Network Performance Analyzer (NPA) with BI Analytics

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***Abstract*—The internet is vital for schools, colleges, and busi- nesses, but common issues like slow connections, cyberattacks, and unauthorized bandwidth use persist due to a lack of affordable oversight tools. To address this gap, we designed and developed the Network Performance Analyzer (NPA), a low-cost, Java-based system using JPcap/WinPcap to monitor and capture network traffic. Captured packets are filtered, exported to a CSV format, and visualized in Power BI (Business Intelligence) dash- boards. Administrators can use the dashboards to track internet bandwidth usage and access protocols (PUA), identify anomalous behavior, and receive real-time warnings about potential risks. The tool is lightweight, easy to use, and supports a secure digital infrastructure, aligning with SDG 9 (Industry, Innovation, Infrastructure) and SDG 4 (Quality Education). Future upgrades include AI-driven threat prediction, cloud storage, IoT support, and mobile functionality.**

***Index Terms*—Network Monitoring, Packet Capture, Power BI, Cybersecurity, Real-time Analytics**

1. Introduction

Today’s companies and educational institutions rely heavily on the internet for daily operations, communication, and instruction. However, issues like low performance, network abuse, and hacking also get brought on by this reliance. Advanced monitoring tools are used by large organizations, but they are frequently out of reach for small companies and larger organizations. As a result, issues go unnoticed until they cause significant disruptions. Research indicates that due to inadequate monitoring, almost 70% of network problems go unreported. The Network Performance Analyzer (NPA), our project, attempts to close this gap. It offers a simple, cost- effective way for IT professionals to keep an eye on things in real time. By improving monitoring accessibility, this work aligns with SDG 9 (Industry, Innovation, and Infrastructure) and SDG 4 (Quality Education).

1. Problem Statement

The web has become a backbone for businesses and schools, undergirding communication, web-based learning, and every- day functions. This reliance introduces an expanding collection of issues like sluggish network speeds, bandwidth abuse, and recurrent cyberattacks, which are particularly formidable

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for IT managers in schools or small businesses who often lack the tools or funding to identify and fix these issues promptly. A primary cause for this is the lack of effective real-time monitoring and analytics. Without adequate insight into network activity, most issues go undetected until severe disruptions are created. Observations indicate that up to 70% of network problems are unreported or unaddressed due to poor monitoring systems, lowering productivity and exposing sensitive information to security breaches.

Existing solutions are not very optimal. Packet-level mon- itoring is very fine-grained in output but is so resource- intensive that small deployments are held back. Flow-based monitoring is less cumbersome to deploy but loses important information for good analysis. Higher-end hybrid solutions like HybridMon try to straddle both methodologies, but these are specialized hardware that is too pricey for small to medium companies. This leaves a distinct gap: schools, colleges, and small businesses require a low-cost, light, and easy-to-use monitoring solution that can observe traffic in real time, extract the significant information, and provide the output in easy-to- understand form. This gap motivates the development of our lightweight Network Performance Analyzer (NPA), which is described in the next section.

1. Literature Survey
2. **Analysis and Design of Computer Networks (Adis- tiyawan et al.) [1]:** This paper explains how a com- pany used a network monitoring system to study traffic flow and reduce congestion. It shows that monitoring tools can help administrators understand problems and improve performance. The idea of simple dashboards inspired my use of Power BI in this project.
3. **Comprehensive Evaluation of Network Performance Monitoring Solutions [2]:** The authors compared differ- ent monitoring methods, including SNMP, packet-based, and flow-based systems. They found that packet methods provide detailed information but need a lot of resources. In contrast, flow methods are easier to use but are less accurate. This shows the need for a balanced and low- cost solution like mine.

# Library of Networks: An Online Tool for Design and Analysis of Network Topologies [3]: This work

created a tool to design and analyze networks before deployment. It helps test network performance in ad- vance, but it does not focus on live monitoring. My project addresses this gap by offering real-time tracking of network activity.

1. **Network Traffic Analysis and Optimization Using Network Analyzers [4]:** This paper studied tools like Wireshark, NetFlow, and sFlow. It showed that packet analyzers provide more details but consume more re- sources, while flow analyzers are faster but less pre- cise. My system takes ideas from both but keeps it lightweight.
2. **Recurrent Neural Network Model to Predict and Monitor Student Performance [5]:** Although this paper is about education, it proves that predictive monitoring can identify problems early. This aligns with my project, where predictive analytics helps detect unusual network activity before it becomes a threat.
3. **Utilizing Network Adapters for Network Timing Performance Evaluation and Monitoring [6]:** Here, the authors used special hardware to measure network timing and performance. This approach works well, but it is costly and complex. My project avoids this issue by using software-based packet capture in Java.
4. **Advancing Network Monitoring with Packet-Level Records and Selective Flow Aggregation (Hybrid- Mon) [7]:** This foundational paper introduced Hybrid- Mon, which combines packet data with flow aggre- gation. It operates effectively but relies on expensive programmable switches. My project adopts the idea of merging detail with efficiency but presents it in a simple, affordable software tool.
5. Objectives

