Alexandria National University

Faculty of Computing and Data Science

Computer Networks – Final Project

Project Title:

Email Client Application

Submitted by:

• Ahmed Hesham – ID: 2305277

•Youssef Hesham – ID: 2305205

• Hager Amr – ID: 2305197

• Adel Maged – ID: 2305291

Instructor: Dr. Mohamed Rezk

TA: Eng. Ahmed Ashraf / Eng. Miar Mamdouh / Eng. Salma Magdy

Date: 18/12/2025

1- Introduction

- This project implements an email notification system that integrates **SMTP**, **IMAP**, and **TCP socket programming**.
  The system allows sending emails using SMTP and monitoring incoming emails using IMAP.
  Whenever a new email is detected, a **real-time TCP notification** is sent from the server to the client.
- The goal of this project is to demonstrate practical usage of **application layer protocols** and **transport layer communication**.

2- System Architecture

The system consists of four main components:

- **SMTP Client**: Sends emails using Gmail SMTP server.
- **IMAP Client**: Monitors the inbox and detects new incoming emails.
- **TCP Notification Server**: Sends notifications to connected clients.
- **TCP Notification Client**: Receives real-time notifications

Architecture Flow:

1. Email is sent using SMTP.
2. IMAP client checks the inbox.
3. If a new email is detected, the TCP server sends a notification.
4. The TCP client receives and displays the notification.

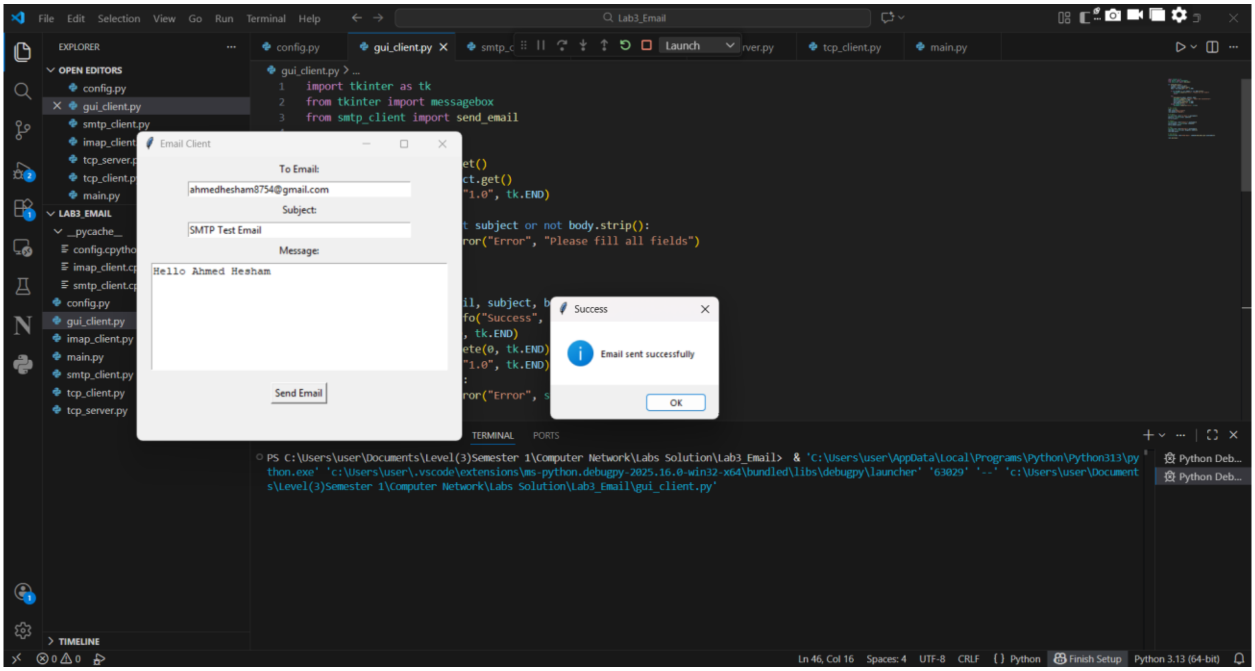
3- Technologies Used

- Programming Language: **Python**
- Protocols:
  - SMTP (Email Sending)
  - IMAP (Email Receiving)
  - TCP (Notification System)
- Tools:
  - Wireshark
  - Gmail (App Password)
  - Python socket library

