NETWORK TRAFFIC ANALYSIS FOR CYBER THREAT DETECTION

A Project report submitted

in partial fulfillment of requirement for the award of degree

BACHELOR OF TECHNOLOGY

in

SCHOOL OF COMPUTER SCIENCE AND ARTIFICIAL INTELLIGENCE

by

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CERTIFICATE

This is to certify that this project entitled **"NETWORK TRAFFIC ANALYSIS FOR CYBER THREAT DETECTION"** is the bonafied work carried out by **ARAVIND, MAHESH, SUMAN, NIMESH, KARTHIKEYA as a Project for the partial fulfillment to award the degree BACHELOR OF TECHNOLOGY in School of Computer Science and Artificial Intelligence during the academic year 2024-2025 under our guidance and Supervision.**

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ACKNOWLEDGEMENT

We owe an enormous debt of gratitude to our Project guide **Dr.Pramoda Patro,Assoc.Prof** as well as Head of the School of CS&AI , **Dr. M.Sheshikala, Professor** and Dean of the School of CS&AI, **Dr.Indrajeet Gupta Professor** for guiding us from the beginning through the end of the Capstone Project with their intellectual advices and insightful suggestions. We truly value their consistent feedback on our progress, which was always constructive and encouraging and ultimately drove us to the right direction.

We express our thanks to project co-ordinators **Mr. Sallauddin Md, Asst. Prof., and Dr.D.Ramesh Asst. Prof.** for their encouragement and support.

Finally, we express our thanks to all the teaching and non-teaching staff of the department for their suggestions and timely support.

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ABSTRACT

The Real-Time Network Traffic Analyzer is a Python-based application designed to monitor, capture, and analyze live network traffic. Developed using a combination of powerful libraries such as Scapy, Pandas, Matplotlib, and Tkinter, the tool provides a user-friendly graphical interface for real-time packet sniffing and basic anomaly detection. This project aims to bridge theoretical knowledge of computer networks with hands-on experience in network security and data analysis.

The application enables users to observe live packet flow, extract key attributes such as IP addresses, protocol types, and timestamps, and classify traffic based on protocol behavior. With Scapy, the system captures packets directly from the network interface, while Pandas is used to transform and analyze the data. Matplotlib provides dynamic visualizations of traffic patterns, and Tkinter allows for intuitive interaction through a responsive GUI. Multithreading ensures that the application remains responsive during continuous packet capture, making it suitable for real-time analysis.

Throughout development, we gained critical insights into network protocols, packet structures, and real-time data processing. We also implemented a basic anomaly detection mechanism to identify potential threats like DoS attacks or port scans using heuristic-based analysis. The project emphasized practical skills in debugging, application architecture, and the integration of multiple technologies.

The analyzer is ideal for educational use, home networks, and initial-level monitoring in small organizations. Its modularity and extensibility lay the groundwork for future enhancements such as machine learning-based threat detection, deep packet inspection, database integration, and cross-platform deployment. Overall, this project demonstrates how open-source tools and fundamental programming principles can be harnessed to develop efficient and meaningful solutions in the domain of network analysis and cybersecurity.

CHAPTER 1
INTRODUCTION

In the modern digital age, network security is a crucial aspect of safeguarding information systems. With the ever-increasing threat landscape, monitoring network traffic has become an essential part of ensuring data integrity, confidentiality, and availability. Network traffic analyzers are vital tools for detecting unauthorized access, malicious attacks, and abnormal behaviors in real-time. This project, titled "Real-Time Network Traffic Analyzer," is designed to fulfill the need for an intuitive, lightweight tool that captures and analyzes live network traffic on a host machine.

Developed using Python, this application uses Scapy for low-level packet sniffing, Pandas for data processing, Matplotlib for visualization, and Tkinter for GUI development. It collects live packet data over a 15-second window, processes the data to identify protocols (TCP, UDP, Others), and alerts the user if a single IP address generates a suspicious number of packets. The application displays a graphical representation of protocol distribution, aiding users in understanding the dominant types of traffic.

This analyzer is primarily intended for educational use, offering an approachable way to learn about network traffic behavior, protocol distribution, and anomaly detection without diving deep into complex enterprise tools. It's a product of the ZKP Warriors initiative aimed at promoting cybersecurity literacy and real-time diagnostic capabilities.

PROBLEM IDENTIFICATION

In today's interconnected world, devices on a network are continuously transmitting and receiving packets. While many of these transactions are legitimate, malicious traffic is often camouflaged within this data, making detection difficult. The primary problem this project addresses is the absence of accessible tools for real-time, understandable traffic analysis, especially for beginners or educational purposes.

Many existing network monitoring tools such as Wireshark are comprehensive but come with steep learning curves. They require a deep understanding of networking concepts and protocols, which might not be feasible for beginners or those looking for quick diagnostics. Additionally, these tools often overload the user with raw packet information without meaningful summaries or visualizations.

There is a need for a simple, interactive tool that highlights key network behaviors, such as repeated packet transmission from a single source, indicative of potential attacks. This tool aims to identify basic anomalies like DoS patterns and provide intuitive graphical insights into protocol usage without requiring extensive networking knowledge.

The absence of real-time alerts, minimal visual feedback, and difficulty in understanding traditional tools motivated the development of this lightweight, GUI-based analyzer that anyone with basic computing knowledge can use effectively.

CHAPTER 2

Requirement Analysis, Risk Analysis, Feasibility Analysis

To develop the Real-Time Network Traffic Analyzer, a set of functional and non-functional requirements were defined:

Functional Requirements:

- Capture live network packets for a defined time period (default: 15 seconds).
- Identify and classify packets by protocols (TCP, UDP, Others).
- Record and analyze source IP addresses and packet counts.
- Trigger alerts if traffic from a single IP exceeds a specified threshold.
- Display summary of alerts in a GUI window.
- Visualize protocol distribution using a bar chart.

Non-Functional Requirements:

- Provide a responsive and user-friendly graphical interface.
- Ensure compatibility with major platforms (Linux, Windows).
- Maintain data privacy by not storing or exporting packets.
- Ensure low memory and CPU usage.

Tools and Libraries:

- Programming Language: Python 3.x
- GUI Toolkit: Tkinter
- Packet Sniffing: Scapy
- Data Analysis: Pandas
- Visualization: Matplotlib
- Threading: Python's threading module for responsive UI

These requirements ensure the tool meets usability, performance, and security expectations for educational and light diagnostic purposes.

