilizing signature-based, anomaly- based, and behavioral analysis techniques, IPS can effectively identify known and unknown threats[9]. When integrated with the centralized intelligence of UTM, IPS benefits from real-time threat intelligence updates, coordinated defense mechanisms, and policy enforcement across the network[8].

This thesis explores the architecture, implementation, and effectiveness of an IPS embedded in a UTM framework. It evaluates how this integration addresses challenges such as scalability, performance, and adaptability in dynamic network environments[2]. The research delves into case studies and experimental setups to analyze the detection accuracy, response times, and resource utilization of the integrated system[1][3].

Additionally, the thesis emphasizes the potential of machine learning and artificial intelligence to improve the predictive capabilities of IPS within UTM. By automating the detection of anomalous patterns and utilizing threat intelligence feeds, the integrated system can proactively identify and mitigate emerging threats with higher accuracy. [5][6].

Some common key Aspects of Intrusion Prevention System:
1. Purpose and importance: The primary objective of this paper is to identify and block malicious data in real-time. The IPS employs a mixo fsignature-based detection and anomaly-based methods to recognize threats like unauthorized access, malware, and zero- day attacks[1][9]. By providing immediateresponses to detected threats, the system reduces the risk of data breaches and unauthorized accesssystem downtime[10].
2. UTM Integration: Unified Threat Management (UTM) consolidates multiple security services— including firewalls, antivirus, content filtering, and the IPS itself—into a single management platform[4]. This integration simplifies security administration while providing a comprehensive, layered defense mechanism that can adapt to dynamic network environments[3][8].
3. Tools and Techniques: This paper employs SNORT, a widely-used open-source intrusion detection and prevention system, as the core detection tool[2][7]. Signature-basedmethodsareusedforknownthreats, while machine learning-based anomaly detection identifies unknown or zero-day threats[5]. These methods ensure thorough protection across multiple threat vectors. [9].

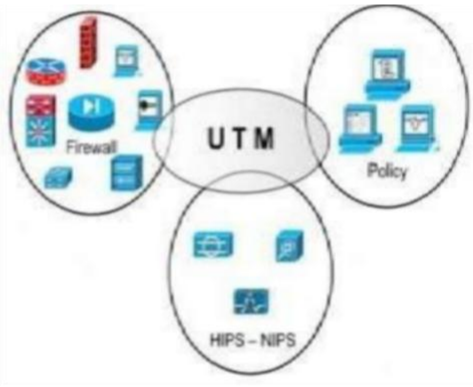


**Fig1:UTM Flow System**

4. Real-time Monitoring and Automation: The IPS is designed for real-time traffic monitoring, detecting malicious patterns, and taking immediate action to block threats[2][8]. Automated SNORT rules and periodic updates ensure the system is always equipped to handle the latest cybersecurity riskswith minimal manual intervention[7].

5. Logging andReporting:Thesystemintegratesrobust logging and reporting mechanisms, leveraging tools like MySQL and the ELK stack (ElasticSearch, Logstash, Kibana)[3]. These logs and provide detailed insights into detected reports. threats, their origins, and the system's response. The information helps security teams assess risks and refine the system for enhanced performance[6][11].

## IV. PROBLEM STATEMENT

In modern cyber security, intrusion detection systems (IDS) have evolved into Intrusion Prevention Systems (IPS), which not only detect but actively block malicious activities. The integration of IPS within a Unified Threat Management (UTM) framework consolidates multiple security services under one management umbrella. This paper aims to build a robust IPS using SNORT, addressing challenges like ensuring accurate signatures, managinglarge traffic efficiently, and optimizing deployment.

## V. SNORTASAN IPS

SNORT is a popular open-source Intrusion Detection and Prevention System (IDS/IPS) designed to analyze network traffic and identify suspicious activities. Its powerful rule- based system allows for real-time analysis and detection of threats. Its robust rule-based system enables real-time analysis and response to threats. In this paper, SNORT serves as the core IPS tool, integrated into a Unified Threat Management (UTM) framework

1. Features and Capabilities

Signature-Based Detection: SNORT uses predefined rules to identify known attack patterns, ensuring high accuracy in detecting malicious traffic

Anomaly Detection: By monitoring deviations from the usual network behavior, SNORT can detect potential zero-day attacks.

Real-Time Alerting: The system generates immediate alerts for identified threats, facilitating prompt response.

Customizability: Users can create custom rules to adapt SNORT to specific network requirements.

2. Integration with UTM:

SNORT's integration into the UTM framework enhances overall network security by:

Centralized Management: Combining SNORT with other security tools like firewalls and antivirus systems that's implifiest head ministration.