4- Implementation Details

4.1 SMTP Client

- Uses Gmail SMTP server.
- Sends email securely using SSL.
- App Password is used instead of the real Gmail password.



```
import tkinter as tk
from tkinter import messagebox
from smtp_client import send_email

et()
ct.get()
"1.0", tk.END)

t subject or not body.strip():
ror("Error", "Please fill all fields")

il, subject, b
fo("Success",
, tk.END)
ete(0, tk.END)
"1.0", tk.END)
:
ror("Error", s
```

Email Client

To Email: ahmedhesham8754@gmail.com

Subject: SMTP Test Email

Message:

```
Hello Ahmed Hesham
```

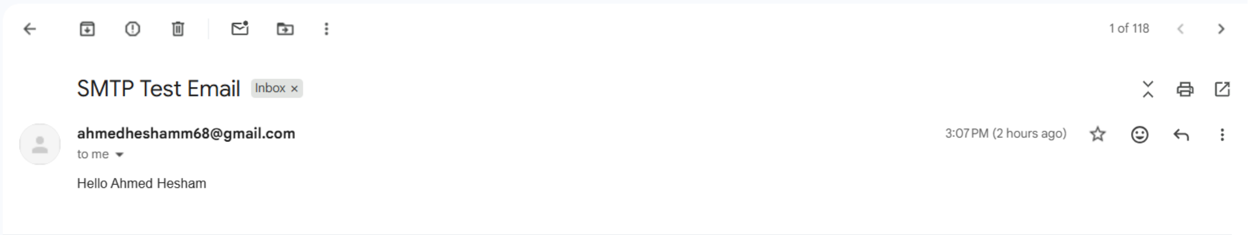
Send Email

Success

Email sent successfully

OK

```
PS C:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email>  & 'C:\Users\user\AppData\Local\Programs\Python\Python313\python.exe' 'c:\Users\user\.vscode\extensions\ms-python.debugpy-2025.16.0-win32-x64\bundled\libs\debugpy\launcher' '63029' '--' 'c:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email\gui_client.py'
```



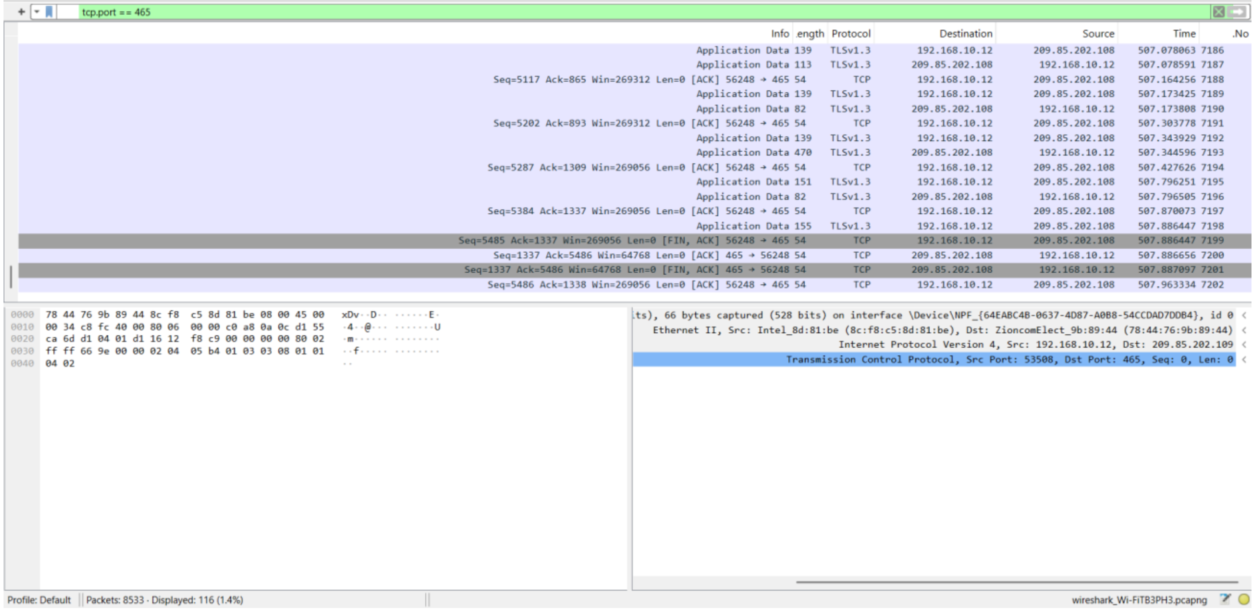
SMTP Test Email

ahmedheshamm68@gmail.com

3:07 PM (2 hours ago)