CHAPTER 3
PROPOSED SOLUTION

The proposed system is a Python-based Real-Time Network Traffic Analyzer that provides a lightweight, user-friendly solution for monitoring live packet data on a local machine. Unlike traditional network analysis tools that are often complex and overloaded with information, this tool is designed for simplicity, clarity, and accessibility—ideal for students, educators, and beginner cybersecurity enthusiasts.

This system uses a modular approach to capture, analyze, and visualize network traffic data. It is developed using Python 3.x, leveraging key libraries like Scapy for packet sniffing, Pandas for data processing, Matplotlib for chart visualization, and Tkinter for building the graphical user interface (GUI). Each component of the system is loosely coupled, allowing for scalability and future upgrades.

When the application is launched, users can initiate packet capture by simply clicking the "Start Sniffing" button on the GUI. The system captures all incoming and outgoing packets on the network interface for a default duration of 15 seconds. During this time, it extracts key metadata such as source IP, destination IP, protocol type, packet length, and timestamps. All captured packet data is stored temporarily in memory and not written to disk, ensuring user privacy and data security.

The core logic includes a threshold-based anomaly detection mechanism. If any single source IP address sends more than 10 packets within the sniffing window, the system flags it as potentially suspicious. This is a simplified rule-based method for identifying common attacks like Denial-of-Service (DoS) or unusually active devices on the network. Detected anomalies are displayed in real-time in the GUI's alert area, making it easy for users to understand the issue without needing deep technical knowledge.

Once sniffing is complete, the application summarizes the traffic using a bar chart generated with Matplotlib. This chart shows the distribution of protocols (TCP, UDP, and Others), helping users visually identify what types of traffic dominate their network. The GUI provides buttons to switch between packet alerts and traffic charts, offering an interactive and informative experience.

Key Features of the Proposed System:

1. Real-Time Packet Sniffing

   Uses Scapy to monitor live packets with minimal delay, capturing essential details such as source and destination IPs, protocol types, and timestamps.

2. User-Friendly Interface

   Built with Tkinter, the GUI allows users to interact with the tool easily—start and stop sniffing, view alerts, and generate charts—all from a single window.

3. Protocol-BasedVisualization

   Displays a bar chart of protocol distribution (TCP, UDP, Others) post-capture, enabling quick insights into traffic composition.

4. Anomaly Detection with Alerts

   Implements a rule-based alert system that flags any IP generating more than a specified number of packets, helping detect suspicious behavior or potential attacks.

5. Privacy-Focused Design

   All packet data is handled in memory and not logged or transmitted, ensuring user privacy and safe usage.

6. Cross-Platform Compatibility

   Runs smoothly on both Windows and Linux systems without requiring administrative access or external dependencies beyond Python libraries.

7. Modular Architecture

   Separate components for sniffing, processing, analyzing, and visualizing data allow easy future enhancement (e.g., replacing Matplotlib with Seaborn or adding ML-based detection).

   This tool emphasizes real-time feedback, simplicity, and educational value, making it perfect for quick diagnostics and learning scenarios. It provides just enough functionality to highlight network behaviors and detect obvious anomalies without overwhelming the user. The modular build also serves as a foundation for more advanced future versions, possibly incorporating AI or cloud-based monitoring.

In conclusion, the proposed system delivers an efficient, intuitive, and privacy-respecting solution for real-time network traffic analysis on personal computers, especially in learning and demonstration environments.

MODEL TRAINING

Although the current version of the Real-Time Network Traffic Analyzer uses a rule-based logic system for anomaly detection, the concept of model training is vital to understand for future development of more advanced, intelligent systems. Traditional network analyzers often depend on static thresholds and expert-defined heuristics to identify unusual behavior. While this is efficient for basic pattern recognition, it may miss complex or evolving attack patterns that do not conform to predefined rules.

To build an ML-enhanced analyzer, one would typically start by collecting a comprehensive dataset of network traffic that includes both normal and abnormal behavior. Public datasets like CICIDS2017, KDD99, or UNSW-NB15 are commonly used in academic research for this purpose. These datasets provide labeled traffic flows that help train supervised models such as decision trees, support vector machines (SVM), or neural networks.

Features used for training might include:

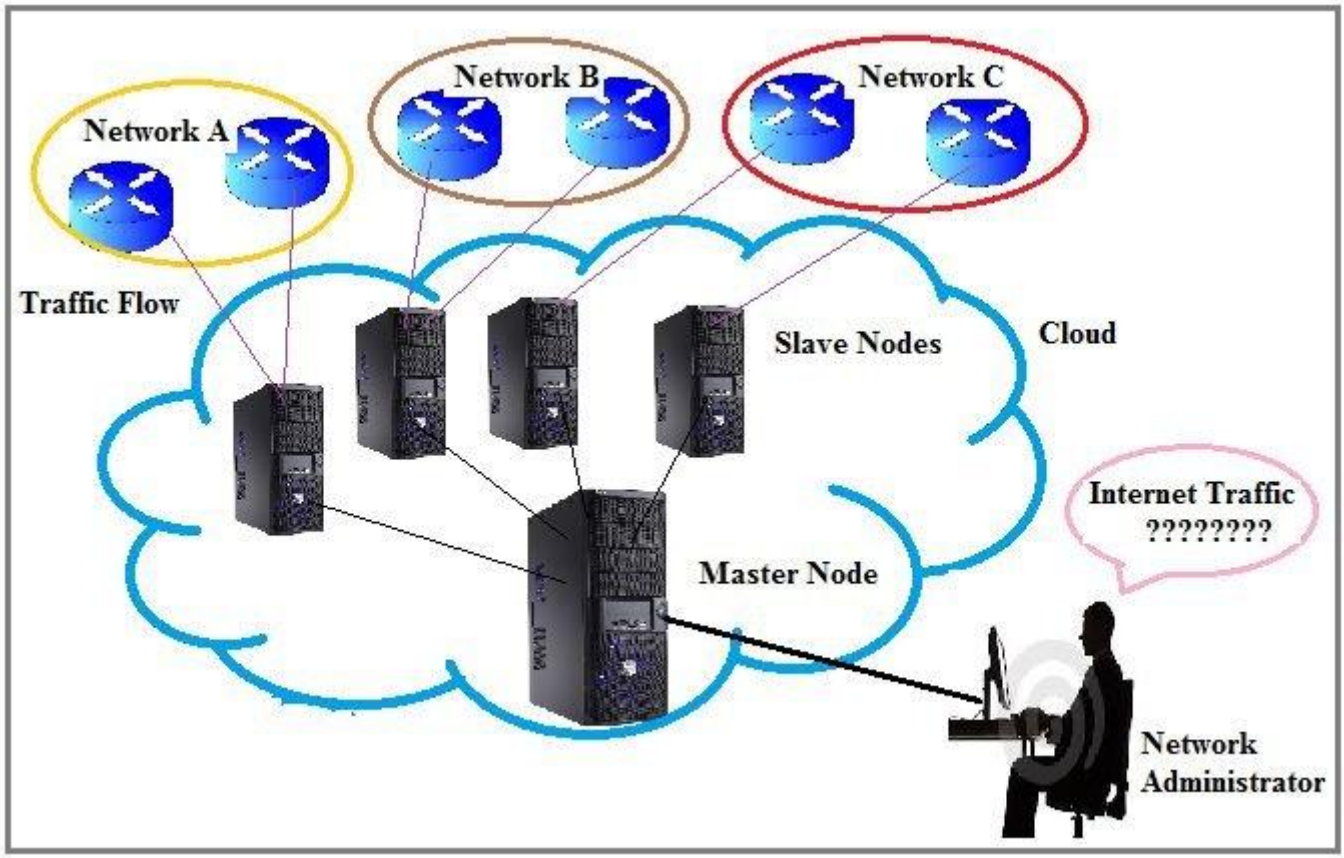
- Packet size
- Source and destination IP and port
- Time intervals between packets (inter-arrival time)
- Protocol types
- Packet counts per flow
- Flag settings (e.g., SYN, ACK)

