Project Report

Network Applications Project Report

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CS - 5A

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Objectives:

The primary objective of this project is to develop a collection of network applications to explore and demonstrate fundamental concepts of network programming, including ICMP ping, traceroute, multi-threaded traceroute, a web server, and a proxy server. The project leverages socket programming to provide efficient and scalable network solutions.

Technologies Used:

- - **Programming Language**:
    - Python 3

- - **Libraries:**
    - - "*socket"* for low-level networking
    - - "*argparse"* for command-line argument parsing
    - - "threading" for multi-threaded implementation
    - - "*os*" and "*sys*" for system-level operations
    - - "*struct*" for handling binary data
    - - "*time"* for performance measurement

- **Tools:**
    - - Command-line Interface
    - - Basic text editor/IDE

Implementation Details:

- ## Design and Approach

The project is designed as a command-line application with modular functionality. Each feature (ping, traceroute, web server, proxy server) is implemented as a class that inherits from a base class, ensuring extensibility and maintainability. The `argparse` library handles sub-command arguments to provide a user-friendly interface.

- ## Cisco/Socket Programming Concepts

Raw Sockets: Used for ICMP ping and traceroute functionalities.

UDP and TCP Sockets: Applied in traceroute, web server, and proxy server implementations.

Multi-threading: Enhances performance and responsiveness, especially for multi-threaded traceroute and handling concurrent web/proxy server requests.

- ## Key Code Snippets

Example: ICMP Ping Implementation

Send ICMP Echo Request

```
packet = struct.pack('!BBHHH', ICMP_ECHO_REQUEST, 0, checksum, packet_id,
sequence_number)

sock.sendto(packet, (destination, 1))
```

Receive ICMP Echo Reply

```
response, addr = sock.recvfrom(65535)
```

Example: Web Server Request Handling

with open(filename[1:], 'r') as f:

content = f.read()

