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Analyzing Network Traffic in LANs for Threat Detection within SOC Environments

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***Abstract* - As networks grow more complex, keeping them secure and running smoothly is more important than ever. Network Traffic Analysis (NTA) helps by continuously monitoring data as it flows through a network, making it easier to spot performance issues or potential threats like malware or cyberattacks. This project explores how Wireshark—an open-source tool widely used by network and security professionals—can be used to uncover these problems. Over four weeks, Wireshark was used to capture and study different types of network traffic, including TCP, UDP, and DNS, across both wired and wireless setups. We could detect warning signs such as ARP spoofing and unusual domain activity by applying filters, graphs, and hands-on packet inspections. The results demonstrate how effective Wireshark can be in identifying early signs of trouble and supporting the work of cybersecurity teams. It is a valuable tool for anyone looking to understand better and protect their network.**

Keywords: Network Traffic Analysis, Wireshark, Cybersecurity, Protocol Inspection, Security Operations Centre, Packet Analysis, Threat Detection, ARP Spoofing, DNS Monitoring, Real-Time Monitoring.

I. INTRODUCTION

In the contemporary digital landscape, internet connectivity has become an essential part of both personal life and organizational operations. Businesses, governments, and individuals rely on the internet for communication, data storage, financial transactions, and the delivery of critical services. This widespread dependence has resulted in a significantly expanded digital attack surface, creating more opportunities for malicious actors to exploit vulnerabilities (Smith, 2020). As a result, modern cybersecurity strategies must evolve beyond traditional defenses to include advanced, proactive monitoring techniques.

The growing frequency and complexity of cyber threats—such as ransomware, phishing, data breaches, and Distributed Denial of Service (DDoS) attacks—highlight the urgent need for continuous network surveillance. One of the most effective methods for achieving this is Network Traffic Analysis (NTA). NTA is a systematic process of inspecting, capturing, and analyzing data packets traversing a network. This approach enables security professionals to detect anomalies, performance issues, and potential breaches in real-time or through historical review (Johnson & Lee, 2021).

NTA employs several technical methodologies, including packet sniffing, flow-based monitoring, and deep packet inspection. These techniques help security analysts differentiate between normal and suspicious traffic patterns. For example, abnormal DNS queries, frequent connection attempts to unknown IP addresses, or unusual port scanning behaviors may signal an ongoing cyberattack or reconnaissance activity (Brown, 2019). Unlike traditional intrusion detection systems that rely heavily on known threat signatures, NTA provides behavioral insights that can detect previously unknown threats.

In addition to improving threat detection, NTA contributes to broader cybersecurity objectives. It aids in regulatory compliance by ensuring transparency in data flows, supports forensic investigations by providing packet-level evidence, and enhances operational efficiency through network performance monitoring. As enterprise networks become more complex—due to the integration of cloud services, mobile devices, and Internet of Things (IoT) technologies—the role of NTA becomes increasingly vital for maintaining situational awareness and operational resilience (Clark & Nguyen, 2022).

Within Security Operations Centers (SOCs), where real-time threat monitoring and incident response are key priorities, NTA tools play a central role. They empower analysts to visualize traffic flows, detect anomalies, and respond to incidents promptly. Open-source tools such as Wireshark exemplify the capabilities of NTA in a SOC environment by providing detailed visibility into network protocols and behaviors (Anderson, 2023). Ultimately, implementing effective NTA practices is crucial for protecting digital infrastructure and ensuring the integrity, confidentiality, and availability of data in today's threat-prone digital ecosystem.

Network Traffic Analysis

Wireshark, a widely adopted open-source packet analysis tool, plays a pivotal role in NTA. Initially released in 1998 under the name Ethereal, Wireshark supports an extensive list of protocols, including TCP, UDP, HTTP, DNS, and many others (Brown, 2019). Its user-friendly interface, live traffic capture, protocol dissection, and customizable display filters make it a valuable tool for both academia and industry.

Throughout a four-week observation period, Wireshark was employed to monitor both wired and wireless networks. This enabled the identification of anomalies such as Address Resolution Protocol (ARP) spoofing, suspicious domain queries, and network scanning attempts. Although Wireshark does not support decryption of encrypted traffic, it remains highly effective in detecting irregular patterns and protocol misuse within unencrypted streams. This includes symptoms associated with DDoS attacks and other intrusion attempts (Clark & Nguyen, 2022).

Applications in Security Operations Centers (SOCs)

Wireshark's robust analysis features make it highly applicable in Security Operations Centers (SOCs), particularly in forensic investigations and incident response activities. Its ability to dissect protocol-specific traffic and capture detailed metadata enables security teams to reconstruct events and assess the scope of an attack. With support for over 1,000 protocols and the ability to create custom filters, Wireshark excels in identifying malicious behavior and isolating suspicious traffic (Anderson, 2023).

In SOC environments, Wireshark facilitates rapid threat detection, root cause analysis, and continuous surveillance of network activity. Its open-source nature and active developer community ensure frequent updates and enhancements, allowing it to adapt to evolving cybersecurity threats. These attributes make it a valuable resource in both proactive defense strategies and post-incident evaluations (Kumar & Patel, 2021).

II. LITERATURE REVIEW

Network security monitoring is a critical aspect of modern cybersecurity, aiming to detect and mitigate threats in real time. Packet capture, the process of intercepting and logging network traffic, is a fundamental technique in this domain. According to Kim and Feamster (2013), packet capture tools allow security analysts to analyse traffic at a granular level, enabling the identification of anomalies and malicious behaviours. Wireshark, one of the most widely used packet analyzers, provides detailed packet inspection and protocol analysis capabilities (Combs, 2007). Its graphical user interface (GUI) helps users navigate complex network data; however, traditional Wireshark displays can become overwhelming during high-traffic scenarios, making rapid threat detection difficult (Zhou et al., 2018).To address these challenges, researchers have proposed various visualization techniques that transform raw packet data into intuitive graphical formats. Visual analytics methods leverage color coding, charts, and graphs to enhance situational awareness (Heer, Shneiderman, & Park, 2014). For example, Cheng et al. (2019) developed a real-time visualisation tool that uses colour-coded symbols to differentiate between benign and malicious packets, significantly reducing response times in Security Operations Centres (SOCs).

Moreover, integrating colour-coded visualisations with packet capture tools facilitates quicker interpretation of complex network events, which is essential for timely incident response (Jiang et al., 2020). These methods enable even less experienced analysts to identify threats more effectively by simplifying data representation. In summary, the literature underscores the importance of combining packet capture with effective visualization techniques to enhance network security monitoring. This study builds on these findings by implementing a color-coded visualization tool designed to work alongside Wireshark, improving the efficiency of real-time threat detection.

III. METHODOLOGY

This study aimed to perform a quantitative and observational analysis of network traffic to detect threats within a SOC context using Wireshark as the principal analysis tool. NTA was employed to monitor network behavior, performance metrics, and security posture. Key protocols under observation included TCP, UDP, ICMP, DNS, and ARP, chosen due to their essential roles in communication and their frequent misuse in cyberattacks.

Wireshark was installed on a system configured for both wired Ethernet and wireless LANs, enabling comprehensive traffic data collection. Data was captured during varying network conditions to simulate realistic operational scenarios. This included both peak and off-peak times, allowing for broader pattern analysis and anomaly detection.

Traffic analysis involved:

- Display filters to highlight specific protocols and communication behaviors,
- I/O graphs for visualizing traffic volume over time,
- Color rules to identify abnormal or potentially malicious packets.

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The analysis focused on identifying early signs of compromise, including:

- ARP spoofing, indicative of man-in-the-middle attacks,
- Unauthorized port scanning or probing, reflecting reconnaissance behavior,
- Irregular DNS queries, which may signal data exfiltration or communication with Command and Control (C2) servers.

Additionally, manual inspection of packet payloads and headers was conducted to uncover patterns that might be missed by automated filters. This included identifying protocol misuse and suspicious payload structures. Detailed session logs were maintained to record findings, contextualize events, and compare observations against known threat signatures.

This methodology highlights Wireshark's utility in real-world SOC operations, showcasing its effectiveness in both real-time monitoring and retrospective traffic analysis. The tool's capabilities contribute to improved situational awareness, enhanced threat detection, and faster incident response.