Once data is collected and features are extracted, it is split into training and testing datasets. The training data is used to fit the model, teaching it to distinguish between legitimate and suspicious behaviors. The testing set evaluates how well the model generalizes to unseen data. Common evaluation metrics include accuracy, precision, recall, F1-score, and confusion matrix.

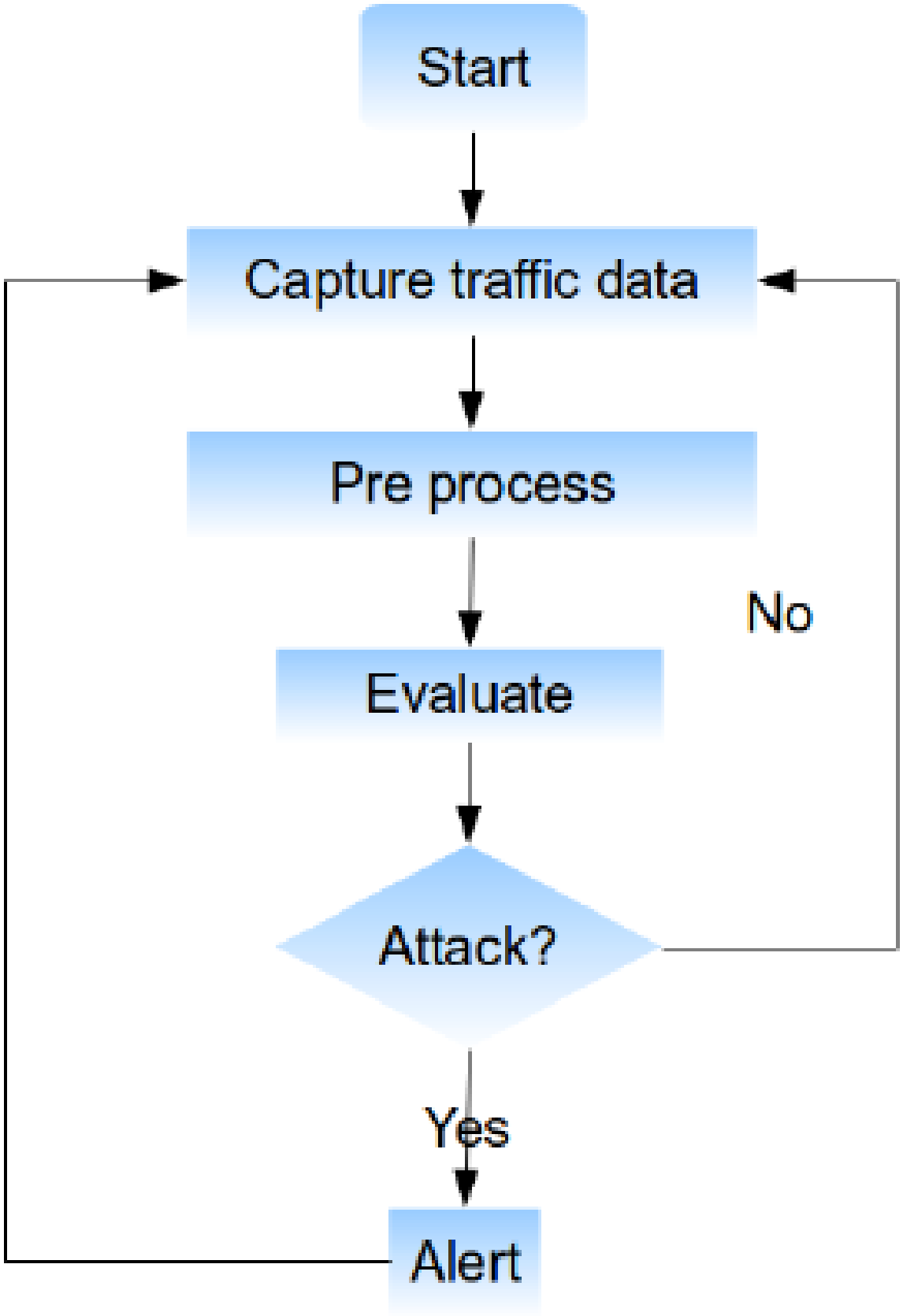
In a real-time system like the one developed for this project, the trained model could be integrated into the analysis pipeline. As packets are captured and features extracted, the model would instantly classify the flow as benign or malicious and update the GUI accordingly. This allows for dynamic, adaptive detection that evolves over time and is more resilient to zero-day or polymorphic attacks..