Comprehensive Threat Visibility: Provides a unified view of network threats across multiple layers.

Streamlined Security Policies: Allows for consistent enforcement of security policies throughout the network.

3. Implementation Steps:

Rule Configuration: Configure SNORT with default and user-defined types of rules for detecting various threats of intrusions and vulnerabilites, threats.

Traffic Monitoring: Analyze incoming and outgoing traffic for suspicious patterns.

Alert Management: Integrate SNORT seamlessly with logging systems such as MySQL and the ELK stack to record and track security incidents effectively..

Testing and Optimization: Simulate attack scenarios to test SNORT's detection capabilities and optimize its performance.

4. Advantages of Using SNORT:

Open-Source Flexibility: SNORT's open-source nature allows customization and scalability.

Cost-Effectiveness: Provides an enterprise-grade security without significant financial investment.

Community Support: A large community of developers ensures regular updates and extensive documentation.

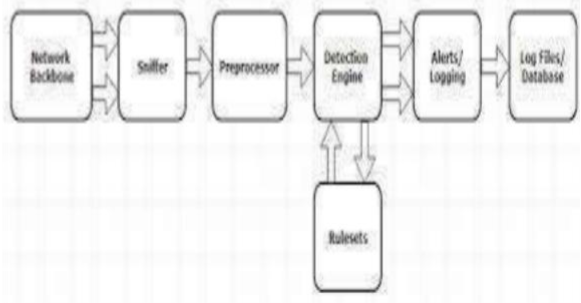


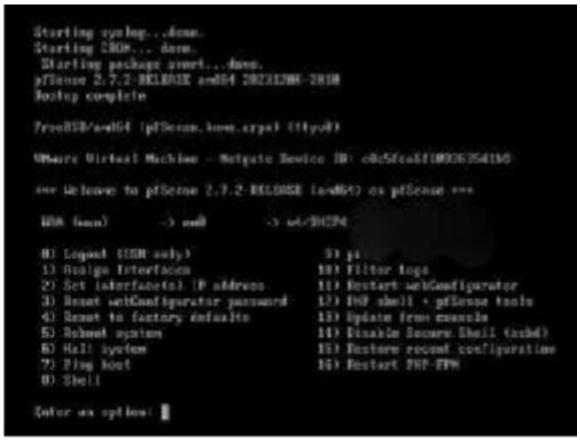
**Fig2: Snortasan IPS**

## VIMETHODOLOGY

### A. Setting Up UTM and SNORT

1. **Installation and Configuration of the UTM Platform**

Unified Threat Management (UTM) platforms Such as pfSense or OPNsense serve as comprehensive security solutions for managing and" Let me know if you need further formatting network traffic. The installation process begins with Acquiring the appropriate software image from the official websites of pfSense or OPNsense. After preparing a bootable medium, the software is installed on a dedicated system or virtual machine. Key configurations include defining network interfaces, setting up basic fire wall rules, and configuring administrative access.



```
Starting syslog...done.
Starting CRON... done.
 Starting package snort...done.
pfSense 2.7.2-RELEASE amd64 20231206-2010
Bootup complete

FreeBSD/amd64 (pfSense.home.arpa) (ttyv0)

VMware Virtual Machine - Netgate Device ID: [illegible]

*** Welcome to pfSense 2.7.2-RELEASE (amd64) on pfSense ***

 WAN (wan)       -> em0       -> v4/DHCP4

 0) Logout (SSH only)                  9) pf
 1) Assign Interfaces                 10) Filter Logs
 2) Set interface(s) IP address       11) Restart webConfigurator
 3) Reset webConfigurator password    12) PHP shell + pfSense tools
 4) Reset to factory defaults         13) Update from console
 5) Reboot system                     14) Disable Secure Shell (sshd)
 6) Halt system                       15) Restore recent configuration
 7) Ping host                         16) Restart PHP-FPM
 8) Shell

Enter an option:
```

**Fig3: Pf Sense**

### 2. Deployment of SNORT within the UTM Framework

SNORT, an open-source Intrusion Detection and Prevention System (IDPS), is integrated into the UTM for enhanced network monitoring and protection. This deployment starts with installing the SNORT package through the UTM's package manager. After installation, the configuration of interfaces to monitor traffic is carried out, ensuring all critical network segments are under surveillance. Subsequently, administrators configure SNORT to operate in either detection or prevention mode, depending on network requirements. Prevention mode, integrated with the UTM, actively blocks malicious traffic. Proper tuning of the system minimizes false positives and ensures robust threat detection.