Hello Ahmed Hesham

smtp_capture (Wire shark)>>(tcp.port == 465)



Info	.ength	Protocol	Destination	Source	Time	.No
Application Data	139	TLSv1.3	192.168.10.12	209.85.202.108	507.078063	7186
Application Data	113	TLSv1.3	209.85.202.108	192.168.10.12	507.078591	7187
Seq=5117 Ack=865 Win=269312 Len=0 [ACK] 56248 → 465	54	TCP	192.168.10.12	209.85.202.108	507.164256	7188
Application Data	139	TLSv1.3	192.168.10.12	209.85.202.108	507.173425	7189
Application Data	82	TLSv1.3	209.85.202.108	192.168.10.12	507.173808	7190
Seq=5202 Ack=893 Win=269312 Len=0 [ACK] 56248 → 465	54	TCP	192.168.10.12	209.85.202.108	507.303778	7191
Application Data	139	TLSv1.3	192.168.10.12	209.85.202.108	507.343929	7192
Application Data	470	TLSv1.3	209.85.202.108	192.168.10.12	507.344596	7193
Seq=5287 Ack=1309 Win=269056 Len=0 [ACK] 56248 → 465	54	TCP	192.168.10.12	209.85.202.108	507.427626	7194
Application Data	151	TLSv1.3	192.168.10.12	209.85.202.108	507.796251	7195
Application Data	82	TLSv1.3	209.85.202.108	192.168.10.12	507.796505	7196
Seq=5384 Ack=1337 Win=269056 Len=0 [ACK] 56248 → 465	54	TCP	192.168.10.12	209.85.202.108	507.870073	7197
Application Data	155	TLSv1.3	192.168.10.12	209.85.202.108	507.886447	7198
Seq=5485 Ack=1337 Win=269056 Len=0 [FIN, ACK] 56248 → 465	54	TCP	192.168.10.12	209.85.202.108	507.886447	7199
Seq=1337 Ack=5486 Win=64768 Len=0 [ACK] 465 → 56248	54	TCP	209.85.202.108	192.168.10.12	507.886656	7200
Seq=1337 Ack=5486 Win=64768 Len=0 [FIN, ACK] 465 → 56248	54	TCP	209.85.202.108	192.168.10.12	507.887097	7201
Seq=5486 Ack=1338 Win=269056 Len=0 [ACK] 56248 → 465	54	TCP	192.168.10.12	209.85.202.108	507.963334	7202

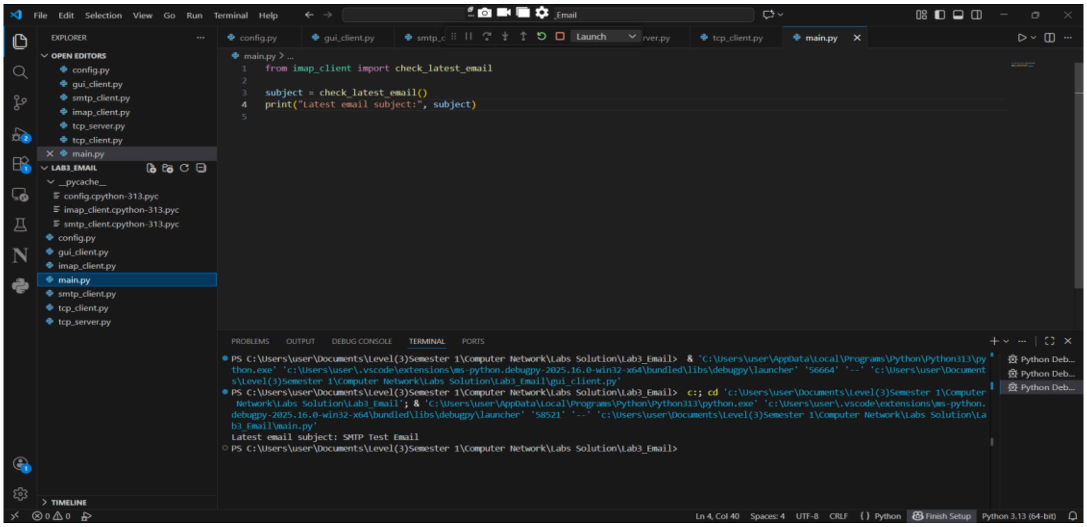
```
0000  78 44 76 9b 89 44 8c f8  c5 8d 81 be 08 00 45 00   xDv··D·· ······E·
0010  00 34 c8 fc 40 00 80 06  00 00 c0 a8 0a 0c d1 55   ·4··@··· ·······U
0020  ca 6d d1 04 01 d1 16 12  f8 c9 00 00 00 00 80 02   ·m······ ········
0030  ff ff 66 9e 00 00 02 04  05 b4 01 03 03 08 01 01   ··f····· ········
0040  04 02                                              ··
```

```
its), 66 bytes captured (528 bits) on interface \Device\NPF_{64EABC4B-0637-4D87-A0B8-54CCDAD7DDB4}, id 0
    Ethernet II, Src: Intel_8d:81:be (8c:f8:c5:8d:81:be), Dst: ZioncomElect_9b:89:44 (78:44:76:9b:89:44)
                                 Internet Protocol Version 4, Src: 192.168.10.12, Dst: 209.85.202.109
                        Transmission Control Protocol, Src Port: 53508, Dst Port: 465, Seq: 0, Len: 0
```