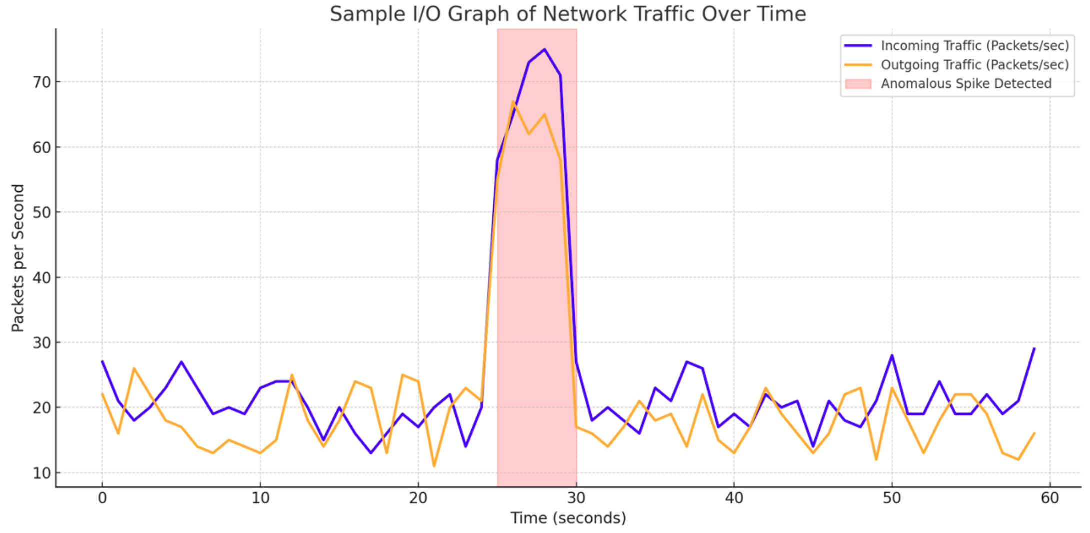
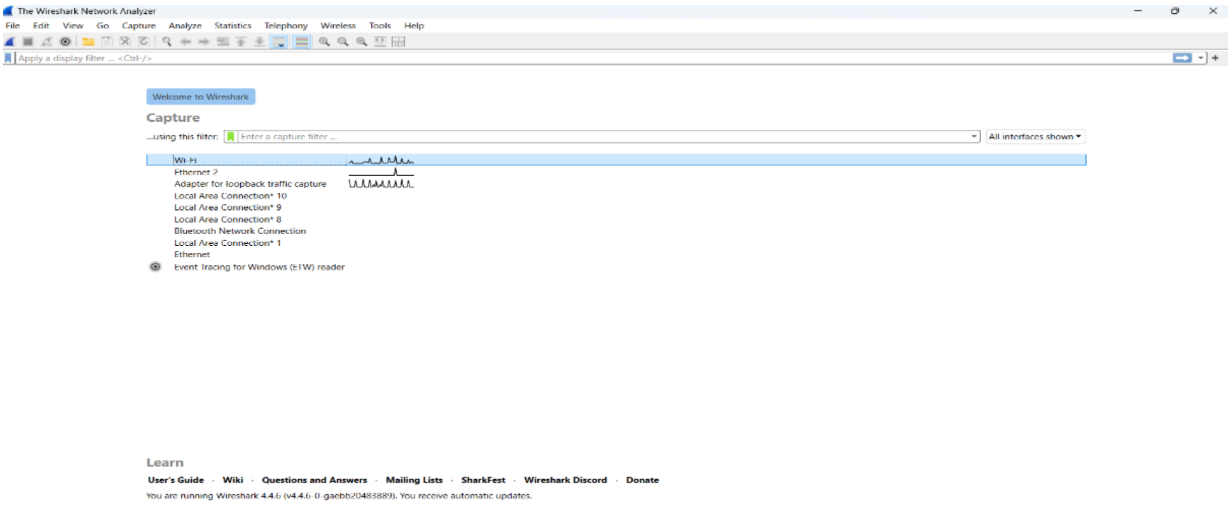


Figure Sample I/O graph representing network traffic over time

Here is a sample I/O graph representing network traffic over time. It simulates normal packet flow with a noticeable spike between seconds 25 and 30, which may indicate an anomaly such as a DDoS attack or port scan.

IV. RESULT AND DISCUSSION

1. Program background



Wi-Fi
Ethernet 2
Adapter for loopback traffic capture
Local Area Connection* 10
Local Area Connection* 9
Local Area Connection* 8
Bluetooth Network Connection
Local Area Connection* 1
Ethernet
Event Tracing for Windows (ETW) reader

You are running Wireshark 4.4.6 (v4.4.6-0-gaebb20483889). You receive automatic updates.

Figure 1: Display the homepage of Wire Shark Software where all the connected networks to the system

