Network Trafficking Visualization: Analysis, Detection and Visualization of Network Traffic for Enhanced Security and Performance

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Abstract

This thesis presents a comprehensive study on network traffic visualization for the purposes of security monitoring and performance analysis. It includes data collection techniques, preprocessing pipelines, visualization strategies, implementation with Python (Scapy, NetworkX, Plotly), and a case study demonstrating anomaly detection via visualization. The document contains practical code examples and a system flowchart.

Chapter 1: Introduction

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Chapter 2: Literature Review

Historical approaches to traffic analysis: packet capture and manual inspection with Wireshark.

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Chapter 3: Methodology

System architecture overview: capture, preprocessing, storage, visualization, and alerting.

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Data collection: using tshark/pcap and Scapy scripts for capturing relevant fields.

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Feature extraction: bytes/sec, packets/sec, unique IP counts, port distributions, protocol breakdowns.

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Visualization design: mapping features to visual encodings — node-link graphs, timelines, heatmaps.

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Chapter 4: Implementation

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Chapter 5: Results and Analysis

Datasets used: synthetic captures, public pcaps, and campus traces (anonymized).

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Quantitative analysis: detection times, false positives, and resource usage.

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Discussion: strengths and limitations of visualization approaches used.

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Chapter 6: Conclusion and Future Work

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Appendix A: Code Samples

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Visualization script (plotly + networkx) — explanation and full code.

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System Flowchart

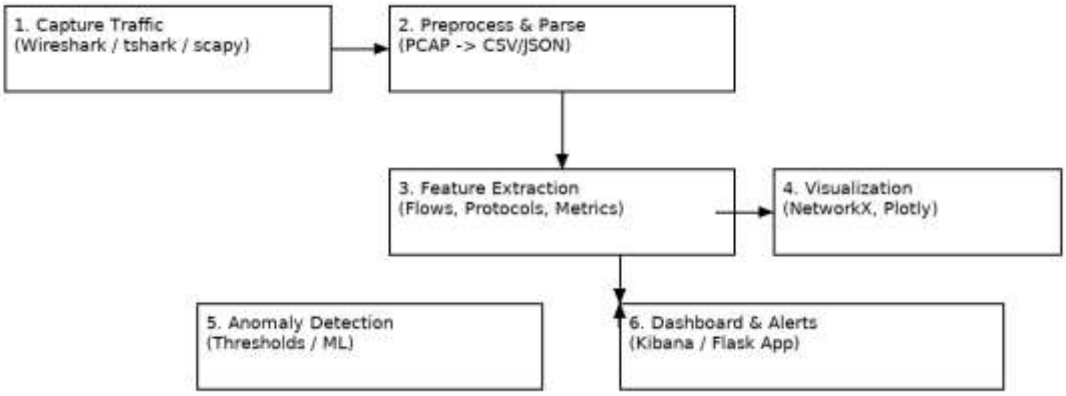

Figure: High-level system flowchart showing capture, preprocessing, feature extraction, visualization, and alerts.

Appendix A: Capture Script (Scapy)

```
# Scapy-based simple packet capture and CSV export
from scapy.all import sniff, IP, TCP, UDP
import csv
def packet_to_row(pkt):
    if IP in pkt:
        ip = pkt[IP]
        sport = pkt.sport if hasattr(pkt, 'sport') else ''
        dport = pkt.dport if hasattr(pkt, 'dport') else ''
        proto = ip.proto
        length = len(pkt)
        return {
            'timestamp': pkt.time,
            'src': ip.src,
            'dst': ip.dst,
            'sport': sport,
            'dport': dport,
            'proto': proto,
            'length': length
        }
def main(output='capture.csv', count=0, iface=None):
    rows = []
    def cb(pkt):
        row = packet_to_row(pkt)
        if row:
            rows.append(row)
    sniff(prn=cb, count=count, iface=iface)
    # write CSV
    keys = ['timestamp','src','dst','sport','dport','proto','length']
    with open(output,'w',newline='') as f:
        writer = csv.DictWriter(f, fieldnames=keys)
        writer.writeheader()
        writer.writerows(rows)
if __name__ == '__main__':
    main(output='capture.csv', count=1000)
```

Appendix B: Preprocessing & Feature Extraction

```
# Preprocessing PCAP-extracted CSV into flows and features
import pandas as pd
df = pd.read_csv('capture.csv')
# convert timestamp
df['timestamp'] = pd.to_datetime(df['timestamp'], unit='s')
# basic aggregation into 5-second windows
df.set_index('timestamp', inplace=True)
```

```
agg = df.groupby([pd.Grouper(freq='5S'), 'src', 'dst']).agg({
    'length': ['sum','count'],
})
agg.columns = ['bytes','pkt_count']
agg = agg.reset_index()
agg.head()
```

Appendix C: Visualization Example (NetworkX + Plotly)

```
# Build a graph from flow aggregates and plot with Plotly
import networkx as nx
import plotly.graph_objects as go
G = nx.DiGraph()
# add nodes and edges
G.add_edge('10.0.0.1','10.0.0.2', weight=1200)
pos = nx.spring_layout(G)
edge_x = []
edge_y = []
for edge in G.edges():
    x0,y0 = pos[edge[0]]
    x1,y1 = pos[edge[1]]
    edge_x += [x0, x1, None]
    edge_y += [y0, y1, None]
edge_trace = go.Scatter(x=edge_x, y=edge_y, mode='lines')
node_x = []
node_y = []
for node in G.nodes():
    x,y = pos[node]
    node_x.append(x); node_y.append(y)
node_trace = go.Scatter(x=node_x, y=node_y, mode='markers+text', text=list(G.nodes()))
fig = go.Figure(data=[edge_trace, node_trace])
fig.show()
```