response = 'HTTP/1.1 200 OK\r\n\r\n' + content

connection_socket.send(response.encode())

```

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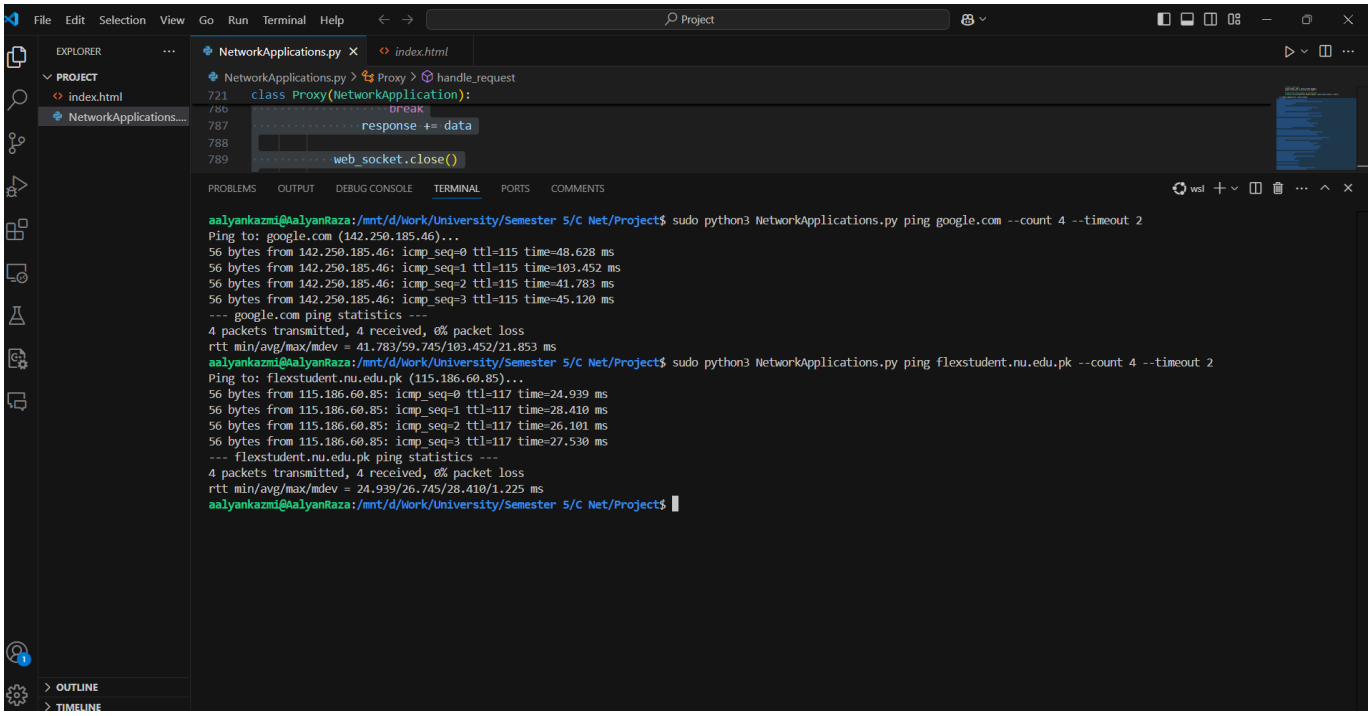
# Results and Testing

- Ping Command:

Successfully sends ICMP echo requests and displays round-trip times.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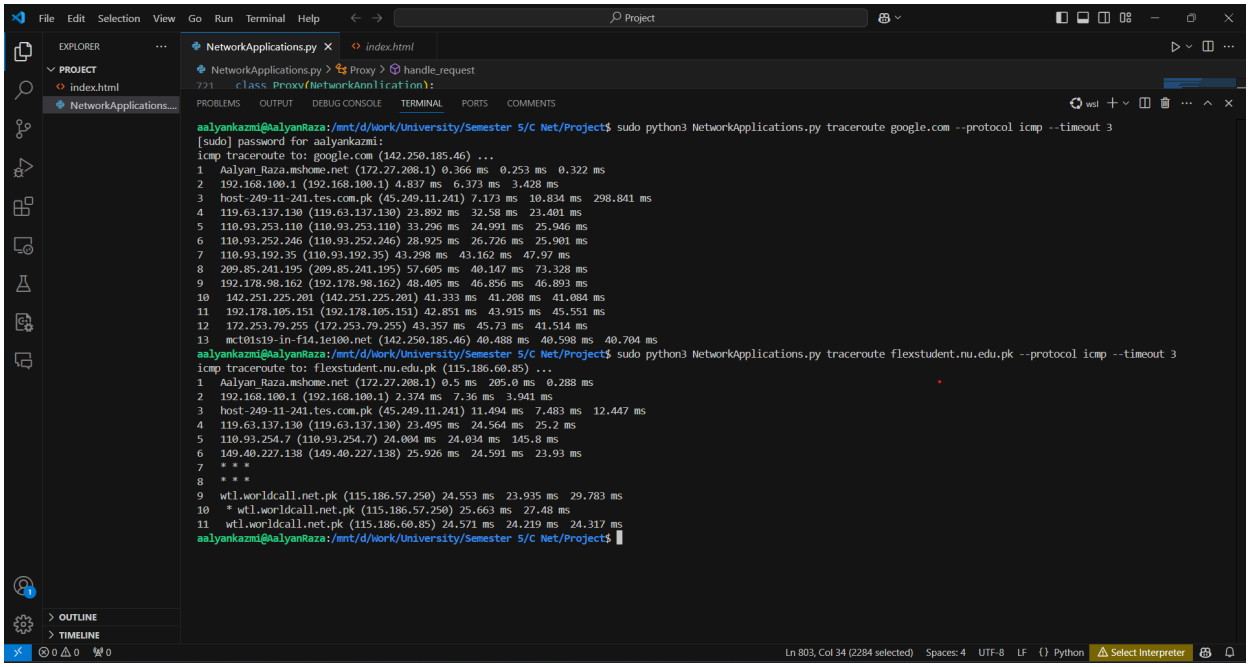
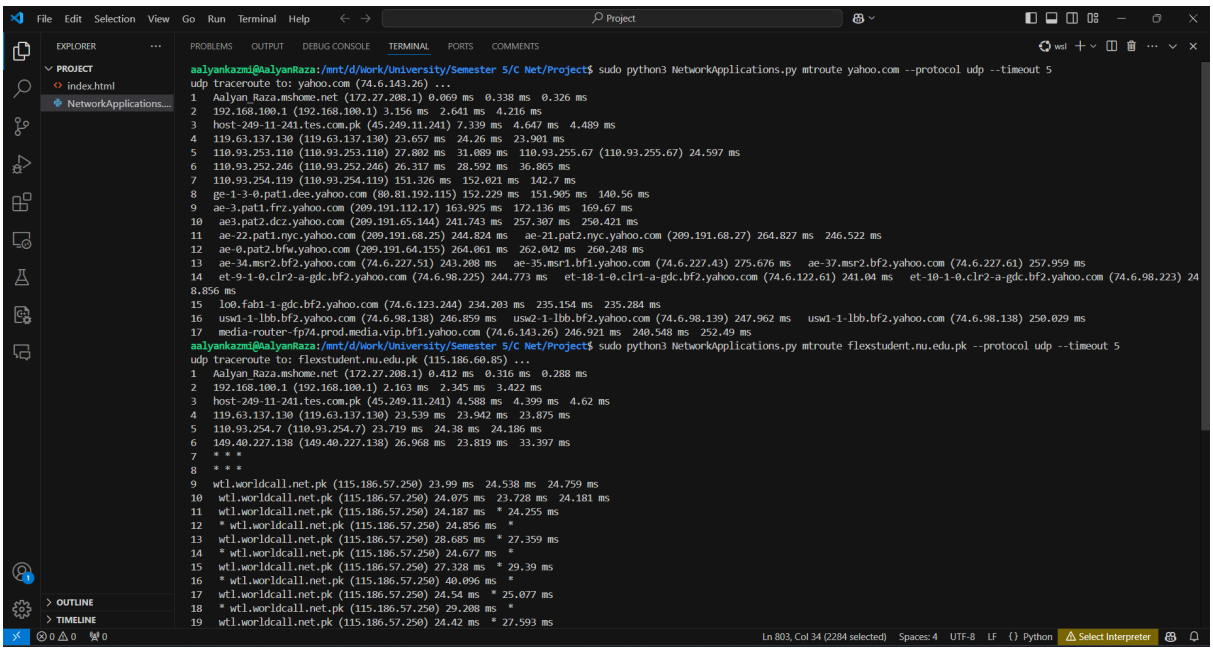
- ## Traceroute Command:

Maps the path packets take to the destination.