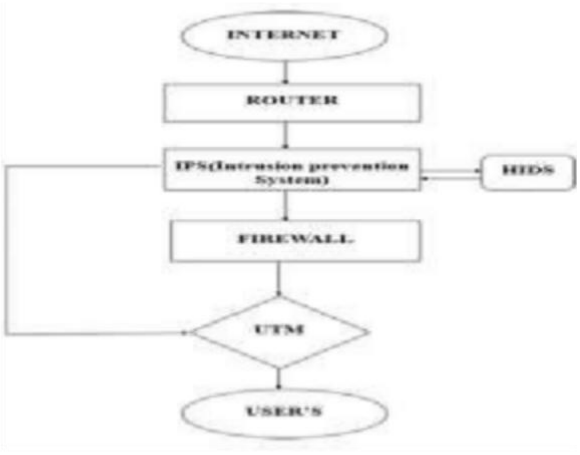


**Fig4: Flow Diagram of Mechanism**

### 3. Defining and Updating SNORT Rules

SNORT's efficacy heavily relies on its rule set, which dictates the types of traffic patterns to monitor and mitigate. Administrators must define custom rules tailored to the organization's security needs, while also leveraging community and commercial rule sets. Regular updates of these rules ensure the system is capable of detecting the latest threats. Automation of this process is often achieved by configuring SNORT to fetch updated rules from trusted repositories, such as the Emerging Threats or SNORT VRT (Vulnerability Research Team) data bases.

B. Logging and Analysis

**1. Integration of My SQLor the ELKStack for Logging**

Logging plays a crucial role in understanding network events and detecting anomalies. To this end, structured logging solutions like MySQL or the ELK (Elasticsearch, Logstash, Kibana) Stack are integrated into the system. MySQL offers a robust relational database for storing structured logs, whereas the ELK Stack provides a scalable solution for managing and visualizing large volumes of log data.

**2. Dashboard Creation in Kibana**

Kibana, a visualization tool within the ELK Stack, is utilized to create intuitive dashboards for monitoringand analyzing security events. These dashboardsprovidereal-timevisibility intonetworkalerts,intrusion attempts, and overall traffic trends.

C. Traffic Simulation

**1. Simulating Real-World Network Traffic**

Validation of the Intrusion Prevention System (IPS) requires realistic traffic simulation to test its detection and prevention capabilities. Tools such as Metasploit and JMeter are employed for this purpose. Metasploit generates a variety of attack vectors, including exploit payloads and penetration tests, while JMeter simulates legitimate user traffic.

**2. Validating Effectiveness**

During the simulation phase, SNORT logs and UTM dashboards are closely monitored to assess the system’s performance. Key metrics include the detection rate of malicious activities, the rate of false positives, and the overall impact on network latency. Continuous fine- tuning of SNORT rules and UTM configurationsensures optimal performance

## VI. BENEFITS

1. **Customizable Detection Rules**: The IPS allows users to define custom rules, enabling detection of specific threats unique to their network environment. This adaptability ensures the system is always relevant and effective
2. **Integrated Threat Management**: combining SNORT with UTM, the system provides a unified solution that simplifies management and reduces operational overhead while offering robust multi-layered security.
3. **Machine Learning Enhancements:** Incorporating algorithms improves pattern recognition, enabling the IPS to adapt emerging threats and detect previously unseen

vulnerabilities.

4. **Real-Time Monitoring and Automation**: SNORT's ability to perform real-time traffic analysis and automated responses ensures prompt mitigation of incidents.
5. **Scalable Architecture**: The modular design allows to handle increasing traffic loads and evolving security demands without compromising performance or accuracy.

## VII. RESULT

**The system was evaluated under various traffic loads and attack scenarios. The following observations were made:**

1. **Accuracy**: SNORT demonstrated high accuracy in detecting signature-based threats**.**
2. **Performance:** The system maintained optimal performance even under high traffic conditions, thanks to its multi-threaded design.
3. **Scalability:** The modular architecture allows easy scaling to accommodate growing network demands.