In summary, model training involves teaching a computational model to detect and classify network traffic based on patterns in historical data. While the present tool relies on heuristic thresholds, it lays the foundation for future enhancements where trained models can bring a higher level of automation, accuracy, and adaptability to network security monitoring.

ARCHITECTURE DIAGRAM



FLOW CHART


Start
Capture traffic data
Pre process
No
Evaluate
Attack?
Yes
Alert

DATA FLOW

Understanding the data flow within the Real-Time Network Traffic Analyzer is essential for grasping how information moves through the system—from the moment it enters the network interface to its analysis, visualization, and display on the user interface. This section elaborates on each step in the data flow pipeline, highlighting how data is collected, processed, interpreted, and presented to the user in real time.

1. Packet Capture from Network Interface

The data flow begins with the capture of live network packets. This is achieved using Scapy, a powerful packet manipulation tool in Python. Scapy interacts directly with the system's network interface card (NIC) in promiscuous mode, enabling the system to sniff all incoming and outgoing packets regardless of their intended destination. This allows for comprehensive monitoring of the entire network traffic.

Each captured packet includes various protocol layers such as Ethernet, IP, TCP, UDP, ICMP, and more. Scapy parses these layers to extract meaningful information like source and destination IP addresses, port numbers, payload size, and protocol type. This raw data forms the basis of all subsequent processing and analysis.

2. Real-Time Packet Filtering and Structuring

Once packets are captured, the next step is to filter and structure the data in a usable format. The system applies basic filters to exclude irrelevant or redundant packets—such as those with empty payloads or local loopback traffic—thus reducing noise and improving performance.

After filtering, the packet data is organized into a structured format using Python dictionaries and lists. Each packet's information is appended as a row containing key attributes such as timestamp, source IP, destination IP, protocol, and packet length. This structured list of records is then used to populate a Pandas DataFrame, which acts as the main data structure for analysis.

3. Data Analysis and Anomaly Detection

The structured packet data in the DataFrame undergoes real-time analysis. Various aggregation functions are used to summarize traffic patterns, such as counting the number of packets per protocol or calculating total data transferred by each IP address. This enables the system to monitor trends and detect spikes in traffic.

For anomaly detection, the system uses simple rule-based logic. For instance, if a single IP sends an unusually high number of packets within a short period, it could indicate a Denial-of-Service (DoS) attack or port scanning activity. These anomalies are flagged and logged for display in the alert section of the interface.

4. Visualization and Reporting

To help users understand the ongoing network activity, the analyzed data is visualized using Matplotlib. Real-time charts and graphs are generated to show protocol distribution (e.g., pie chart of TCP, UDP, ICMP traffic), packet count over time, or top talkers (most active IPs).

These visualizations are refreshed at regular intervals and embedded into the graphical user interface using Tkinter. The charts provide intuitive and immediate insights into the network's health and performance, enabling users to identify unusual patterns or potential threats at a glance.

5. Graphical User Interface and User Interaction

The final step in the data flow is the presentation of data through the GUI. The interface is built using Tkinter, with multiple components such as tables, status bars, alert boxes, and embedded plots. Users can view live packet logs, monitor real-time statistics, and receive alerts for any detected anomalies.

To maintain responsiveness, the GUI runs on the main thread while packet sniffing and data processing occur in background threads using Python's multithreading module. Shared data structures are synchronized appropriately to ensure real-time updates without freezing or crashing the interface.

6. Summary of Data Flow

In summary, the data flow in the Real-Time Network Traffic Analyzer follows a modular and systematic approach:

1. Packet Sniffing – Capturing raw packets from the NIC using Scapy.
2. Data Structuring – Extracting key fields and storing them in Pandas DataFrames.
3. Analysis – Aggregating, filtering, and detecting anomalies in real-time.
4. Visualization – Converting analyzed data into plots and charts.
5. Display and Interaction – Presenting the results through a responsive and user-friendly GUI.

This organized flow ensures that the system can handle real-time traffic efficiently while offering valuable insights to the user. Each component in the flow is critical to ensuring the accuracy, speed, and usability of the network monitoring process.

CHAPTER 4
IMPLEMENTATION

The Real-Time Network Traffic Analyzer is implemented using Python, integrating several open-source libraries to provide a complete, responsive, and user-friendly experience. The core functionalities are divided into modules, each responsible for a specific task, including packet capturing, data processing, anomaly detection, visualization, and GUI interactions.

4.1 Environment Setup

To begin with, Python 3.x is required along with the following libraries:

- Scapy – for packet sniffing and network-level access
- Pandas – for structured data analysis
- Matplotlib – for generating protocol distribution charts
- Tkinter – for GUI development
- Threading – to handle real-time packet sniffing without freezing the GUI

The environment can be set up using pip:

pip install scapy pandas matplotlib

Tkinter and threading come built-in with Python.

4.2 GUI Design (Tkinter)

The GUI serves as the control center where users can initiate packet sniffing and view the analysis results. The window includes:

- A "Start Sniffing" button that initiates the packet capture.
- A text area to display alerts or suspicious IPs.
- A "Show Chart" button that becomes active after analysis, displaying protocol distribution.

Tkinter's Text, Button, and Canvas widgets are used to organize and display this information in a visually simple layout. The GUI remains responsive during packet capture thanks to threading.

4.3 Packet Sniffing (Scapy)

When the user clicks "Start Sniffing," a new thread is launched that captures network packets for 15 seconds. Scapy's sniff() function is employed, with a filter to collect only IP packets and a timeout to stop the capture after a predefined interval.

Here's an example of the packet sniffing call:

```
packets = sniff(filter="ip", timeout=15)
```

Each packet is parsed to extract:

- Source IP address
- Destination IP address
- Protocol (TCP/UDP/Other)
- Length of the packet
- Timestamp

Only required fields are stored to maintain low memory usage. The data is temporarily stored in a Python list as dictionaries.

4.4 Data Processing (Pandas)

After sniffing ends, the packet list is converted to a Pandas DataFrame for efficient analysis. The DataFrame allows fast aggregation, grouping, and filtering operations.