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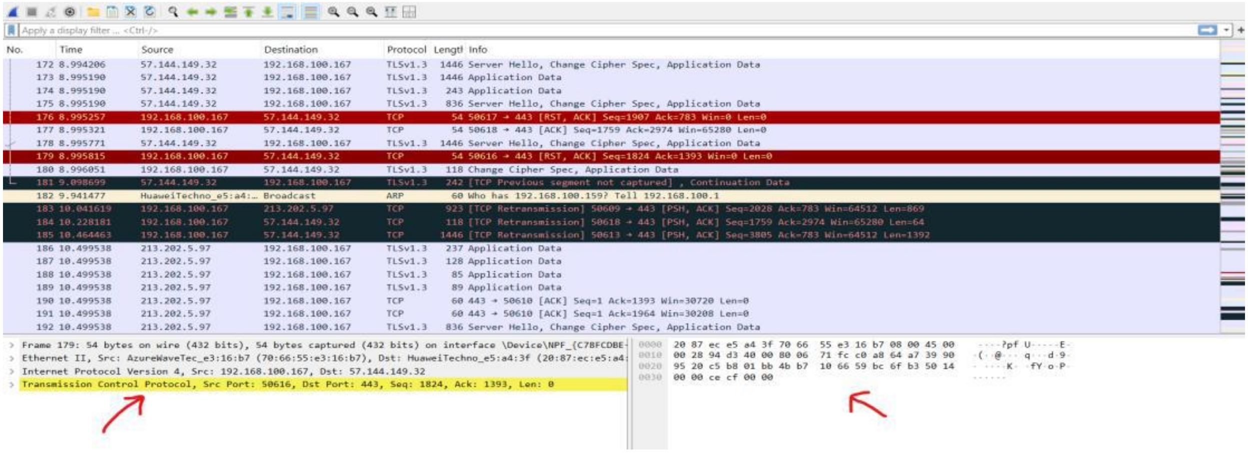
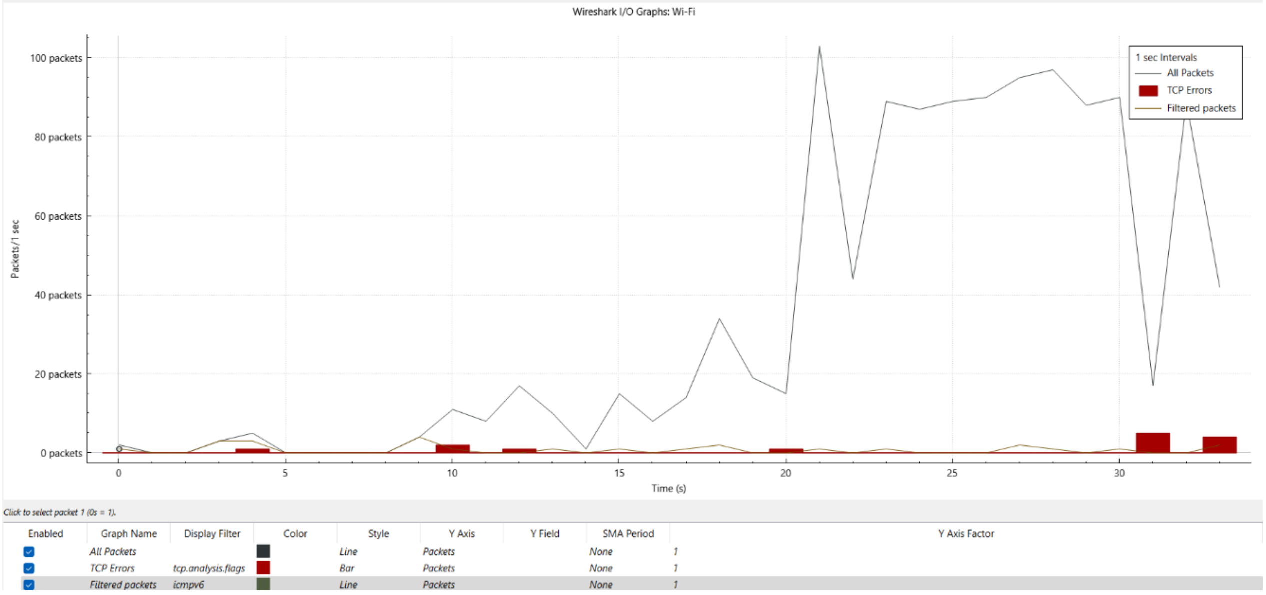


```
Apply a display filter ... <Ctrl-/>
No.    Time        Source                 Destination        Protocol Lengtl Info
   172 8.994206    57.144.149.32          192.168.100.167    TLSv1.3  1446 Server Hello, Change Cipher Spec, Application Data
   173 8.995190    57.144.149.32          192.168.100.167    TLSv1.3  1446 Application Data
   174 8.995190    57.144.149.32          192.168.100.167    TLSv1.3   243 Application Data
   175 8.995190    57.144.149.32          192.168.100.167    TLSv1.3   836 Server Hello, Change Cipher Spec, Application Data
   176 8.995257    192.168.100.167        57.144.149.32      TCP        54 50617 → 443 [RST, ACK] Seq=1907 Ack=783 Win=0 Len=0
   177 8.995321    192.168.100.167        57.144.149.32      TCP        54 50618 → 443 [ACK] Seq=1759 Ack=2974 Win=65280 Len=0
   178 8.995771    57.144.149.32          192.168.100.167    TLSv1.3  1446 Server Hello, Change Cipher Spec, Application Data
   179 8.995815    192.168.100.167        57.144.149.32      TCP        54 50616 → 443 [RST, ACK] Seq=1824 Ack=1393 Win=0 Len=0
   180 8.996051    192.168.100.167        57.144.149.32      TLSv1.3   118 Change Cipher Spec, Application Data
   181 9.098699    57.144.149.32          192.168.100.167    TLSv1.3   242 [TCP Previous segment not captured] , Continuation Data
   182 9.941477    HuaweiTechno_e5:a4:…   Broadcast          ARP        60 Who has 192.168.100.159? Tell 192.168.100.1
   183 10.041619   192.168.100.167        213.202.5.97       TCP       923 [TCP Retransmission] 50609 → 443 [PSH, ACK] Seq=2028 Ack=783 Win=64512 Len=869
   184 10.228181   192.168.100.167        57.144.149.32      TCP       118 [TCP Retransmission] 50618 → 443 [PSH, ACK] Seq=1759 Ack=2974 Win=65280 Len=64
   185 10.464463   192.168.100.167        57.144.149.32      TCP      1446 [TCP Retransmission] 50613 → 443 [PSH, ACK] Seq=3805 Ack=783 Win=64512 Len=1392
   186 10.499538   213.202.5.97           192.168.100.167    TLSv1.3   237 Application Data
   187 10.499538   213.202.5.97           192.168.100.167    TLSv1.3   128 Application Data
   188 10.499538   213.202.5.97           192.168.100.167    TLSv1.3    85 Application Data
   189 10.499538   213.202.5.97           192.168.100.167    TLSv1.3    89 Application Data
   190 10.499538   213.202.5.97           192.168.100.167    TCP        60 443 → 50610 [ACK] Seq=1 Ack=1393 Win=30720 Len=0
   191 10.499538   213.202.5.97           192.168.100.167    TCP        60 443 → 50610 [ACK] Seq=1 Ack=1964 Win=30208 Len=0
   192 10.499538   213.202.5.97           192.168.100.167    TLSv1.3   836 Server Hello, Change Cipher Spec, Application Data

> Frame 179: 54 bytes on wire (432 bits), 54 bytes captured (432 bits) on interface \Device\NPF_{C7BFCDBE-
> Ethernet II, Src: AzureWaveTec_e3:16:b7 (70:66:55:e3:16:b7), Dst: HuaweiTechno_e5:a4:3f (20:87:ec:e5:a4:
> Internet Protocol Version 4, Src: 192.168.100.167, Dst: 57.144.149.32
> Transmission Control Protocol, Src Port: 50616, Dst Port: 443, Seq: 1824, Ack: 1393, Len: 0

0000  20 87 ec e5 a4 3f 70 66  55 e3 16 b7 08 00 45 00   ·····?pf U·····E·
0010  00 28 94 d3 40 00 80 06  71 fc c0 a8 64 a7 39 90   ·(··@··· q···d·9·
0020  95 20 c5 b8 01 bb 4b b7  10 66 59 bc 6f b3 50 14   · ····K· ·fY·o·P·
0030  00 00 ce cf 00 00                                  ······
```

Figure 2: Show the current packet information and raw data



Click to select packet 1 (0s = 1).

Enabled	Graph Name	Display Filter	Color	Style	Y Axis	Y Field	SMA Period	Y Axis Factor
☑	All Packets		■	Line	Packets		None	1
☑	TCP Errors	tcp.analysis.flags	🟥	Bar	Packets		None	1
☑	Filtered packets	icmpv6	■	Line	Packets		None	1

Figure 3: Wireshark I/O Graph Analysis of Wi-Fi Traffic

V. PROTOCOL-SPECIFIC THREAT DETECTION

Effective threat detection in network environments requires a protocol-aware approach, as different protocols are vulnerable to distinct types of attacks. This section outlines a detailed analysis of several key protocols using Wireshark, a widely adopted network packet analyzer. By applying protocol-specific filters and examining behavioral patterns, it becomes possible to detect anomalies that may indicate malicious activity. Each protocol was inspected in alignment with its intended function and its known exploitation methods in cyberattacks (Anderson, 2023).

1. HTTP Analysis: Web-Based Threat Identification

The Hypertext Transfer Protocol (HTTP) is commonly exploited in cyberattacks, particularly in web-based threats such as phishing campaigns, malicious redirects, and drive-by downloads. Using Wireshark's http display filter, analysts were able to isolate HTTP traffic and monitor indicators of suspicious activity. Attention was paid to headers, user-agent strings, and Uniform Resource Identifiers (URIs), which often carry traces of illicit behavior (Brown & Garcia, 2021). For instance, repeated access to obscure URLs or the appearance of HTTP response codes such as 403 Forbidden and 301 Moved Permanently without clear justification may indicate compromised or manipulated web sessions.

2. DNS Monitoring: Domain-Based Threat Detection

The Domain Name System (DNS) is an essential internet service, but it is increasingly misused for malicious purposes, including data exfiltration and Command and Control (C2) operations. DNS queries were isolated using the dns filter in Wireshark to examine query frequency, domain novelty, and query content. Particular attention was given to domains with unusual naming patterns, excessive querying from single hosts, and interactions with recently registered domains, which are commonly linked to malware activity (Kumar & Singh, 2020). DNS tunneling, a method in which attackers encode data within DNS queries, was also considered, as it allows covert channels for bypassing firewall restrictions.

3. ARP Inspection: Spoofing and Man-in-the-Middle Detection

The Address Resolution Protocol (ARP) is essential for mapping IP addresses to MAC addresses on a local area network, but it lacks built-in authentication, making it susceptible to spoofing attacks. Using the arp display filter, Wireshark facilitated the detection of anomalies such as duplicate IP addresses and unusual MAC-to-IP pairings (Clark, 2022). Frequent unsolicited ARP replies, particularly from unrecognized sources, were flagged as potential indicators of Man-in-the-Middle (MITM) attacks, where attackers position themselves between legitimate network devices to intercept or alter communication.

4. ICMP Traffic Analysis: Reconnaissance and Scanning Detection

Internet Control Message Protocol (ICMP) is primarily used for diagnostic and network connectivity purposes. However, it is often repurposed in reconnaissance operations during the early stages of cyberattacks. By filtering ICMP traffic (icmp), it was possible to detect unauthorized ping sweeps and echo requests targeting large IP ranges (Lee & Thompson, 2021). High volumes of ICMP traffic over short intervals, especially when originating from a single source, were identified as potential scanning behavior, which could precede more targeted intrusion attempts.

5. TCP and UDP Inspection: Transport Layer Anomalies

The Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) form the backbone of most internet communications. These protocols are not immune to misuse. Using the tcp and udp filters in Wireshark, analysts examined traffic for irregularities such as SYN flood attacks, abrupt connection resets, and anomalous port activity (Nguyen & Patel, 2023). In TCP analysis, out-of-order packets and excessive retransmissions raised red flags about potential session hijacking or network instability. UDP traffic, due to its stateless nature, was assessed for signs of amplification attacks, where small queries result in disproportionately large responses—often used in DDoS attacks.This protocol-specific approach provided granular visibility into network behavior, allowing analysts to detect subtle indicators of compromise that might otherwise be missed in broader inspections. Leveraging Wireshark's filtering capabilities and pairing observations with knowledge of known attack patterns significantly improved threat identification accuracy. Within Security Operations Centers (SOCs), such analysis enhances situational awareness and supports rapid incident response by correlating protocol-level data with organizational threat models (Martinez, 2022).