**Fig5: ICMPPing**

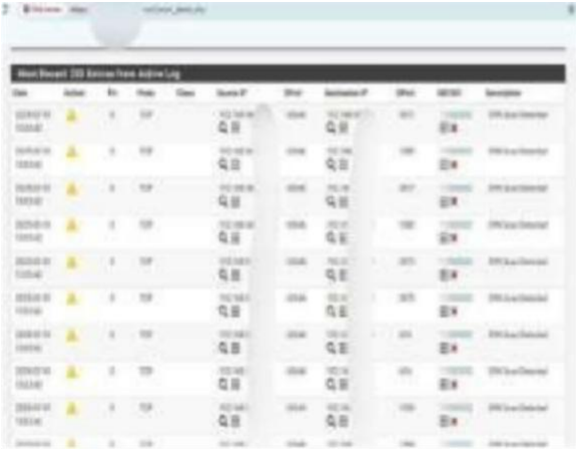


**Fig6: Nmap Scan**

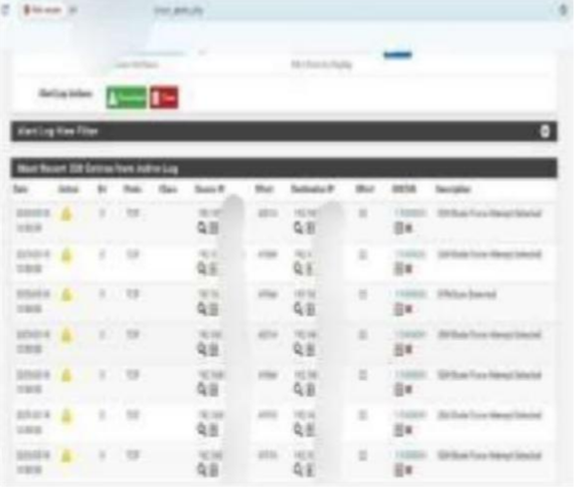


**Fig7: Ssh Brute-force**

**Fig8:Activity Mangement**

## VIII. DISCUSSION

The paper titled **"Design and Implementation of an Intrusion Prevention System (IPS) using Unified Threat Management (UTM)"** focuses on enhancing network security by integrating the advanced features of UTM with an IPS module. Unified Threat Management consolidates multiple security functions, such as firewall, antivirus, content filtering, and intrusion detection, into a single platform, simplifying network defense. By incorporating an IPS, the system not only detects potential threats in real-time but actively prevents malicious activities by blocking suspicious traffic. This implementation aims to protect networks from external attacks, such as Ssh Brute-force, Nmap scan detection, DDoS, malware, and SQL injections, while ensuring minimal performance impact. The paper will involve configuring UTM devices, fine-tuning IPS rules for accurate threat identification, and testing the system under simulated cyber-attacks. This holistic approach provides a scalable and cost- effective solution, addressing the growing need for robust cyber security in modern networks.

This paper focuses on bridging the gap between reactive and proactive security approaches by enabling the UTM to detect and prevent threats like DDoS attacks, malware propagation, phishing attempts, ran somware, and SQL injection attacks. The IPS will becon figured to analyze network traffic patterns and identify threats., and respond dynamically by either dropping malicious packets, sending alerts, or updating access control lists.

Furthermore, the paper will explore how the integration of these technologies impacts network performance, scalability, and user experience. Attention will be given to ensuring that the system is user-friendly for network administrators, with intuitive dashboards for monitoring and reporting threats. The final deliverable will be a robust, scalable, and cost-effective solution capable of securing networks against a wide range of sophisticated cyber threats. By addressing the growing need for multi-layered security in modern IT infrastructures, this paper aims to contribute significantly to the field of network security.

## IX. CONCLUSION

This paper provides a step-by-step implementation of an IPS using SNORT, integrated into a UTM framework. Through this process, we aim to:

- Mitigatepotential attacks in real-time.
- Log events and analyze them for further security insights.
- Optimize network performance while ensuring comprehensive security.

## FUTURE SCOPE

1. Advanced Machine Learning Integration: Future versions of the system can integrate advanced machine learning algorithms to enhance threat detection accuracy and minimize false positives by analyzing behavioral patterns and historical data..
2. Zero-Day Attack Prediction: Enhance the system’s capabilities to predict and mitigate zero-day attacks using AI-driven predictive models and threat intelligence feeds.
3. Cloud-Based Deployment: Expand the deployment options to cloud platforms