A key operation here is counting the number of packets from each source IP:

```
ip_counts = df['src_ip'].value_counts()
```

This result is compared against a threshold (e.g., more than 10 packets from one IP in 15 seconds), and those exceeding the limit are flagged as suspicious. These IPs are collected and displayed as alerts in the GUI.

4.5 Protocol Classification

The analyzer identifies whether each packet is using TCP, UDP, or another protocol by inspecting the Scapy layer:

```
if packet.haslayer(TCP):
    protocol = 'TCP'
elif packet.haslayer(UDP):
    protocol = 'UDP'
else:
    protocol = 'Other'
```

The protocol values are stored in the dataset and used later for chart visualization.

4.6 Visualization (Matplotlib)

Once analysis is complete, the user can click “Show Chart” to view a bar chart of protocol distribution. Using Matplotlib, a bar chart is generated from the protocol count data and displayed in a pop-up window.

```
protocol_counts = df['protocol'].value_counts()
protocol_counts.plot(kind='bar', color=['skyblue', 'lightgreen', 'salmon'])
plt.title("Protocol Distribution")
plt.xlabel("Protocol")
plt.ylabel("Number of Packets")
plt.show()
```

This visualization helps users quickly interpret the dominant traffic type in the captured session.

4.7 Alert System

The application checks for IPs that send more than 10 packets in 15 seconds, which is unusual in most environments. This rule-based anomaly detection method is simple but effective for highlighting potential denial-of-service attempts or scanning behavior.

Alerts are written into the GUI's text area, helping users monitor the situation without reading raw packet logs.

4.8 Multithreading

To prevent the GUI from freezing while capturing packets, threading is used. The packet sniffing and data processing tasks run in a background thread so the interface remains interactive. The threading.Thread class handles this:

```
sniff_thread = threading.Thread(target=sniff_packets)
sniff_thread.start()
```

Proper thread management ensures results are passed back to the main thread safely for UI updates.

4.9 Privacy Considerations

To ensure user privacy, the application avoids logging or storing packet data permanently. All captured data is stored in memory and discarded after the analysis session ends. The tool runs entirely on the local machine without sending data to external servers.

This modular implementation approach makes the analyzer efficient, extensible, and easy to understand. Its real-time capability, visual feedback, and simplicity make it ideal for students, educators, and hobbyists who want to understand network behavior and basic security concepts. Future improvements could include packet filtering by port, logging suspicious activity, or even integrating a machine learning model for more advanced anomaly detection.

PROGRAM

```
import tkinter as tk
from tkinter import ttk, messagebox
from scapy.all import sniff, IP, TCP, UDP
import pandas as pd
import matplotlib.pyplot as plt
import threading
import time



class LiveTrafficAnalyzer:
    def __init__(self):
        self.packets = []
        self.running = False


    def process_packet(self, packet):
        if IP in packet:
            proto = "Other"
            if TCP in packet:
                proto = "TCP"
            elif UDP in packet:
                proto = "UDP"
            self.packets.append({
                "src": packet[IP].src,
```

```
            "dst": packet[IP].dst,
            "proto": proto,
            "len": len(packet),
            "timestamp": time.time()
        })

def start_sniffing(self, duration=15):
    self.packets = []
    self.running = True
    sniff(prn=self.process_packet, timeout=duration, store=False)
    self.running = False

def analyze_packets(self):
    df = pd.DataFrame(self.packets)
    alerts = []
    if df.empty:
        return df, ["⚠ No packets captured. Try again."]

    suspicious_ips = df['src'].value_counts()
    for ip, count in suspicious_ips.items():
        if count > 10:
            alerts.append(f"🚨 [ALERT] High traffic from {ip}: {count} packets")

    return df, alerts
```

```
class App:
    def __init__(self, root):
        self.root = root
        self.root.title("🔍 Real-Time Network Traffic Analyzer")
        self.root.geometry("800x700")
        self.root.configure(bg="#1e1e2f")

        self.analyzer = LiveTrafficAnalyzer()

        style = ttk.Style()
        style.theme_use("clam")
        style.configure("TButton", padding=6, relief="flat", background="#3e3e5b", foreground="white")
        style.configure("TLabel", background="#1e1e2f", foreground="white", font=("Segoe UI", 11))
        style.configure("TFrame", background="#1e1e2f")

        self.frame = ttk.Frame(self.root, padding="20")
        self.frame.pack(expand=True, fill=tk.BOTH)

        self.project_name = ttk.Label(self.frame, text="🛡️ ZKP Warriors", font=("Segoe UI", 20, "bold"), foreground="#00d4ff")
        self.project_name.pack(pady=(0, 5))

        self.title_label = ttk.Label(self.frame, text="🌐 Real-Time Network Traffic Analyzer", font=("Segoe UI", 16, "bold"))
        self.title_label.pack(pady=(0, 10))
```