Profile: Default
Packets: 8533 · Displayed: 116 (1.4%)
wireshark_Wi-FiTB3PH3.pcapng

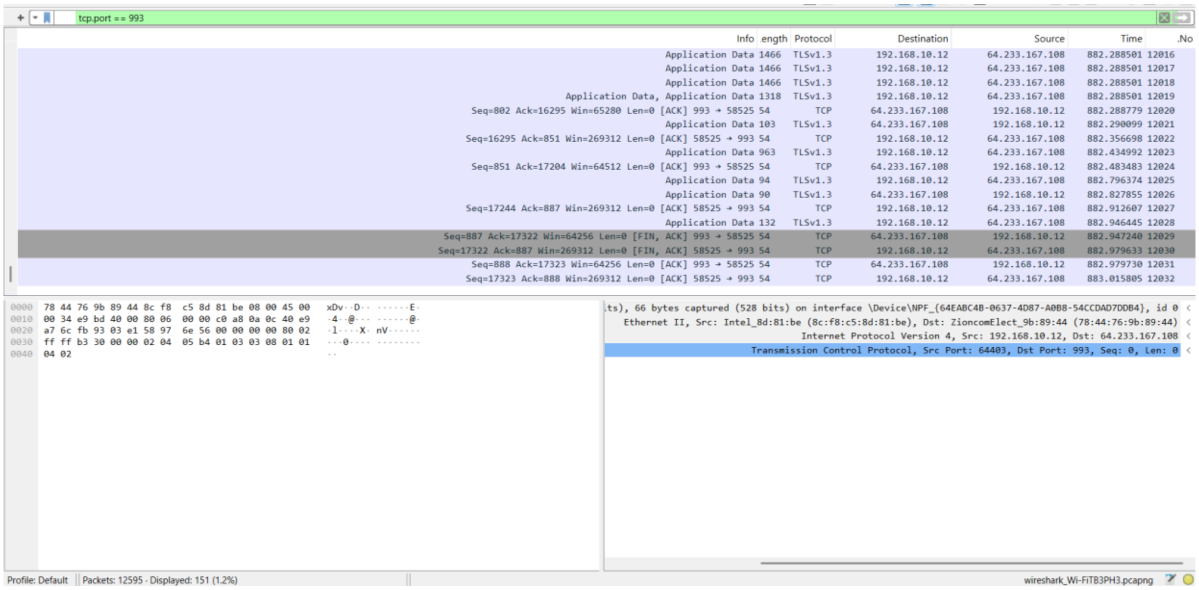
4.2 IMAP Client

- Connects to Gmail IMAP server.
- Checks the inbox for the latest email.
- Extracts the email subject.



```python
from imap_client import check_latest_email

subject = check_latest_email()
print("Latest email subject:", subject)
```