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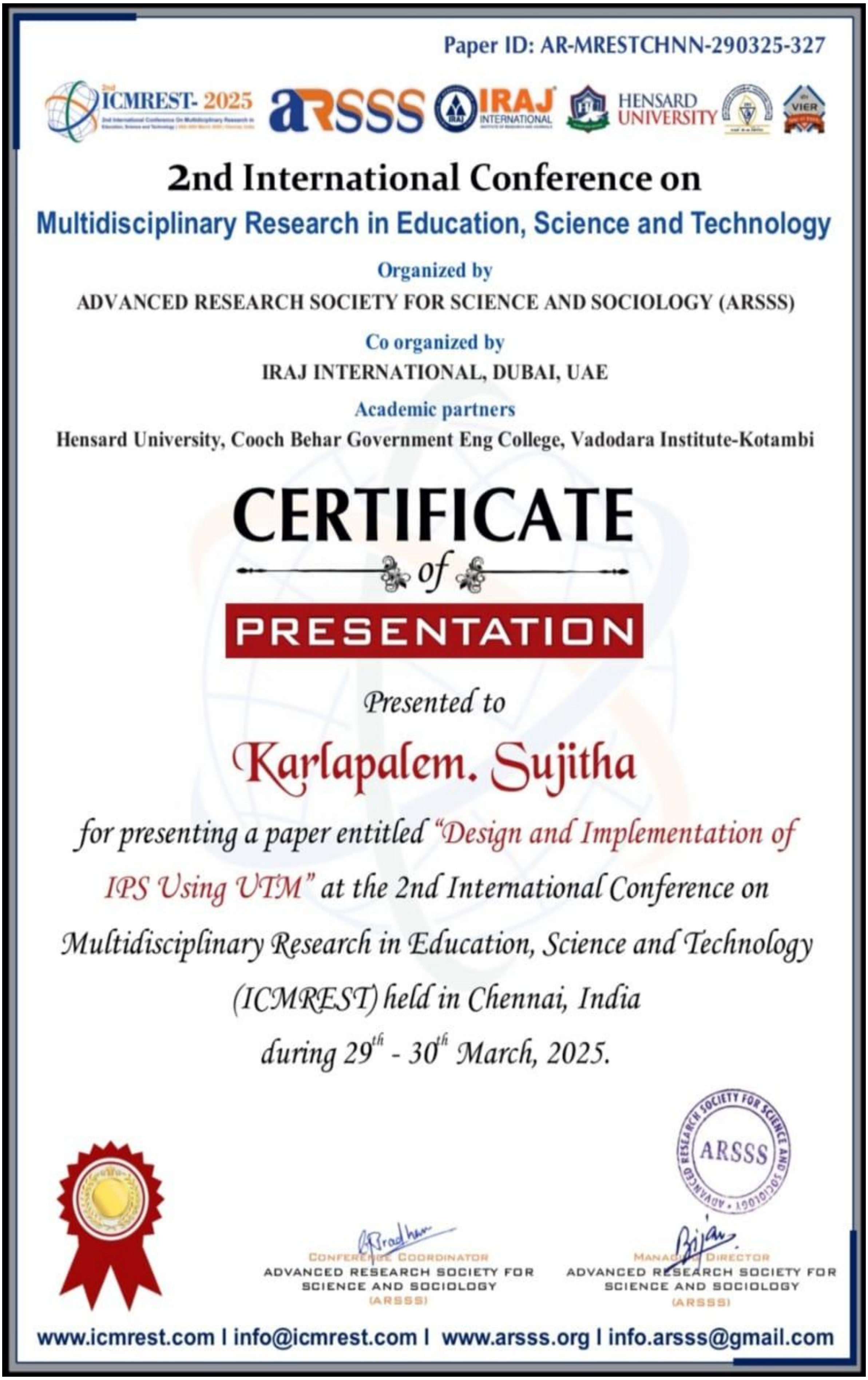