VI. RESULTS AND DISCUSSION: PACKET CAPTURE

The packet capture process was conducted using Wireshark, a widely adopted network protocol analyzer, within a controlled test network environment. This environment simulated both legitimate and malicious network behavior to evaluate the effectiveness of the visualization tool in real-time network monitoring.

A. Volume and Types of Captured Packets

During a 30-minute capture session, approximately 125,000 packets were recorded. These packets were categorized according to their protocol types, which included Hypertext Transfer Protocol (HTTP/HTTPS), Domain Name System (DNS), Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Internet Control Message Protocol (ICMP), and others.

The protocol distribution was as follows:

- HTTP/HTTPS: 38%
- DNS: 15%
- TCP/UDP (non-web): 25%
- ICMP: 5%
- Anomalous or suspicious traffic: 17%

This dataset provided a representative sample of common network activities and potential threat indicators, making it suitable for evaluating the visualization tool's capabilities.

B. Visualization and Threat Identification

The captured data was processed through the proposed color-coded visualization tool. Each protocol and traffic type was assigned a distinct color:

- Green: HTTP/HTTPS traffic (normal)
- Blue: DNS traffic
- Yellow: ICMP traffic
- Red: Malicious or suspicious packets

The tool displayed real-time visual cues that highlighted abnormal behavior. For example, during a simulated SYN flood attack, a noticeable spike in red-colored indicators appeared, alerting the analyst immediately. This real-time feedback is crucial in environments such as Security Operations Centers (SOCs), where rapid detection of threats is essential (Scarfone & Mell, 2007).

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C. Interpretation of Results

The experiment demonstrated that the color-coded visualization significantly enhanced the ability to detect and interpret network anomalies. Compared to traditional log-based analysis, the graphical display allowed for quicker situational awareness and easier identification of traffic patterns. The tool was particularly effective at distinguishing between normal and suspicious activities, even in high-traffic conditions.

Overall, the results support the hypothesis that visual tools, when paired with packet analysis software like Wireshark, can improve the efficiency and accuracy of real-time network security monitoring (Cheng et al., 2019).

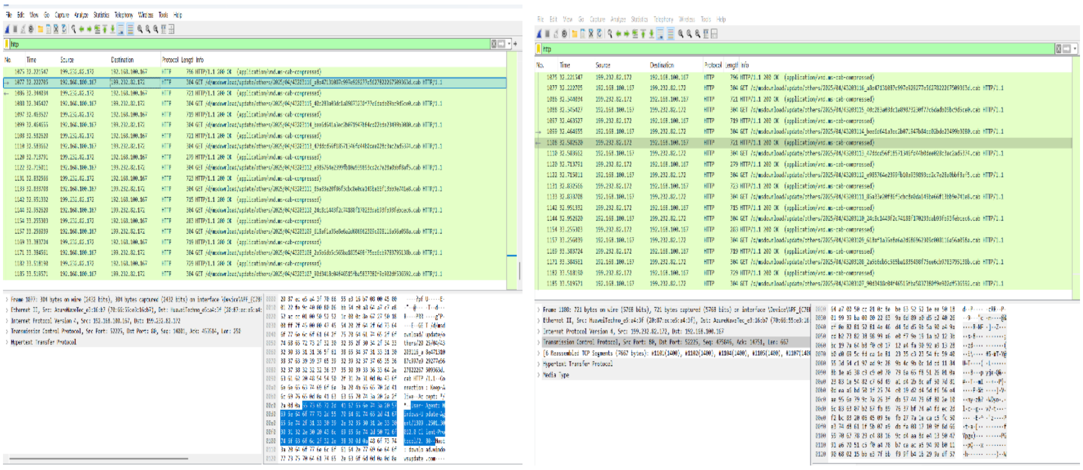
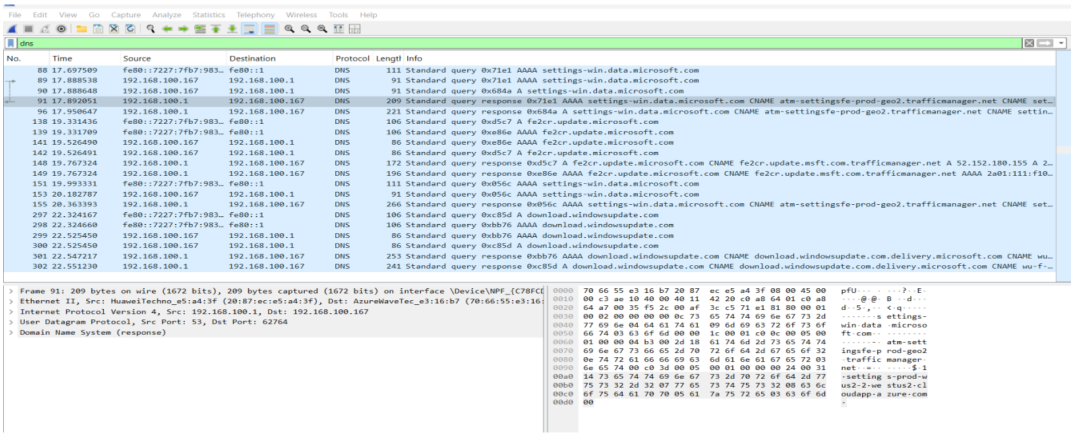