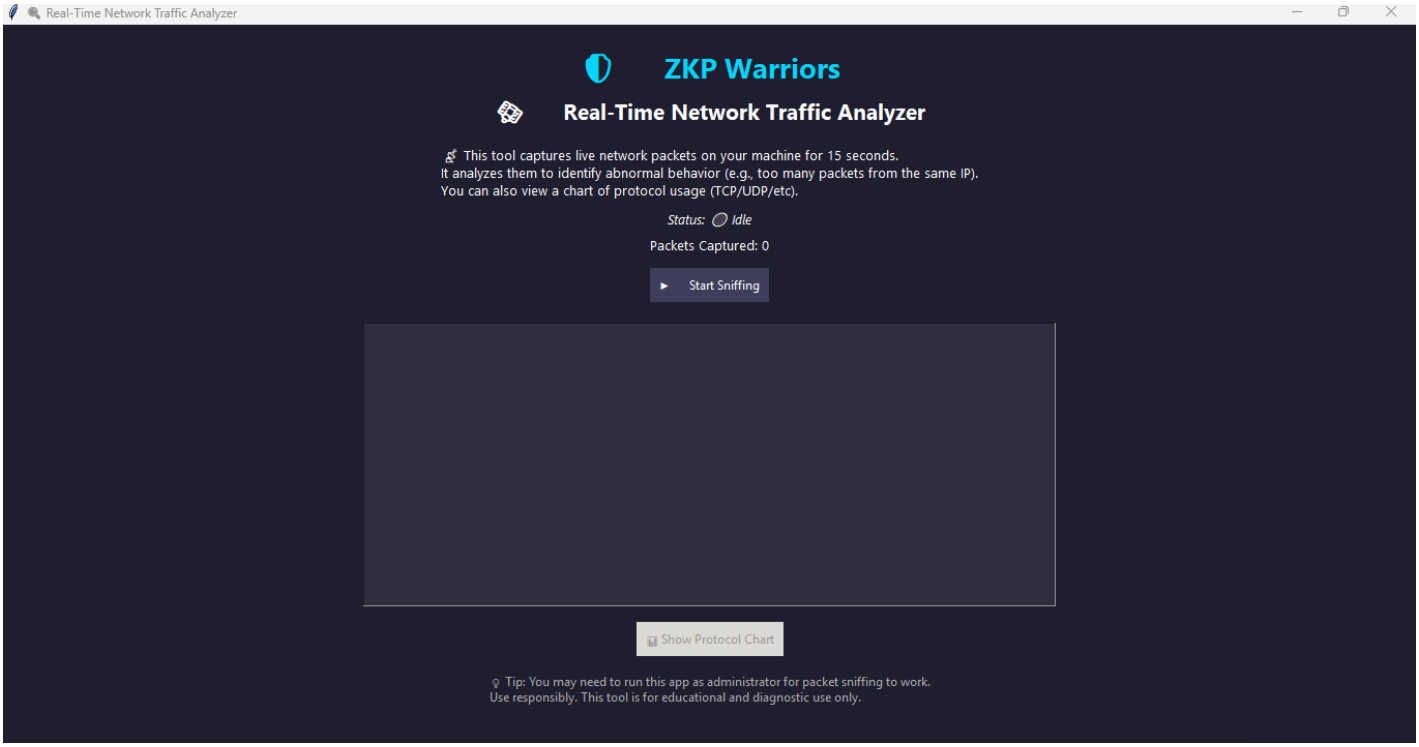
```
self.description = ttk.Label(self.frame, text=(
    "📡 This tool captures live network packets on your machine for 15 seconds.\n"
    "It analyzes them to identify abnormal behavior (e.g., too many packets from the same IP).\n"
    "You can also view a chart of protocol usage (TCP/UDP/etc)."
), font=("Segoe UI", 10), justify="left")
self.description.pack(pady=5)

self.status_label = ttk.Label(self.frame, text="Status: 🔘 Idle", font=("Segoe UI", 10, "italic"))
self.status_label.pack(pady=2)

self.counter_label = ttk.Label(self.frame, text="Packets Captured: 0", font=("Segoe UI", 10))
self.counter_label.pack(pady=2)

self.start_btn = ttk.Button(self.frame, text="▶️ Start Sniffing", command=self.start_sniffing)
self.start_btn.pack(pady=10)

self.text_area = tk.Text(self.frame, width=95, height=18, bg="#2e2e3f", fg="white",
                         insertbackground="white", font=("Consolas", 10))
self.text_area.pack(pady=10)

self.chart_btn = ttk.Button(self.frame, text="📊 Show Protocol Chart", command=self.show_chart)
self.chart_btn.pack(pady=5)
self.chart_btn['state'] = 'disabled'

self.footer_label = ttk.Label(
    self.frame,
```

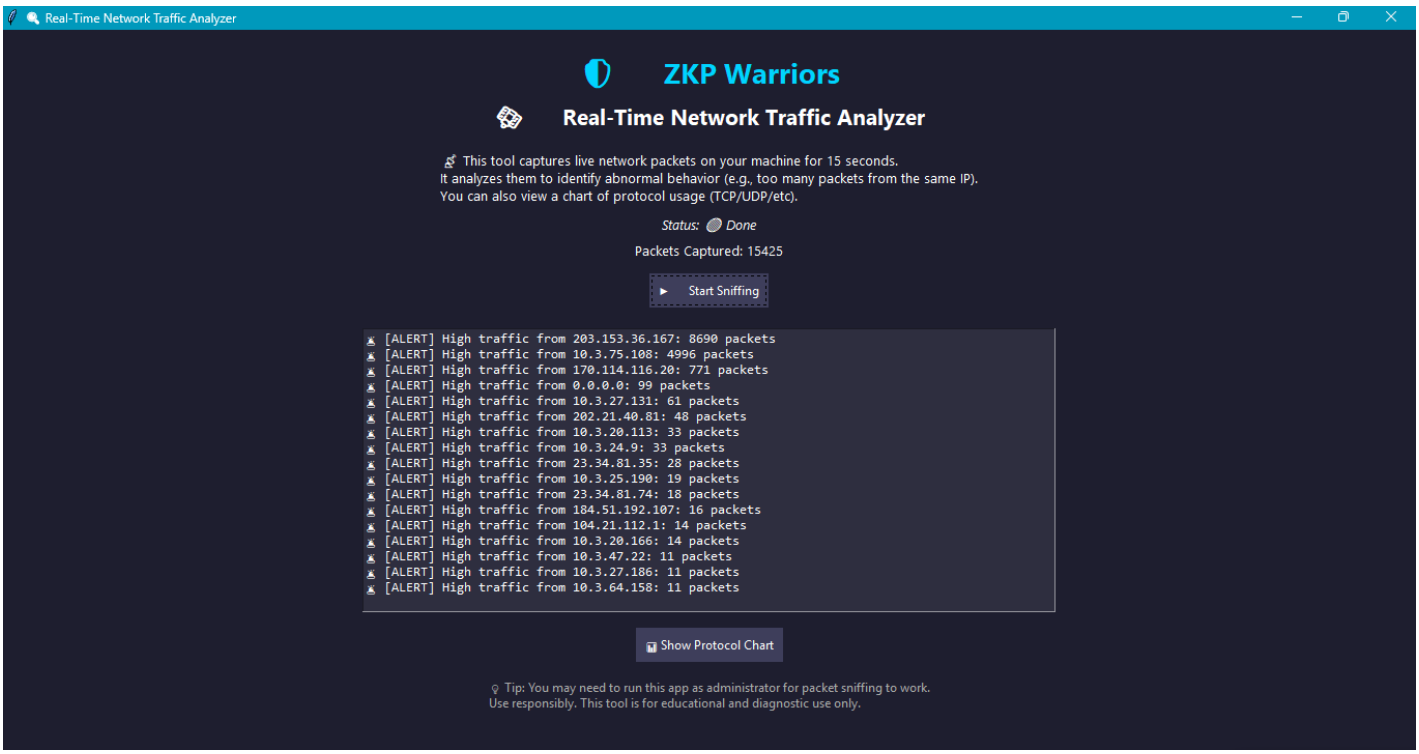
```
        text="💡 Tip: You may need to run this app as administrator for packet sniffing to work.\n"
             "Use responsibly. This tool is for educational and diagnostic use only.",
        font=("Segoe UI", 9), foreground="#aaa"
    )
    self.footer_label.pack(pady=10)

    self.df = None

def start_sniffing(self):
    self.text_area.delete(1.0, tk.END)
    self.status_label.config(text="Status: 🔍 Sniffing...")
    self.counter_label.config(text="Packets Captured: 0")
    self.start_btn['state'] = 'disabled'
    self.chart_btn['state'] = 'disabled'

    def sniff_thread():
        self.analyzer.start_sniffing(duration=15)
        self.df, alerts = self.analyzer.analyze_packets()
        self.text_area.delete(1.0, tk.END)
        self.text_area.insert(tk.END, "\n".join(alerts) if alerts else "☑ No threats detected.")
        self.status_label.config(text="Status: 🔍 Done")
        self.counter_label.config(text=f"Packets Captured: {len(self.analyzer.packets)}")
        self.start_btn['state'] = 'normal'
        self.chart_btn['state'] = 'normal'

    threading.Thread(target=sniff_thread).start()
```

```
    def show_chart(self):
        if self.df is not None and not self.df.empty:
            proto_counts = self.df['proto'].value_counts()
            proto_counts.plot(kind='bar', title="Protocol Distribution", color='skyblue')
            plt.xlabel("Protocol")
            plt.ylabel("Packet Count")
            plt.tight_layout()
            plt.show()



if __name__ == "__main__":
    root = tk.Tk()
    app = App(root)
    root.mainloop()
```