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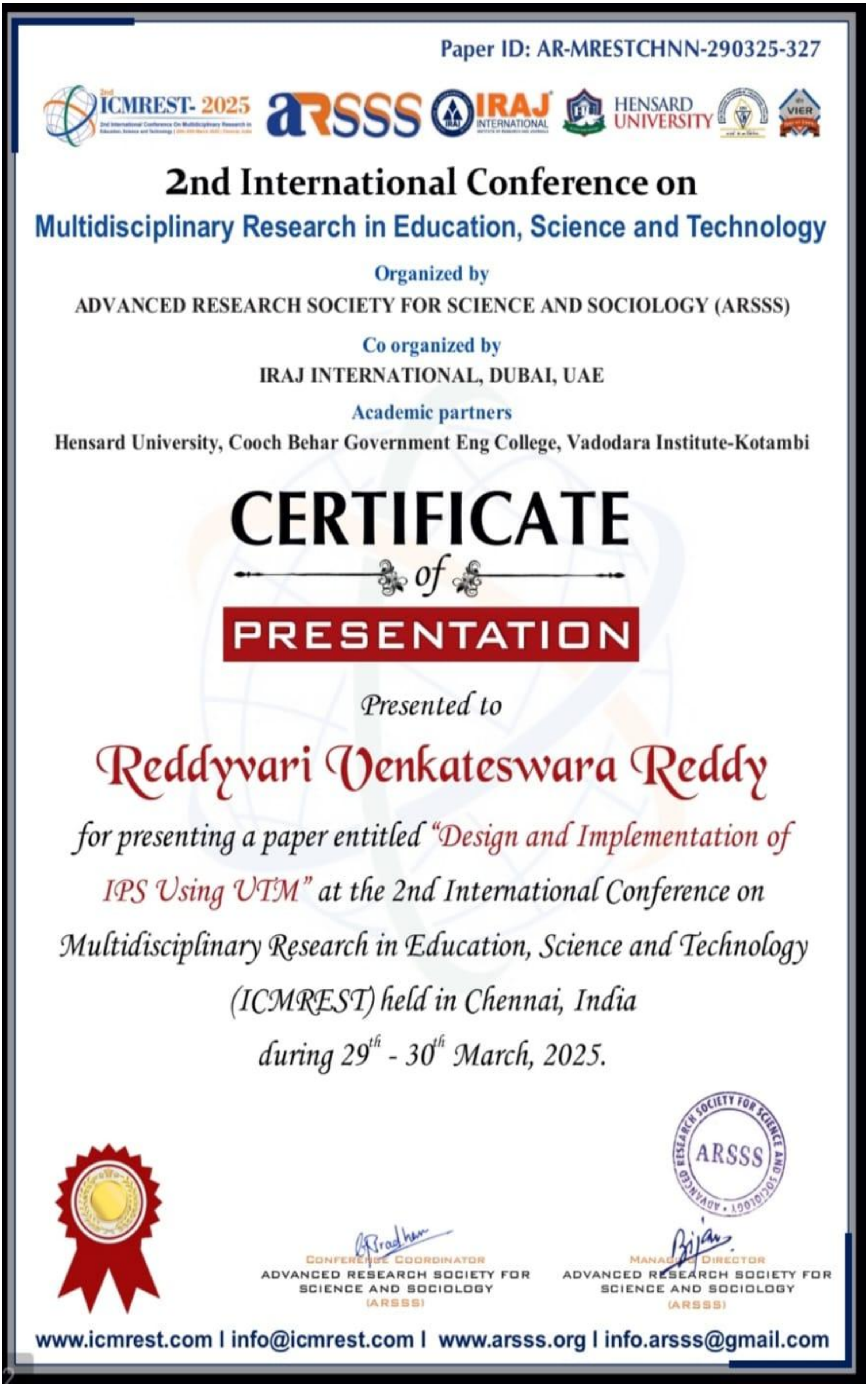

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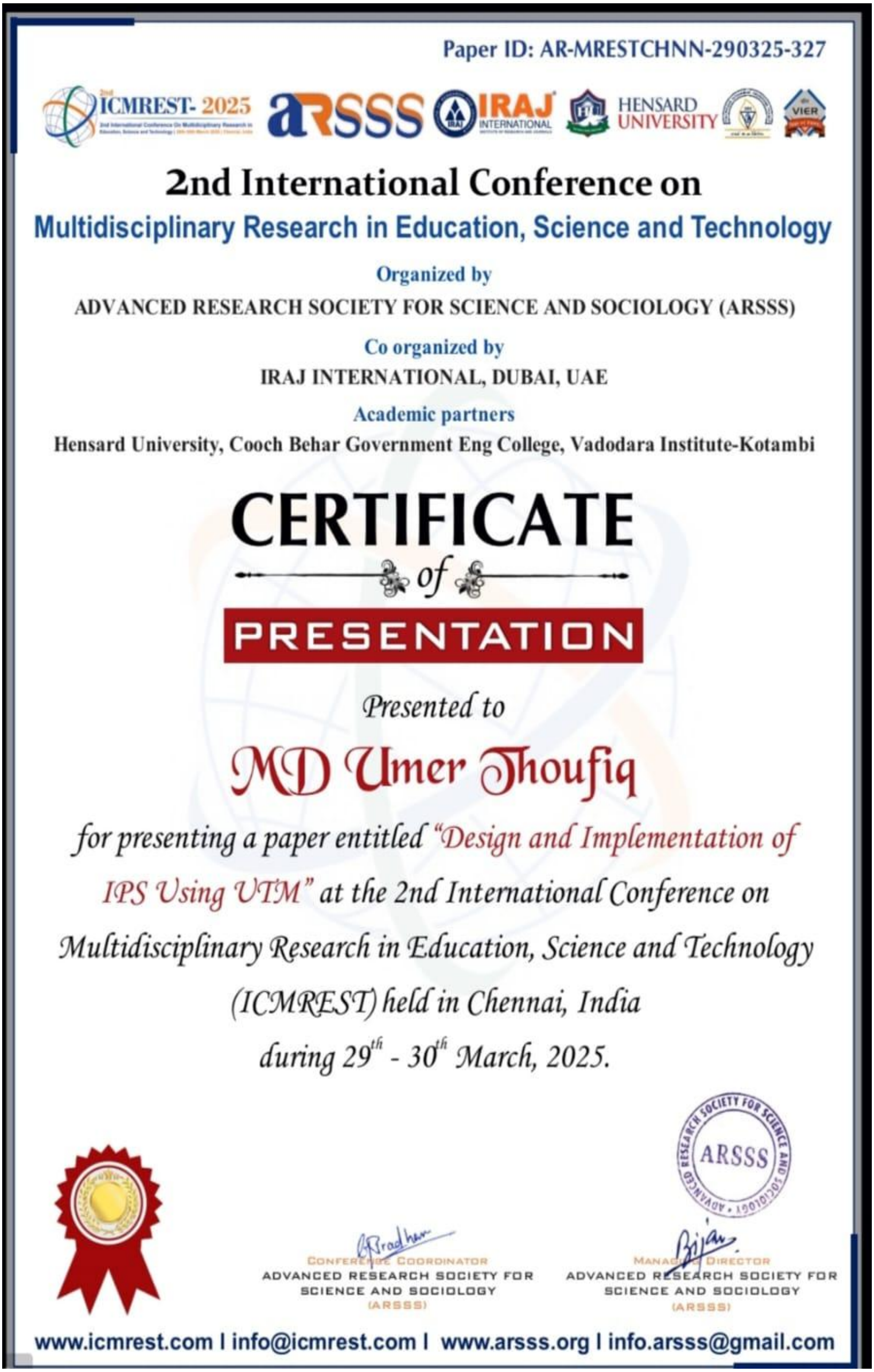