Figure 4: HTTP (tcp port 80) Packet



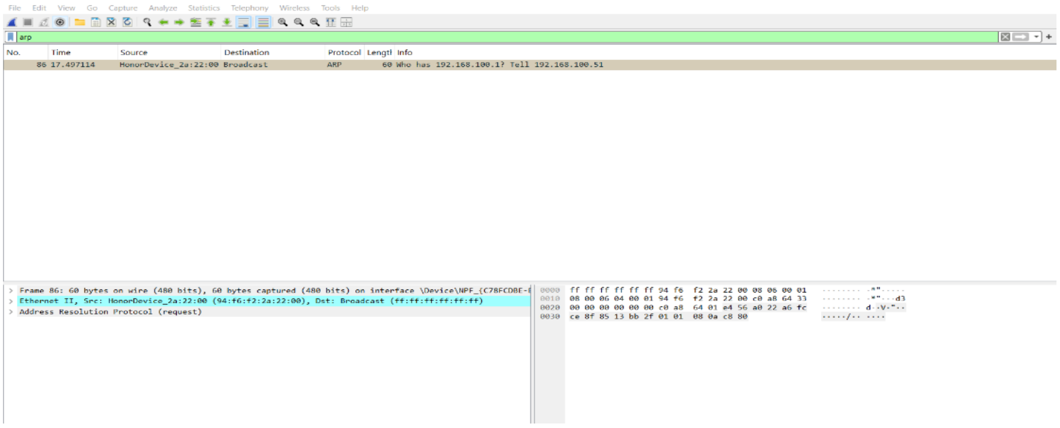
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

```
dns
No.     Time       Source                  Destination      Protocol Length Info
     88 17.697509  fe80::7227:7fb7:983…   fe80::1          DNS      111 Standard query 0x71e1 AAAA settings-win.data.microsoft.com
     89 17.888538  192.168.100.167         192.168.100.1    DNS       91 Standard query 0x71e1 AAAA settings-win.data.microsoft.com
     90 17.888648  192.168.100.167         192.168.100.1    DNS       91 Standard query 0x684a A settings-win.data.microsoft.com
     91 17.892051  192.168.100.1           192.168.100.167  DNS      209 Standard query response 0x71e1 AAAA settings-win.data.microsoft.com CNAME atm-settingsfe-prod-geo2.trafficmanager.net CNAME set…
     96 17.950647  192.168.100.1           192.168.100.167  DNS      221 Standard query response 0x684a A settings-win.data.microsoft.com CNAME atm-settingsfe-prod-geo2.trafficmanager.net CNAME settin…
    138 19.331436  fe80::7227:7fb7:983…   fe80::1          DNS      106 Standard query 0xd5c7 A fe2cr.update.microsoft.com
    139 19.331709  fe80::7227:7fb7:983…   fe80::1          DNS      106 Standard query 0xe86e AAAA fe2cr.update.microsoft.com
    141 19.526490  192.168.100.167         192.168.100.1    DNS       86 Standard query 0xe86e AAAA fe2cr.update.microsoft.com
    142 19.526491  192.168.100.167         192.168.100.1    DNS       86 Standard query 0xd5c7 A fe2cr.update.microsoft.com
    148 19.767324  192.168.100.1           192.168.100.167  DNS      172 Standard query response 0xd5c7 A fe2cr.update.microsoft.com CNAME fe2cr.update.msft.com.trafficmanager.net A 52.152.180.155 A 2…
    149 19.767324  192.168.100.1           192.168.100.167  DNS      196 Standard query response 0xe86e AAAA fe2cr.update.microsoft.com CNAME fe2cr.update.msft.com.trafficmanager.net AAAA 2a01:111:f10…
    151 19.993331  fe80::7227:7fb7:983…   fe80::1          DNS      111 Standard query 0x056c AAAA settings-win.data.microsoft.com
    153 20.182787  192.168.100.167         192.168.100.1    DNS       91 Standard query 0x056c AAAA settings-win.data.microsoft.com
    155 20.363393  192.168.100.1           192.168.100.167  DNS      266 Standard query response 0x056c AAAA settings-win.data.microsoft.com CNAME atm-settingsfe-prod-geo2.trafficmanager.net CNAME set…
    297 22.324167  fe80::7227:7fb7:983…   fe80::1          DNS      106 Standard query 0xc85d A download.windowsupdate.com
    298 22.324660  fe80::7227:7fb7:983…   fe80::1          DNS      106 Standard query 0xbb76 AAAA download.windowsupdate.com
    299 22.525450  192.168.100.167         192.168.100.1    DNS       86 Standard query 0xbb76 AAAA download.windowsupdate.com
    300 22.525450  192.168.100.167         192.168.100.1    DNS       86 Standard query 0xc85d A download.windowsupdate.com
    301 22.547217  192.168.100.1           192.168.100.167  DNS      253 Standard query response 0xbb76 AAAA download.windowsupdate.com CNAME download.windowsupdate.com.delivery.microsoft.com CNAME wu…
    302 22.551230  192.168.100.1           192.168.100.167  DNS      241 Standard query response 0xc85d A download.windowsupdate.com CNAME download.windowsupdate.com.delivery.microsoft.com CNAME wu-f-…

> Frame 91: 209 bytes on wire (1672 bits), 209 bytes captured (1672 bits) on interface \Device\NPF_{C78FCD
> Ethernet II, Src: HuaweiTechno_e5:a4:3f (20:87:ec:e5:a4:3f), Dst: AzureWaveTec_e3:16:b7 (70:66:55:e3:16:
> Internet Protocol Version 4, Src: 192.168.100.1, Dst: 192.168.100.167
> User Datagram Protocol, Src Port: 53, Dst Port: 62764
> Domain Name System (response)

0000  70 66 55 e3 16 b7 20 87  ec e5 a4 3f 08 00 45 00   pfU···· ···?··E·
0010  00 c3 ae 10 40 00 40 11  42 20 c0 a8 64 01 c0 a8   ····@·@· B ··d···
0020  64 a7 00 35 f5 2c 00 af  3c c5 71 e1 81 80 00 01   d··5·,·· <·q·····
0030  00 02 00 00 00 00 0c 73  65 74 74 69 6e 67 73 2d   ·······s ettings-
0040  77 69 6e 04 64 61 74 61  09 6d 69 63 72 6f 73 6f   win·data ·microso
0050  66 74 03 63 6f 6d 00 00  1c 00 01 c0 0c 00 05 00   ft·com·· ········
0060  01 00 00 04 b3 00 2d 18  61 74 6d 2d 73 65 74 74   ······-· atm-sett
0070  69 6e 67 73 66 65 2d 70  72 6f 64 2d 67 65 6f 32   ingsfe-p rod-geo2
0080  0e 74 72 61 66 66 69 63  6d 61 6e 61 67 65 72 03   ·traffic manager·
0090  6e 65 74 00 c0 3d 00 05  00 01 00 00 00 24 00 31   net··=·· ·····$·1
00a0  14 73 65 74 74 69 6e 67  73 2d 70 72 6f 64 2d 77   ·setting s-prod-w
00b0  75 73 32 2d 32 07 77 65  73 74 75 73 32 08 63 6c   us2-2·we stus2·cl
00c0  6f 75 64 61 70 70 05 61  7a 75 72 65 03 63 6f 6d   oudapp·a zure·com
00d0  00                                                 ·
```

Figure 5: DNS (port 53) Packet



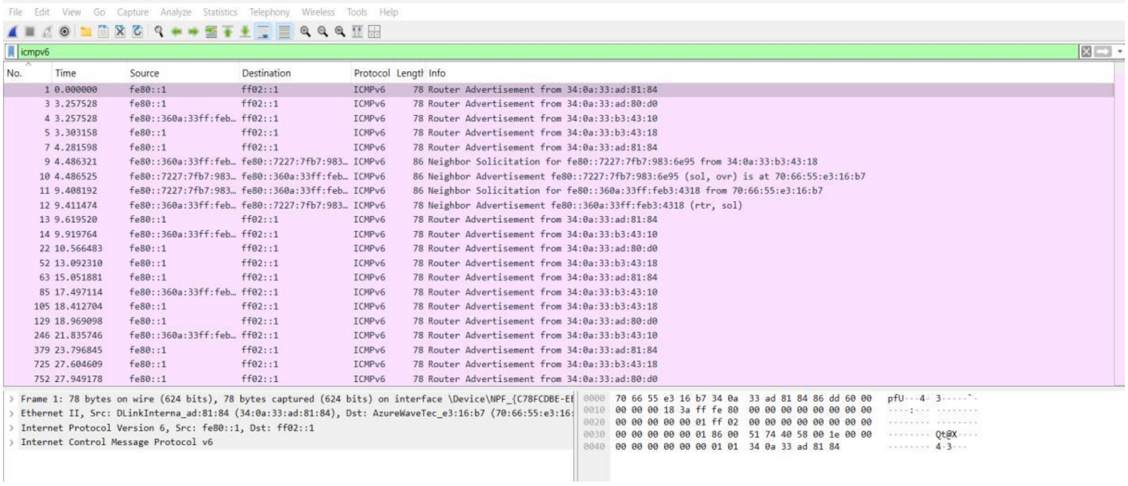
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

```
arp
No.     Time       Source                 Destination  Protocol Length Info
     86 17.497114  HonorDevice_2a:22:00   Broadcast    ARP       60 Who has 192.168.100.1? Tell 192.168.100.51

> Frame 86: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface \Device\NPF_{C78FCDBE-
> Ethernet II, Src: HonorDevice_2a:22:00 (94:f6:f2:2a:22:00), Dst: Broadcast (ff:ff:ff:ff:ff:ff)
> Address Resolution Protocol (request)

0000  ff ff ff ff ff ff 94 f6  f2 2a 22 00 08 06 00 01   ········ ·*"·····
0010  08 00 06 04 00 01 94 f6  f2 2a 22 00 c0 a8 64 33   ········ ·*"···d3
0020  00 00 00 00 00 00 c0 a8  64 01 e4 56 a0 22 a6 fc   ········ d··V·"··
0030  ce 8f 85 13 bb 2f 01 01  08 0a c8 80               ·····/·· ····
```