The principal intent of this project is to develop a straight- forward, affordable, and effective system for monitoring as- pects of network performance in real-time. Many educational institutions - schools, colleges, and small businesses - have low to moderate speed networks, cannot use the bandwidth they pay for, and are vulnerable to cyber-attacks due to a lack of monitoring systems in place. They are unable to pay for prohibitively expensive enterprise monitoring tools, and lightweight solutions already on the market are often incomplete. In response to this gap, our aim is to create a tool written in Java, that will capture certain important aspects of network traffic, process the information to extract extraneous information, and export the data in a format readable within Power BI. Power BI will provide dashboards and charts, allowing the administrators to more easily see how bandwidth is being utilized, identify odd behavior, and make informed decisions to optimize network performance. In summary the goal of this project is provide an affordable and easy to use option that represents the middle ground between enterprise monitoring systems and simple ’flow based’ methods. The expected outcome is an easy-to-use tool providing real-time network insights and Power BI dashboards for administrators.

1. Proposed Methodology

The proposed Network Performance Analyzer (NPA) sys- tem is designed to address the struggles faced by schools, colleges, and small businesses that are limited in revenue to afford higher-end monitoring systems. The system utilizes a layered architecture that facilitates the gleaning of data when it is captured, processed, stored, and finally visualized in a way that makes sense to the administrators. The system will operate as follows:

* **Data Capture Layer:** By using the JPcap/WinPcap libraries the system will listen to live traffic while it captures packets like TCP, UDP, or ARP.
* **Processing Layer:** Raw packets are very messy because there is too much detail. This layer must filter out the unneeded information and retain meaningful attributes like IP address, port, timestamp, and protocol type.
* **Export Layer:** Once the data has been cleaned it will be exported out as a CSV. CSV is a good format because it is lightweight, simple, and can be fired into a number of analytical tools.
* **Visualization Layer:** Power BI will read the CSV and convert it to dashboards that can be easily read. The dash- boards will display charts and graphs to show bandwidth usage, the most accessed IPs, suspicious traffic behaviors, and overall network health.

This design approach differentiates NPA from heavier tools like Wireshark by focusing on the simplicity of supplying essential reporting for IT administrators.

1. Implementation

We built the Network Performance Analyzer (NPA) as a simple Java program, and it used JPcap/WinPcap libraries. This let the program grab actual packets straight from the network as they came in. The system worked in four distinct stages:

* **Data Capture Layer:** Used JPcap/WinPcap to capture TCP, UDP, and ARP packets.
* **Processing Layer:** Filtered unnecessary details and re- tained meaningful fields such as IP address, port number, timestamp, and protocol type.
* **Export Layer:** Saved the processed information in CSV format for lightweight portability.
* **Visualization Layer:** Power BI read the CSV file and generated dashboards to visualize bandwidth usage, pro- tocol distribution, top IPs, and anomalies.

*1) Technologies Used:* Java (NetBeans IDE), JPcap/WinPcap libraries, CSV export, and Power BI.

1. Experimental Setup

The experimental evaluation of the NPA was carried out using the following environment:

* **Hardware:** Intel i5 processor, 8 GB RAM, 256 GB SSD
* **Operating System:** Windows 10 (64-bit)

# Software Stack:

* + Java JDK 17 and NetBeans IDE
  + JPcap/WinPcap libraries
  + Power BI Desktop

**Test Scenario:** We set up the system in a college computer lab with about 30 users. We watched the network for 2 hours when it was busiest – during online classes and regular browsing. Approximately 12,000 packets were captured over a two-hour observation period. Then, we took all that data and made it easy to see using Power BI dashboards to check it out more closely.

1. Results and Discussion

The experimental results demonstrated that the NPA can successfully monitor and visualize network traffic in real time. The dashboards generated using Power BI provided actionable insights for administrators.

1. *Protocol Usage*

The distribution of captured protocols is shown in Table I.

TABLE I

Protocol usage distribution

|  |  |
| --- | --- |
| **Protocol** | **Percentage of Traffic** |
| TCP | 65% |
| UDP | 25% |
| ARP | 10% |

**Observation:** TCP traffic dominated due to web browsing and online classes, while UDP was primarily used for streaming.