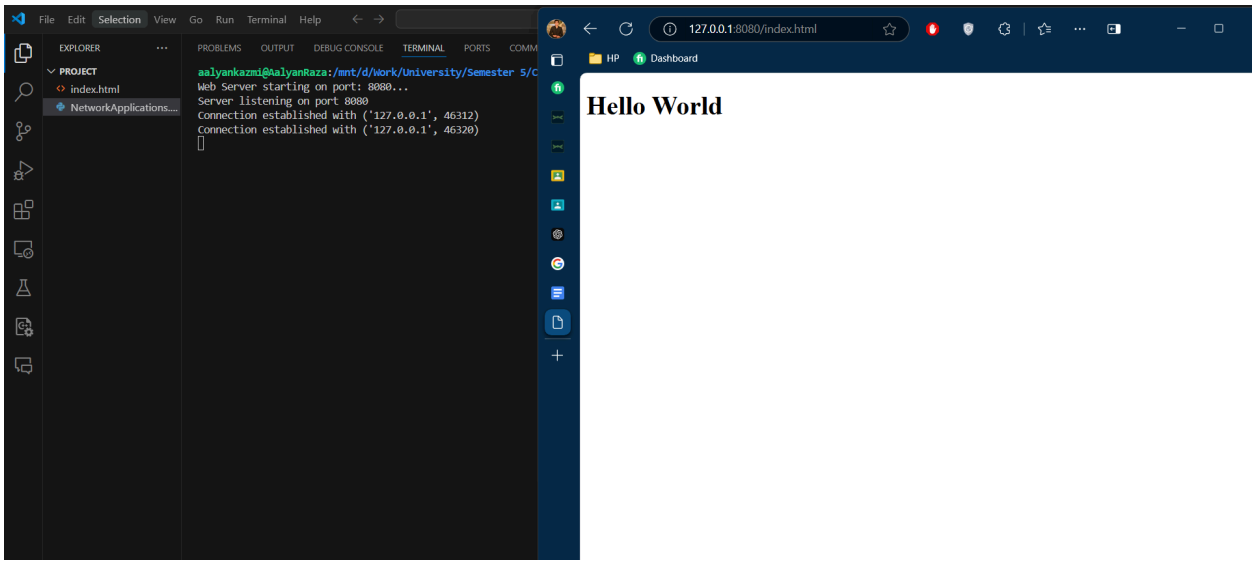
- ## Multi-threaded Traceroute:

Improves performance by concurrently sending and receiving packets.



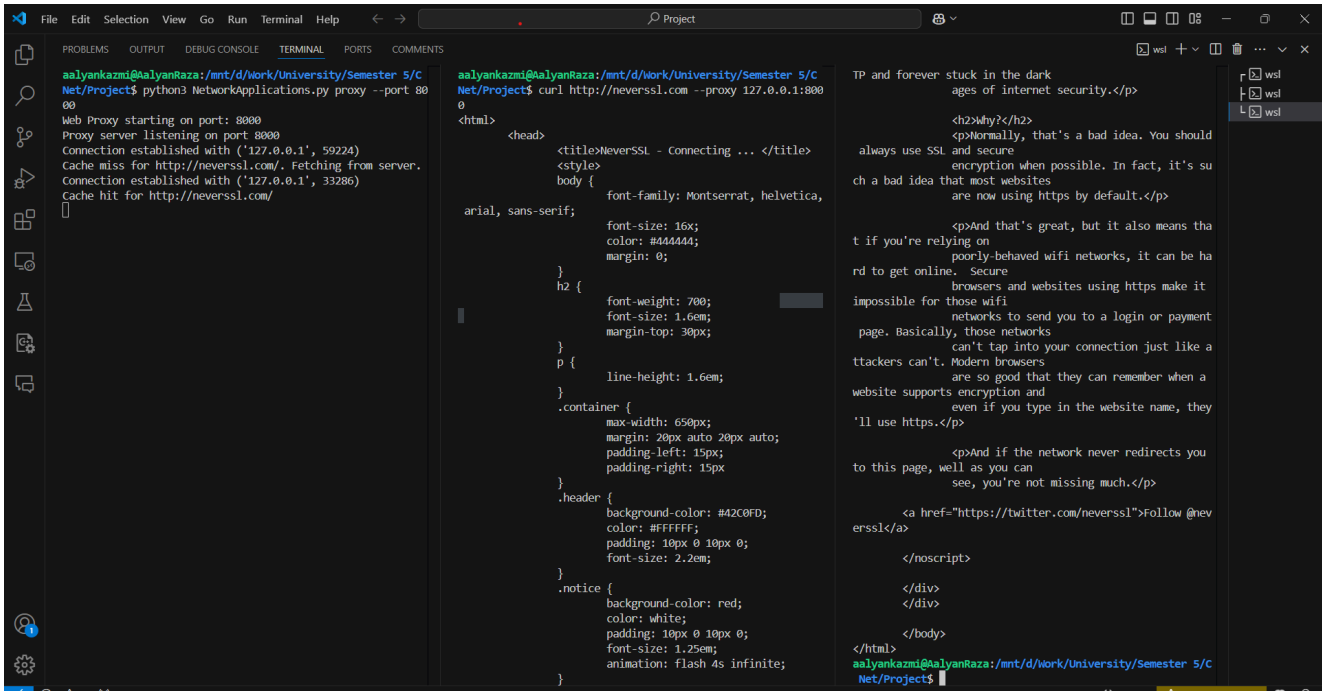
- ## Web Server:

Serves static HTML files.



- ## Proxy Server:

Fetches and caches web content.



Challenges and Learnings:

1. **Raw Socket Permissions:** Overcame administrative permission issues for creating raw sockets.
2. **Timeout Handling:** Implemented robust error handling for timeouts.
3. **Concurrency Bugs:** Debugged thread synchronization issues in multi-threaded traceroute.

Conclusion

This project successfully implements essential network applications using Python. The modular design ensures easy scalability, and the use of socket programming provides an in-depth understanding of networking concepts. Future improvements could include:

- Support for IPv6

- Enhanced logging and reporting features
- Improved user interface with additional customization options

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