Figure 6: ARP Packet

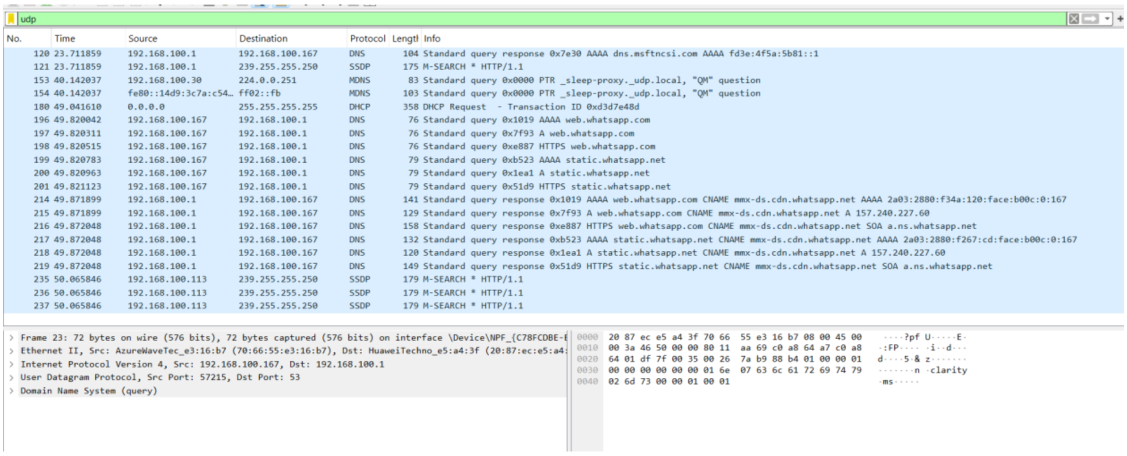

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
icmpv6

```
No.  Time        Source                Destination           Protocol Length Info
  1 0.000000     fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:ad:81:84
  3 3.257528     fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:ad:80:d0
  4 3.257528     fe80::360a:33ff:feb…  ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:b3:43:10
  5 3.303158     fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:b3:43:18
  7 4.281598     fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:ad:81:84
  9 4.486321     fe80::360a:33ff:feb…  fe80::7227:7fb7:983…  ICMPv6    86 Neighbor Solicitation for fe80::7227:7fb7:983:6e95 from 34:0a:33:b3:43:18
 10 4.486525     fe80::7227:7fb7:983…  fe80::360a:33ff:feb…  ICMPv6    86 Neighbor Advertisement fe80::7227:7fb7:983:6e95 (sol, ovr) is at 70:66:55:e3:16:b7
 11 9.408192     fe80::7227:7fb7:983…  fe80::360a:33ff:feb…  ICMPv6    86 Neighbor Solicitation for fe80::360a:33ff:feb3:4318 from 70:66:55:e3:16:b7
 12 9.411474     fe80::360a:33ff:feb…  fe80::7227:7fb7:983…  ICMPv6    78 Neighbor Advertisement fe80::360a:33ff:feb3:4318 (rtr, sol)
 13 9.619520     fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:ad:81:84
 14 9.919764     fe80::360a:33ff:feb…  ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:b3:43:10
 22 10.566483    fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:ad:80:d0
 52 13.092310    fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:b3:43:18
 63 15.051881    fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:ad:81:84
 85 17.497114    fe80::360a:33ff:feb…  ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:b3:43:10
105 18.412704    fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:b3:43:18
129 18.969098    fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:ad:80:d0
246 21.835746    fe80::360a:33ff:feb…  ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:b3:43:10
379 23.796845    fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:ad:81:84
725 27.604609    fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:b3:43:18
752 27.949178    fe80::1               ff02::1               ICMPv6    78 Router Advertisement from 34:0a:33:ad:80:d0

> Frame 1: 78 bytes on wire (624 bits), 78 bytes captured (624 bits) on interface \Device\NPF_{C78FCDBE-EE
> Ethernet II, Src: DLinkInterna_ad:81:84 (34:0a:33:ad:81:84), Dst: AzureWaveTec_e3:16:b7 (70:66:55:e3:16:
> Internet Protocol Version 6, Src: fe80::1, Dst: ff02::1
> Internet Control Message Protocol v6

0000  70 66 55 e3 16 b7 34 0a  33 ad 81 84 86 dd 60 00   pfU···4· 3·····`·
0010  00 00 00 18 3a ff fe 80  00 00 00 00 00 00 00 00   ····:··· ········
0020  00 00 00 00 00 01 ff 02  00 00 00 00 00 00 00 00   ········ ········
0030  00 00 00 00 00 01 86 00  51 74 40 58 00 1e 00 00   ········ Qt@X····
0040  00 00 00 00 00 00 01 01  34 0a 33 ad 81 84         ········ 4·3···
```

Figure 7: ICMPv6 (icmpv6)

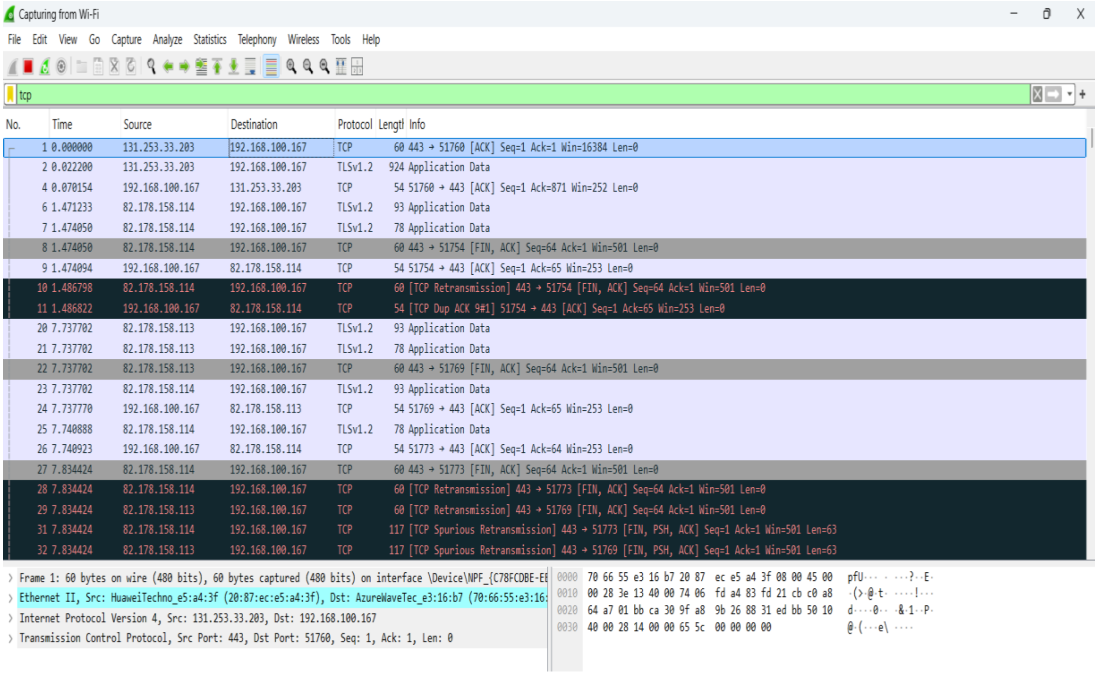


```
No.  Time        Source                Destination        Protocol Length Info
120 23.711859    192.168.100.1         192.168.100.167    DNS      104 Standard query response 0x7e30 AAAA dns.msftncsi.com AAAA fd3e:4f5a:5b81::1
121 23.711859    192.168.100.1         239.255.255.250    SSDP     175 M-SEARCH * HTTP/1.1
153 40.142037    192.168.100.30        224.0.0.251        MDNS      83 Standard query 0x0000 PTR _sleep-proxy._udp.local, "QM" question
154 40.142037    fe80::14d9:3c7a:c54…  ff02::fb           MDNS     103 Standard query 0x0000 PTR _sleep-proxy._udp.local, "QM" question
180 49.041610    0.0.0.0               255.255.255.255    DHCP     358 DHCP Request  - Transaction ID 0xd3d7e48d
196 49.820042    192.168.100.167       192.168.100.1      DNS       76 Standard query 0x1019 AAAA web.whatsapp.com
197 49.820311    192.168.100.167       192.168.100.1      DNS       76 Standard query 0x7f93 A web.whatsapp.com
198 49.820515    192.168.100.167       192.168.100.1      DNS       76 Standard query 0xe887 HTTPS web.whatsapp.com
199 49.820783    192.168.100.167       192.168.100.1      DNS       79 Standard query 0xb523 AAAA static.whatsapp.net
200 49.820963    192.168.100.167       192.168.100.1      DNS       79 Standard query 0x1ea1 A static.whatsapp.net
201 49.821123    192.168.100.167       192.168.100.1      DNS       79 Standard query 0x51d9 HTTPS static.whatsapp.net
214 49.871899    192.168.100.1         192.168.100.167    DNS      141 Standard query response 0x1019 AAAA web.whatsapp.com CNAME mmx-ds.cdn.whatsapp.net AAAA 2a03:2880:f34a:120:face:b00c:0:167
215 49.871899    192.168.100.1         192.168.100.167    DNS      129 Standard query response 0x7f93 A web.whatsapp.com CNAME mmx-ds.cdn.whatsapp.net A 157.240.227.60
216 49.872048    192.168.100.1         192.168.100.167    DNS      158 Standard query response 0xe887 HTTPS web.whatsapp.com CNAME mmx-ds.cdn.whatsapp.net SOA a.ns.whatsapp.net
217 49.872048    192.168.100.1         192.168.100.167    DNS      132 Standard query response 0xb523 AAAA static.whatsapp.net CNAME mmx-ds.cdn.whatsapp.net AAAA 2a03:2880:f267:cd:face:b00c:0:167
218 49.872048    192.168.100.1         192.168.100.167    DNS      120 Standard query response 0x1ea1 A static.whatsapp.net CNAME mmx-ds.cdn.whatsapp.net A 157.240.227.60
219 49.872048    192.168.100.1         192.168.100.167    DNS      149 Standard query response 0x51d9 HTTPS static.whatsapp.net CNAME mmx-ds.cdn.whatsapp.net SOA a.ns.whatsapp.net
235 50.065846    192.168.100.113       239.255.255.250    SSDP     179 M-SEARCH * HTTP/1.1
236 50.065846    192.168.100.113       239.255.255.250    SSDP     179 M-SEARCH * HTTP/1.1
237 50.065846    192.168.100.113       239.255.255.250    SSDP     179 M-SEARCH * HTTP/1.1

> Frame 23: 72 bytes on wire (576 bits), 72 bytes captured (576 bits) on interface \Device\NPF_{C78FCDBE-E
> Ethernet II, Src: AzureWaveTec_e3:16:b7 (70:66:55:e3:16:b7), Dst: HuaweiTechno_e5:a4:3f (20:87:ec:e5:a4:
> Internet Protocol Version 4, Src: 192.168.100.167, Dst: 192.168.100.1
> User Datagram Protocol, Src Port: 57215, Dst Port: 53
> Domain Name System (query)

0000  20 87 ec e5 a4 3f 70 66  55 e3 16 b7 08 00 45 00    ····?pf U·····E·
0010  00 3a 46 50 00 00 80 11  aa 69 c0 a8 64 a7 c0 a8   ·:FP···· ·i··d···
0020  64 01 df 7f 00 35 00 26  7a b9 88 b4 01 00 00 01   d····5·& z·······
0030  00 00 00 00 00 00 01 6e  07 63 6c 61 72 69 74 79   ·······n ·clarity
0040  02 6d 73 00 00 01 00 01                            ·ms·····
```