1. *Bandwidth Utilization by IPs*

The top 5 IP addresses consuming the highest bandwidth are presented in Table II. **Observation:** The data revealed

TABLE II

Top 5 IP addresses by bandwidth

|  |  |
| --- | --- |
| **IP Address** | **Bandwidth Used (MB)** |
| 192.168.1.10 | 530 |
| 192.168.1.25 | 420 |
| 192.168.1.14 | 390 |
| 192.168.1.18 | 365 |
| 192.168.1.30 | 280 |

that certain IP addresses consumed disproportionately high bandwidth, highlighting possible misuse.

1. *Visualization Outputs*

As shown in Figure 1, the Power BI dashboard visualizes key network metrics. The system generated the following visualizations in Power BI:

* + **Figure 1. Packet Distribution and Port Activity:** show- ing timestamp-based packet proportions and the relation- ship between Record Count and SourcePort.

These visualizations made it easier for non-technical admin- istrators to understand network behavior.

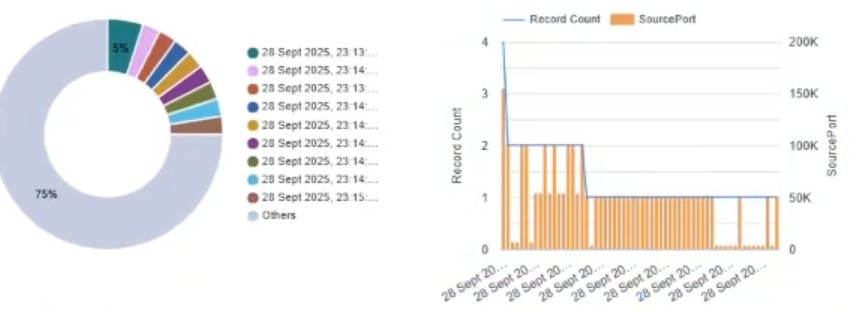


Fig. 1. Visualization outputs showing protocol distribution, bandwidth trend, and top IPs in Power BI dashboard.

1. System Architecture

The architecture of the proposed Network Performance Analyzer is shown in Figure 2. Data flows sequentially from packet capture to processing, export, and visualization layers. This modular design ensures scalability and allows for easy upgrades such as AI integration, IoT monitoring, and mobile applications.

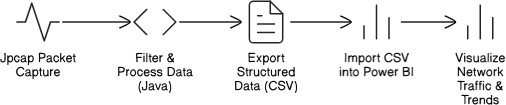


Fig. 2. System architecture of the Network Performance Analyzer (NPA)

1. Future Scope

Although the current version of NPA performs important monitoring activities, there exists a pathway for it to be en- hanced and become more sophisticated. Some future directions include the following:

* + **AI and Machine Learning Integration:** If we trained models on the patterns of network traffic, the system could autonomously discover threats or develop threat predictions and forecasts prior to an attack.
  + **Mobile Application:** A mobile-friendly version for ad- ministrators could grant users visibility on the network while using a mobile device (and not forcing users to be confined to the desktop).
  + **Cloud-Based Monitoring:** Putting historical metadata in the Cloud for each network would provide access from anywhere and potentially allow for analysis across multiple campuses or branches of a business.
  + **IoT Integration:** With the increased proliferation of smart devices, NPA could be provided extended moni- toring capabilities around IoT-based devices.
  + **Automated Actions:** Triggering automated responses is possible in conjunction with detected suspicious activity.
  + **Edge Computing Support:** Processing data closer to the source on edge devices could reduce latency and improve real-time response capabilities for threat detection.

These enhancements create an opportunity for NPA to be more than just a monitoring tool, but an intelligent security assistant.

1. Conclusion

The Network Performance Analyzer (NPA) project demon- strates that a combination of a dependable and cost-effective monitoring option can be created for smaller organizations. The integration of Java-based packet capture and the analytical power of Power BI provides administrators with real-time visi- bility into network usage, threats, and application performance. The system is lightweight and resource-efficient, and the graphics help non-technical staff understand network data using simple visualizations to either support their existing awareness or advance their understanding. NPA fills the gap between basic flow-based tools and expensive enterprise so- lutions that have little to no value for the target audience:

schools, colleges, and small businesses.

In conclusion, NPA illustrates the value of making digital infrastructure tools accessible. Network monitoring tools will ultimately help organizations monitor their network perfor- mance and security, but the value extends to incorporate strategic goals, including but not limited to SDG 9 (Industry, Innovation, and Infrastructure) and SDG 4 (Quality Educa- tion). By providing accessible real-time monitoring, NPA sup- ports secure, efficient, and data-driven network management in educational and small-scale environments.

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