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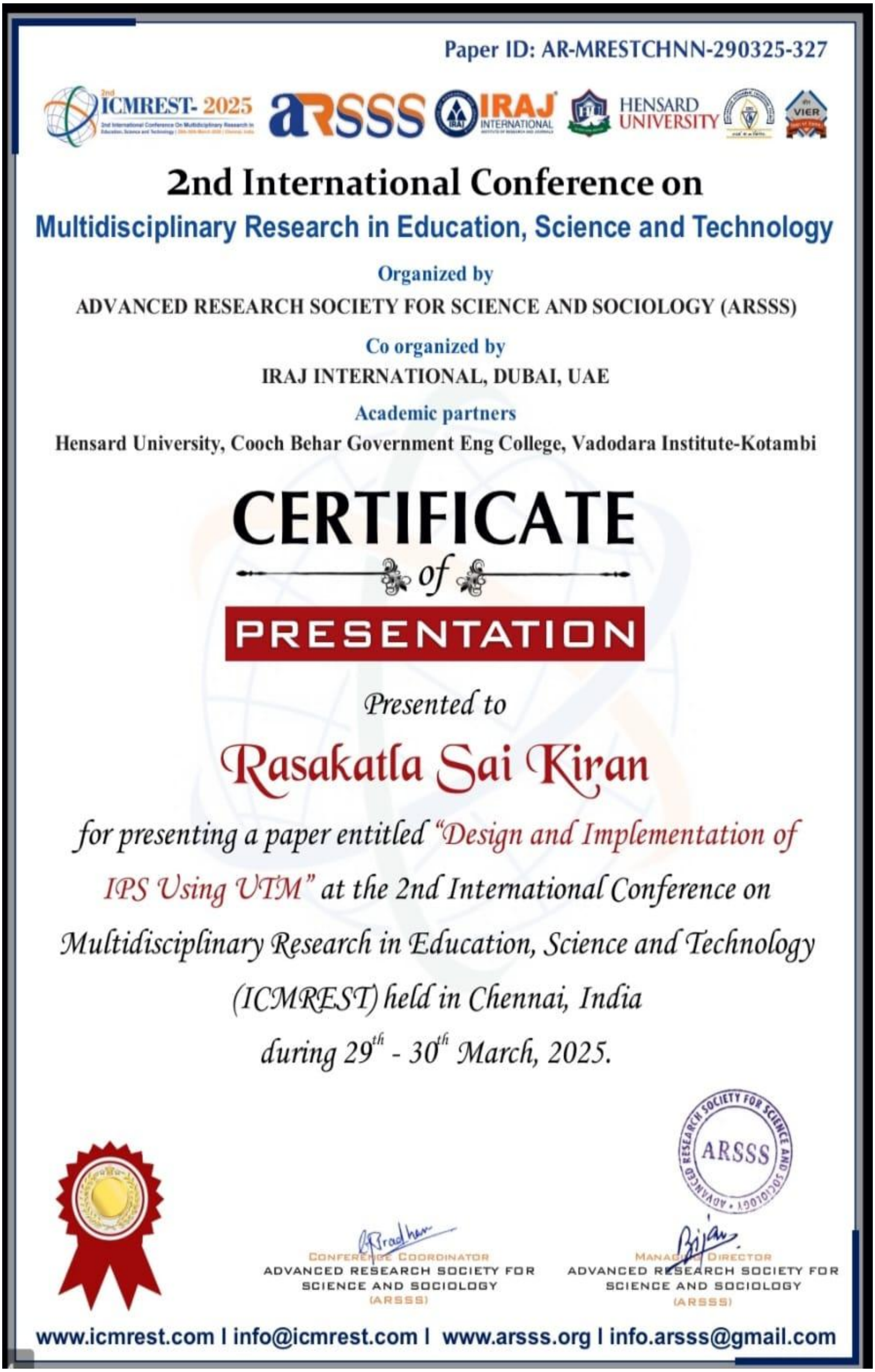