Figure 8: UDP Packet


Capturing from Wi-Fi
File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help
tcp

```
No. Time       Source            Destination       Protocol Length Info
  1 0.000000   131.253.33.203    192.168.100.167   TCP       60 443 → 51760 [ACK] Seq=1 Ack=1 Win=16384 Len=0
  2 0.022200   131.253.33.203    192.168.100.167   TLSv1.2  924 Application Data
  4 0.070154   192.168.100.167   131.253.33.203    TCP       54 51760 → 443 [ACK] Seq=1 Ack=871 Win=252 Len=0
  6 1.471233   82.178.158.114    192.168.100.167   TLSv1.2   93 Application Data
  7 1.474050   82.178.158.114    192.168.100.167   TLSv1.2   78 Application Data
  8 1.474050   82.178.158.114    192.168.100.167   TCP       60 443 → 51754 [FIN, ACK] Seq=64 Ack=1 Win=501 Len=0
  9 1.474094   192.168.100.167   82.178.158.114    TCP       54 51754 → 443 [ACK] Seq=1 Ack=65 Win=253 Len=0
 10 1.486798   82.178.158.114    192.168.100.167   TCP       60 [TCP Retransmission] 443 → 51754 [FIN, ACK] Seq=64 Ack=1 Win=501 Len=0
 11 1.486822   192.168.100.167   82.178.158.114    TCP       54 [TCP Dup ACK 9#1] 51754 → 443 [ACK] Seq=1 Ack=65 Win=253 Len=0
 20 7.737702   82.178.158.113    192.168.100.167   TLSv1.2   93 Application Data
 21 7.737702   82.178.158.113    192.168.100.167   TLSv1.2   78 Application Data
 22 7.737702   82.178.158.113    192.168.100.167   TCP       60 443 → 51769 [FIN, ACK] Seq=64 Ack=1 Win=501 Len=0
 23 7.737702   82.178.158.114    192.168.100.167   TLSv1.2   93 Application Data
 24 7.737770   192.168.100.167   82.178.158.113    TCP       54 51769 → 443 [ACK] Seq=1 Ack=65 Win=253 Len=0
 25 7.740888   82.178.158.114    192.168.100.167   TLSv1.2   78 Application Data
 26 7.740923   192.168.100.167   82.178.158.114    TCP       54 51773 → 443 [ACK] Seq=1 Ack=64 Win=253 Len=0
 27 7.834424   82.178.158.114    192.168.100.167   TCP       60 443 → 51773 [FIN, ACK] Seq=64 Ack=1 Win=501 Len=0
 28 7.834424   82.178.158.114    192.168.100.167   TCP       60 [TCP Retransmission] 443 → 51773 [FIN, ACK] Seq=64 Ack=1 Win=501 Len=0
 29 7.834424   82.178.158.113    192.168.100.167   TCP       60 [TCP Retransmission] 443 → 51769 [FIN, ACK] Seq=64 Ack=1 Win=501 Len=0
 31 7.834424   82.178.158.114    192.168.100.167   TCP      117 [TCP Spurious Retransmission] 443 → 51773 [FIN, PSH, ACK] Seq=1 Ack=1 Win=501 Len=63
 32 7.834424   82.178.158.113    192.168.100.167   TCP      117 [TCP Spurious Retransmission] 443 → 51769 [FIN, PSH, ACK] Seq=1 Ack=1 Win=501 Len=63

> Frame 1: 60 bytes on wire (480 bits), 60 bytes captured (480 bits) on interface \Device\NPF_{C78FCDBE-EE
> Ethernet II, Src: HuaweiTechno_e5:a4:3f (20:87:ec:e5:a4:3f), Dst: AzureWaveTec_e3:16:b7 (70:66:55:e3:16:
> Internet Protocol Version 4, Src: 131.253.33.203, Dst: 192.168.100.167
> Transmission Control Protocol, Src Port: 443, Dst Port: 51760, Seq: 1, Ack: 1, Len: 0

0000  70 66 55 e3 16 b7 20 87  ec e5 a4 3f 08 00 45 00   pfU··· · ···?··E·
0010  00 28 3e 13 40 00 74 06  fd a4 83 fd 21 cb c0 a8   ·(>·@·t· ····!···
0020  64 a7 01 bb ca 30 9f a8  9b 26 88 31 ed bb 50 10   d····0·· ·&·1··P·
0030  40 00 28 14 00 00 65 5c  00 00 00 00               @·(···e\ ····
```

Figure 9: TCP Packet

VII. TRAFFIC ANALYSIS AND OBSERVATIONS

The network traffic captured during the observation period was extensively analyzed using Wireshark, offering valuable insights into the structure, behavior, and composition of communications within the monitored environment. A variety of protocols were detected in the data, with Transmission Control Protocol (TCP), User Datagram Protocol (UDP), and Internet Control Message Protocol (ICMP) emerging as the most frequently observed. TCP traffic dominated the dataset, which is consistent with its central role in managing reliable, connection-oriented communication—such as those underpinning web browsing, email, and secure HTTP (HTTPS) interactions (Stewart, 2021). UDP traffic, while less voluminous than TCP, was consistently present and primarily associated with Domain Name System (DNS) resolution processes. ICMP packets, frequently used for diagnostic operations like ping and traceroute, were also captured intermittently, signaling the presence of routine network health checks and connectivity tests.

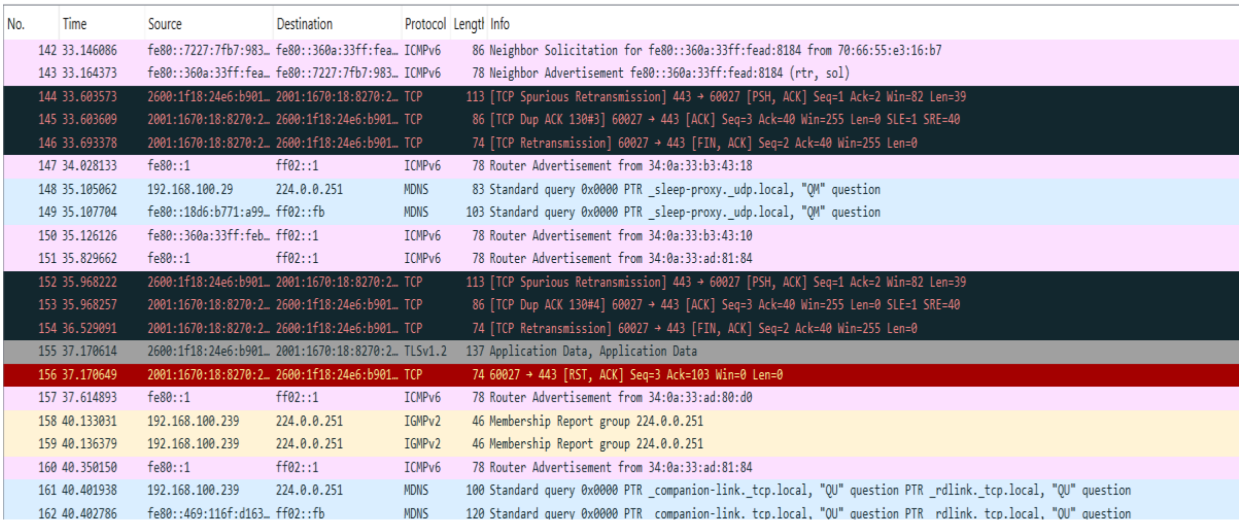
Wireshark's built-in statistical tools, particularly the "Conversations" and "Endpoints" features, were employed to analyze the distribution and flow of traffic across devices. These tools provided detailed visibility into the IP addresses most involved in data exchange, thereby identifying the top talkers—both in terms of data sent and received. By examining these metrics, it was possible to establish a clear profile of network behavior, track communication patterns, and evaluate whether any hosts demonstrated anomalous activity, such as excessive traffic generation or persistent communication with external IPs (Kurose & Ross, 2022).