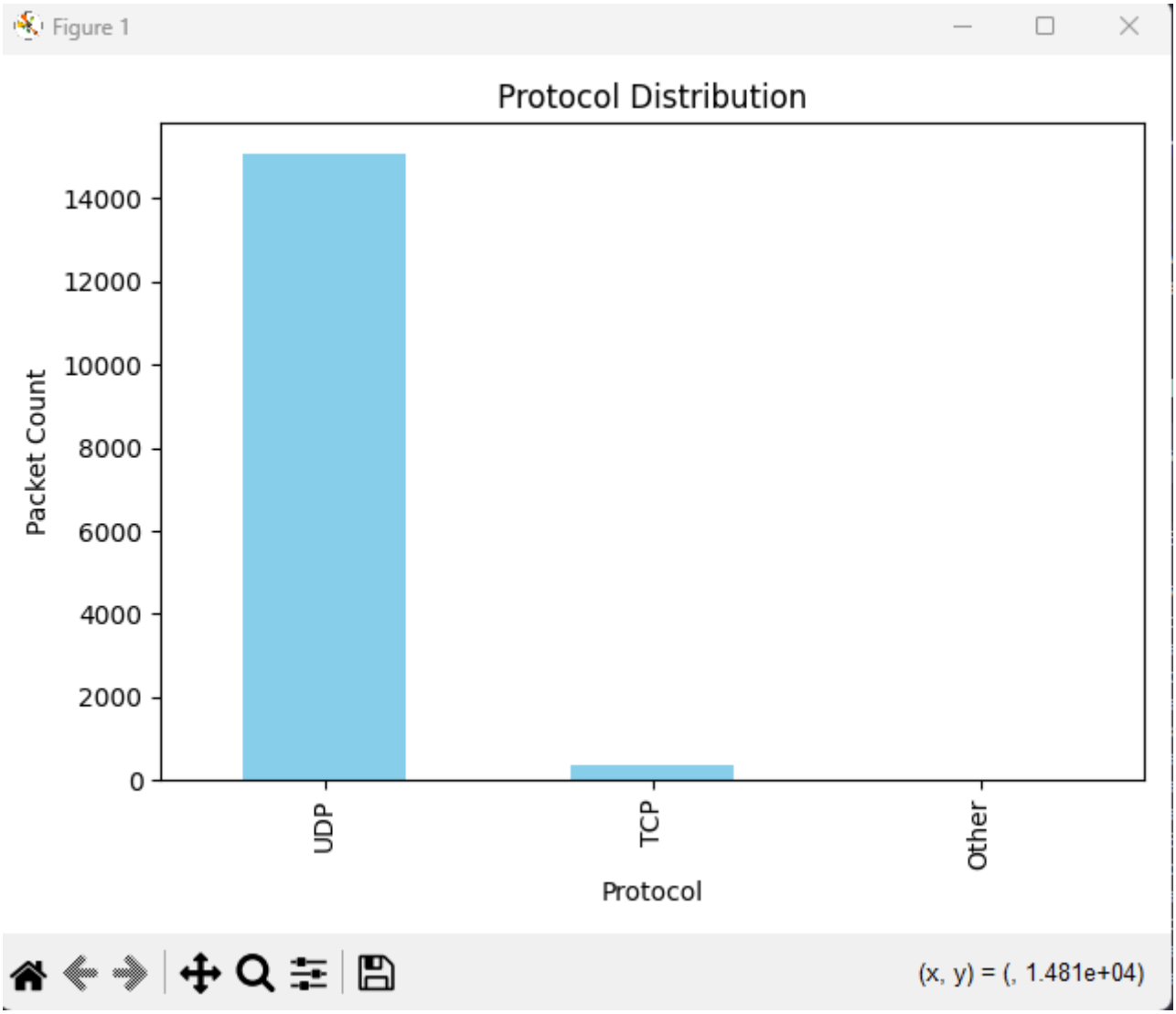
CHAPTER 5

RESULTS





```
[ALERT] High traffic from 203.153.36.167: 8690 packets
[ALERT] High traffic from 10.3.75.108: 4996 packets
[ALERT] High traffic from 170.114.116.20: 771 packets
[ALERT] High traffic from 0.0.0.0: 99 packets
[ALERT] High traffic from 10.3.27.131: 61 packets
[ALERT] High traffic from 202.21.40.81: 48 packets
[ALERT] High traffic from 10.3.20.113: 33 packets
[ALERT] High traffic from 10.3.24.9: 33 packets
[ALERT] High traffic from 23.34.81.35: 28 packets
[ALERT] High traffic from 10.3.25.190: 19 packets
[ALERT] High traffic from 23.34.81.74: 18 packets
[ALERT] High traffic from 184.51.192.107: 16 packets
[ALERT] High traffic from 104.21.112.1: 14 packets
[ALERT] High traffic from 10.3.20.166: 14 packets
[ALERT] High traffic from 10.3.47.22: 11 packets
[ALERT] High traffic from 10.3.27.186: 11 packets
[ALERT] High traffic from 10.3.64.158: 11 packets
```



CHAPTER 6
LEARNING OUTCOME

The development and implementation of the Real-Time Network Traffic Analyzer provided a wide range of technical and conceptual learning experiences. This section outlines the core knowledge and skills gained throughout the project under specific subheadings.