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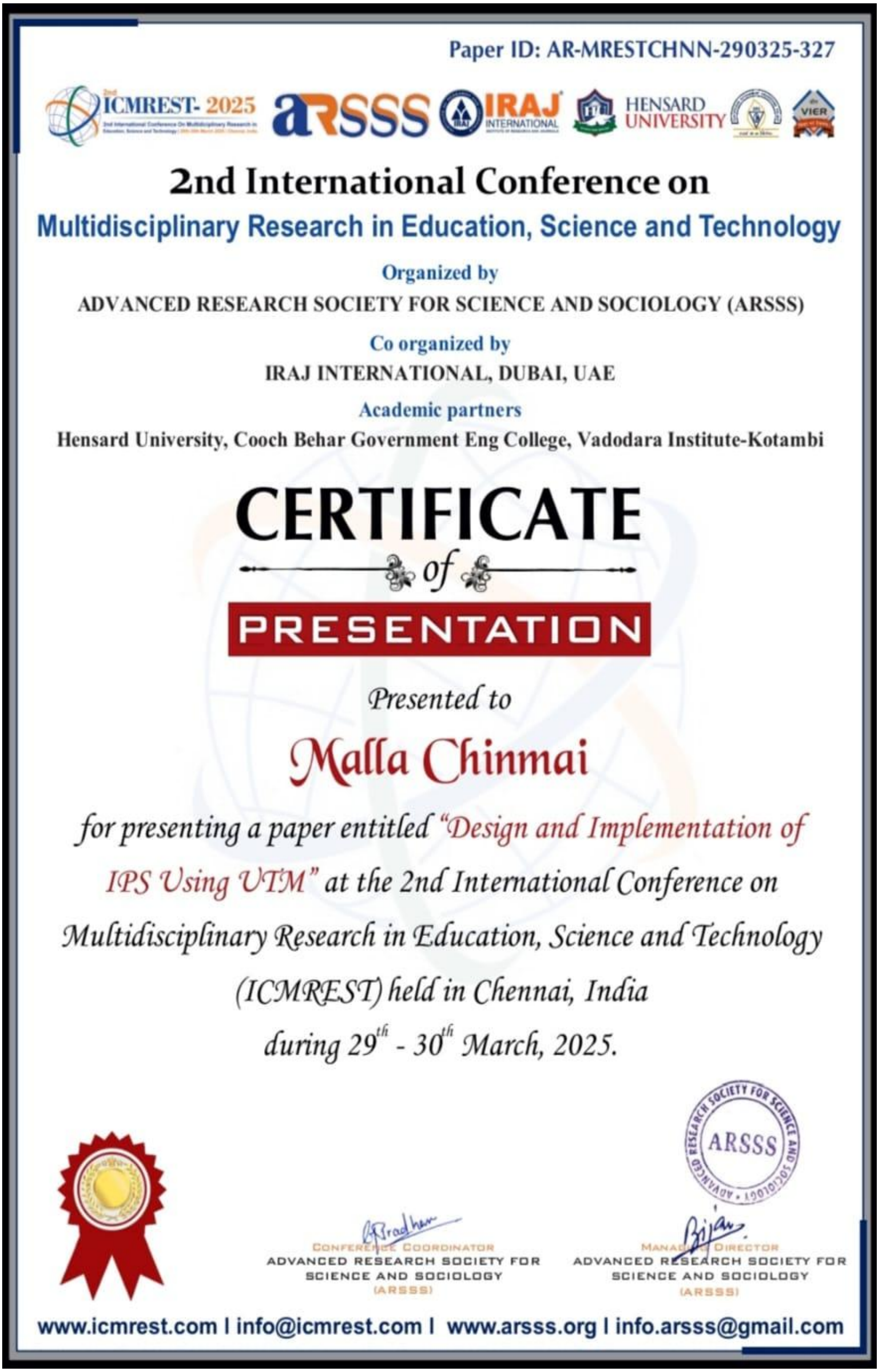

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