Although the majority of traffic appeared consistent with expected usage patterns, some irregularities were observed within the TCP stream. Specifically, a number of TCP retransmissions and duplicate acknowledgments (ACKs) were detected. These artifacts generally reflect transient network performance issues—such as momentary congestion, jitter, or packet loss—rather than indications of a security incident. In dynamic network environments, such behavior is not uncommon and typically points to fluctuations in network load or latency rather than malicious activity (Peterson & Davie, 2020).

Notably, no definitive signs of malicious behavior were uncovered during the packet capture window. There was no evidence of Address Resolution Protocol (ARP) spoofing, no abnormal DNS query patterns, and no signs of ICMP flood attacks or reconnaissance-related behavior. The absence of suspicious payloads, erratic connection attempts, or protocol misuse suggests that the network was operating within its normal security and performance thresholds throughout the monitoring period.

The results of this analysis underscore Wireshark's utility as a powerful diagnostic and monitoring solution. It not only provides granular visibility into standard traffic operations but also supports early detection of performance bottlenecks and anomalous behavior. For cybersecurity professionals operating within Security Operations Centers (SOCs), such insights are essential for maintaining continuous situational awareness, validating network integrity, and responding swiftly to potential threats (Anderson, 2023).

Default Coloring in Wireshark



No.	Time	Source	Destination	Protocol	Lengtl	Info
142	33.146086	fe80::7227:7fb7:983…	fe80::360a:33ff:fea…	ICMPv6	86	Neighbor Solicitation for fe80::360a:33ff:fead:8184 from 70:66:55:e3:16:b7
143	33.164373	fe80::360a:33ff:fea…	fe80::7227:7fb7:983…	ICMPv6	78	Neighbor Advertisement fe80::360a:33ff:fead:8184 (rtr, sol)
144	33.603573	2600:1f18:24e6:b901…	2001:1670:18:8270:2…	TCP	113	[TCP Spurious Retransmission] 443 → 60027 [PSH, ACK] Seq=1 Ack=2 Win=82 Len=39
145	33.603609	2001:1670:18:8270:2…	2600:1f18:24e6:b901…	TCP	86	[TCP Dup ACK 130#3] 60027 → 443 [ACK] Seq=3 Ack=40 Win=255 Len=0 SLE=1 SRE=40
146	33.693378	2001:1670:18:8270:2…	2600:1f18:24e6:b901…	TCP	74	[TCP Retransmission] 60027 → 443 [FIN, ACK] Seq=2 Ack=40 Win=255 Len=0
147	34.028133	fe80::1	ff02::1	ICMPv6	78	Router Advertisement from 34:0a:33:b3:43:18
148	35.105062	192.168.100.29	224.0.0.251	MDNS	83	Standard query 0x0000 PTR _sleep-proxy._udp.local, "QM" question
149	35.107704	fe80::18d6:b771:a99…	ff02::fb	MDNS	103	Standard query 0x0000 PTR _sleep-proxy._udp.local, "QM" question
150	35.126126	fe80::360a:33ff:feb…	ff02::1	ICMPv6	78	Router Advertisement from 34:0a:33:b3:43:10
151	35.829662	fe80::1	ff02::1	ICMPv6	78	Router Advertisement from 34:0a:33:ad:81:84
152	35.968222	2600:1f18:24e6:b901…	2001:1670:18:8270:2…	TCP	113	[TCP Spurious Retransmission] 443 → 60027 [PSH, ACK] Seq=1 Ack=2 Win=82 Len=39
153	35.968257	2001:1670:18:8270:2…	2600:1f18:24e6:b901…	TCP	86	[TCP Dup ACK 130#4] 60027 → 443 [ACK] Seq=3 Ack=40 Win=255 Len=0 SLE=1 SRE=40
154	36.529091	2001:1670:18:8270:2…	2600:1f18:24e6:b901…	TCP	74	[TCP Retransmission] 60027 → 443 [FIN, ACK] Seq=2 Ack=40 Win=255 Len=0
155	37.170614	2600:1f18:24e6:b901…	2001:1670:18:8270:2…	TLSv1.2	137	Application Data, Application Data
156	37.170649	2001:1670:18:8270:2…	2600:1f18:24e6:b901…	TCP	74	60027 → 443 [RST, ACK] Seq=3 Ack=103 Win=0 Len=0
157	37.614893	fe80::1	ff02::1	ICMPv6	78	Router Advertisement from 34:0a:33:ad:80:d0
158	40.133031	192.168.100.239	224.0.0.251	IGMPv2	46	Membership Report group 224.0.0.251
159	40.136379	192.168.100.239	224.0.0.251	IGMPv2	46	Membership Report group 224.0.0.251
160	40.350150	fe80::1	ff02::1	ICMPv6	78	Router Advertisement from 34:0a:33:ad:81:84
161	40.401938	192.168.100.239	224.0.0.251	MDNS	100	Standard query 0x0000 PTR _companion-link._tcp.local, "QU" question PTR _rdlink._tcp.local, "QU" question
162	40.402786	fe80::469:116f:d163…	ff02::fb	MDNS	120	Standard query 0x0000 PTR _companion-link._tcp.local, "QU" question PTR _rdlink._tcp.local, "QU" question

Figure 10: Coloring in Wireshark

Table 1: Wireshark color

Color	Description	What does it indicate
Black	TCP issues	TCP retransmits, duplicate ACKs, spurious retransmits (indications of network issues)
Red	TCP reset	TCP RST (reset) or sudden connection closure, sometimes zero-length TCP segments
Blue	ICMP/ICMPV6	Router Advertisements, Neighbor Solicitations (traffic from the IPv6 protocol)
Pink	MDNS (Multicast DNS)	Multicast DNS queries based on UDP, normally from local domains within LANs
Yellow	IGMP	Internet Group Management Protocol (group communication or streaming)
Grey	Normal traffic	Packets which do not meet any special rules (usually normal harmless traffic)

VIII. CONCLUSION

Network Traffic Analysis (NTA) remains a foundational practice in safeguarding the performance, integrity, and security of modern networked systems. As networks continue to expand in complexity and exposure, the ability to detect, analyze, and respond to threats in real time has become essential—especially within Security Operations Centers (SOCs). In this context, Wireshark stands out as a powerful and accessible tool that enables detailed packet-level inspection and comprehensive traffic monitoring.

Throughout this study, Wireshark demonstrated its utility in uncovering anomalies across multiple protocols, such as TCP, UDP, ICMP, ARP, and DNS. Although not a dedicated Intrusion Detection System (IDS), Wireshark significantly augments threat detection capabilities by allowing security analysts to identify and investigate incidents like Denial-of-Service (DoS) attacks, port scans, ARP spoofing, and potential data exfiltration attempts. Its ability to dissect a wide range of protocols and visualize traffic patterns in real time makes it instrumental for both proactive threat detection and post-incident forensic analysis.

Furthermore, with customizable filters, graphical tools, and metadata extraction features, Wireshark enables analysts to make data-driven decisions based on concrete network evidence. This empowers SOC teams to enhance situational awareness, reduce incident response time, and validate compliance with security policies and regulatory frameworks.

Given its open-source nature, robust community support, and continuous updates, Wireshark remains a reliable and adaptable tool in the face of evolving cyber threats. While it may not replace specialized IDS/IPS systems, its integration into SOC workflows significantly strengthens the overall cybersecurity posture of any organization.

In summary, as cyber threats become more sophisticated, integrating packet-level network analysis tools like Wireshark into the daily operations of SOCs is not just beneficial—it is imperative. Its role in early anomaly detection, network troubleshooting, and forensic traceability makes it a cornerstone of modern cybersecurity defense strategies.

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