6.1 Understanding of Network Protocols

Working on this project enhanced our understanding of how different networking protocols operate in real time. By capturing live packets, we gained firsthand experience with IP, TCP, UDP, and other protocols. The need to classify and analyze packets based on protocol types solidified our theoretical knowledge of the OSI and TCP/IP models, packet structure, and protocol behavior in different types of traffic.

6.2 Packet Sniffing with Scapy

The use of Scapy introduced us to powerful low-level network programming in Python. We learned how to sniff packets directly from the network interface, interpret different layers of packets, and extract relevant information such as source and destination IPs, protocol types, and timestamps. This taught us the significance of working close to the network layer and understanding how raw data is structured and transmitted.

6.3 Data Analysis with Pandas

Pandas played a critical role in transforming raw packet data into structured datasets. We learned how to create and manipulate DataFrames, perform aggregations, and filter data based on conditions. These operations were essential for detecting anomalies and generating insights from the network traffic, thereby building our data analysis skills, which are highly valuable in both data science and cybersecurity.

6.4 Visualization and Interpretation

By using Matplotlib for visualization, we were able to convert analytical data into comprehensible charts and graphs. We learned the importance of data visualization in cybersecurity, particularly in recognizing traffic patterns, protocol distribution, and suspicious activity. This skill is important for both real-time monitoring and reporting in professional environments.

6.5 GUI Development with Tkinter

Designing the graphical user interface (GUI) using Tkinter provided us with practical knowledge in building desktop applications. We learned how to integrate different widgets, manage event handling, and update the

interface dynamically based on real-time input. This experience has broadened our ability to design user-friendly applications that are both interactive and functional.

6.6 Multithreading and Application Responsiveness

One of the key technical challenges was maintaining GUI responsiveness during live packet capture. Implementing multithreading allowed us to run packet sniffing processes in the background without freezing the user interface. This helped us understand concurrency in Python and how to manage threads safely when dealing with shared data and UI updates.

6.7 Real-Time Systems and Responsiveness

Building a real-time system required us to ensure timely responses and minimal lag in capturing and processing data. We gained a deeper appreciation for real-time constraints and how to manage them using optimized code and efficient data structures.

6.8 Security Awareness and Anomaly Detection

Implementing a basic anomaly detection system enhanced our understanding of common security threats such as Denial-of-Service (DoS) attacks and port scanning. We learned how suspicious behavior can be identified using simple heuristics and traffic analysis, and how these concepts can be extended into more advanced intrusion detection systems.

6.9 Problem-Solving and Debugging

Throughout the project, we encountered multiple challenges including network permissions, packet loss, GUI freezing, and unexpected data types. Resolving these issues improved our problem-solving abilities and made us more proficient in debugging real-world applications.

6.10 Integration of Multiple Technologies

The project required the integration of Scapy (network layer), Pandas (data processing), Matplotlib (visualization), and Tkinter (GUI). Successfully combining these technologies taught us how to architect modular applications, handle dependencies, and maintain a clean separation of concerns.

PROJECT IMPACT AND FUTURE SCOPE

The Real-Time Network Traffic Analyzer serves as a practical and educational tool for understanding live network behavior and detecting potential security issues. By enabling real-time packet sniffing and simple anomaly detection, the project demonstrates how even a lightweight application can provide insights into network health and usage. Its accessible design makes it suitable for academic use, home networks, and early-stage monitoring in small organizations.

The project also builds awareness of basic cybersecurity practices by encouraging users to observe and interpret their network activity. This awareness is crucial in today's digital environment where security threats are frequent and often go unnoticed.

Future Scope

Although the current system performs basic traffic analysis, there are several areas where it can be extended:

- **Advanced Detection Algorithms**: Incorporating machine learning models can enable more accurate and intelligent anomaly detection.
- **Packet Filtering and Deep Packet Inspection**: Allowing users to set filters for specific ports, IP ranges, or protocols can enhance usability.
- **Database Integration**: Storing captured data in a local or cloud-based database could support historical analysis and reporting.
- **Cross-Platform Support**: With additional effort, the system could be made available on other platforms like Linux and macOS.
- **Integration with Firewalls or Alerts**: Real-time alerts or automated responses (like IP blocking) can be implemented to enhance security.

CONCLUSION

The Real-Time Network Traffic Analyzer project was an enriching experience that combined theoretical knowledge of computer networks with practical implementation in Python. Through this project, we not only understood how network packets function but also developed the skills to capture, analyze, and visualize network traffic in real time.

The modular structure of the application — combining Scapy for packet capture, Pandas for data processing, Matplotlib for visualization, and Tkinter for GUI development — allowed us to create a compact but powerful tool. The use of multithreading enabled real-time responsiveness, making the application practical and user-friendly.

Moreover, the implementation of anomaly detection based on IP behavior highlighted the importance of network security. It gave us a hands-on understanding of how even simple rule-based systems can detect abnormal patterns that may indicate potential threats.

The project has laid a strong foundation for further exploration in network security, traffic analysis, and system development. It has also reinforced best practices in software design, user interaction, and real-time data processing. With further enhancement and scalability, this tool can evolve into a robust utility for educational, personal, or even enterprise-level use.

In conclusion, the Real-Time Network Traffic Analyzer is a testament to how open-source tools and fundamental programming skills can be harnessed to build meaningful, functional, and secure software applications. It has been a valuable journey that bridges the gap between classroom learning and real-world application.

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