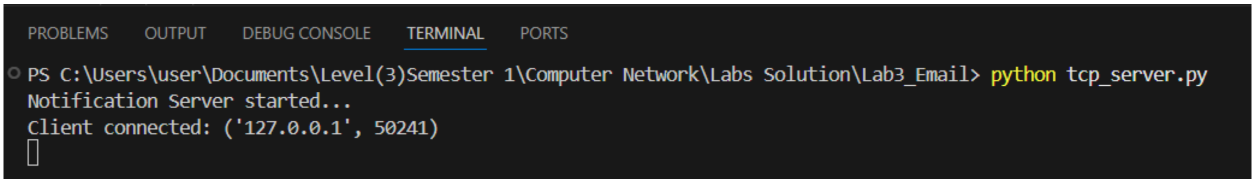
```
PS C:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email>  & 'C:\Users\user\AppData\Local\Programs\Python\Python313\python.exe' 'c:\Users\user\.vscode\extensions\ms-python.debugpy-2025.16.0-win32-x64\bundled\libs\debugpy\launcher' '56664' '--' 'c:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email\gui_client.py'
PS C:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email>  c:; cd 'c:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email'; & 'C:\Users\user\AppData\Local\Programs\Python\Python313\python.exe' 'c:\Users\user\.vscode\extensions\ms-python.debugpy-2025.16.0-win32-x64\bundled\libs\debugpy\launcher' '58521' '--' 'c:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email\main.py'
Latest email subject: SMTP Test Email
PS C:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email>
```



```
tcp.port == 993

                                                   Info .ength Protocol     Destination          Source           Time   .No
                                  Application Data 1466   TLSv1.3     192.168.10.12   64.233.167.108  882.288501 12016
                                  Application Data 1466   TLSv1.3     192.168.10.12   64.233.167.108  882.288501 12017
                                  Application Data 1466   TLSv1.3     192.168.10.12   64.233.167.108  882.288501 12018
                Application Data, Application Data 1318   TLSv1.3     192.168.10.12   64.233.167.108  882.288501 12019
  Seq=802 Ack=16295 Win=65280 Len=0 [ACK] 993 → 58525 54      TCP    64.233.167.108    192.168.10.12  882.288779 12020
                                  Application Data 103    TLSv1.3    64.233.167.108    192.168.10.12  882.290099 12021
 Seq=16295 Ack=851 Win=269312 Len=0 [ACK] 58525 → 993 54      TCP     192.168.10.12   64.233.167.108  882.356698 12022
                                  Application Data 963    TLSv1.3     192.168.10.12   64.233.167.108  882.434992 12023
  Seq=851 Ack=17204 Win=64512 Len=0 [ACK] 993 → 58525 54      TCP    64.233.167.108    192.168.10.12  882.483483 12024
                                  Application Data 94     TLSv1.3     192.168.10.12   64.233.167.108  882.796374 12025
                                  Application Data 90     TLSv1.3    64.233.167.108    192.168.10.12  882.827855 12026
 Seq=17244 Ack=887 Win=269312 Len=0 [ACK] 58525 → 993 54      TCP     192.168.10.12   64.233.167.108  882.912607 12027
                                  Application Data 132    TLSv1.3     192.168.10.12   64.233.167.108  882.946445 12028
 Seq=887 Ack=17322 Win=64256 Len=0 [FIN, ACK] 993 → 58525 54  TCP    64.233.167.108    192.168.10.12  882.947240 12029
Seq=17322 Ack=887 Win=269312 Len=0 [FIN, ACK] 58525 → 993 54  TCP     192.168.10.12   64.233.167.108  882.979633 12030
  Seq=888 Ack=17323 Win=64256 Len=0 [ACK] 993 → 58525 54      TCP    64.233.167.108    192.168.10.12  882.979730 12031
 Seq=17323 Ack=888 Win=269312 Len=0 [ACK] 58525 → 993 54      TCP     192.168.10.12   64.233.167.108  883.015805 12032

0000  78 44 76 9b 89 44 8c f8  c5 8d 81 be 08 00 45 00   xDv··D·· ······E·
0010  00 34 e9 bd 40 00 80 06  00 00 c0 a8 0a 0c 40 e9   ·4··@··· ······@·
0020  a7 6c fb 93 03 e1 58 97  6e 56 00 00 00 00 80 02   ·l····X· nV······
0030  ff ff b3 30 00 00 02 04  05 b4 01 03 03 08 01 01   ···0···· ········
0040  04 02                                              ··

ts), 66 bytes captured (528 bits) on interface \Device\NPF_{64EABC4B-0637-4D87-A0B8-54CCDAD7DDB4}, id 0 <
   Ethernet II, Src: Intel_8d:81:be (8c:f8:c5:8d:81:be), Dst: ZioncomElect_9b:89:44 (78:44:76:9b:89:44) <
                               Internet Protocol Version 4, Src: 192.168.10.12, Dst: 64.233.167.108 <
                   Transmission Control Protocol, Src Port: 64403, Dst Port: 993, Seq: 0, Len: 0 <

Profile: Default | Packets: 12595 · Displayed: 151 (1.2%)                    wireshark_Wi-FiTB3PH3.pcapng
```

4.3 TCP Notification Server

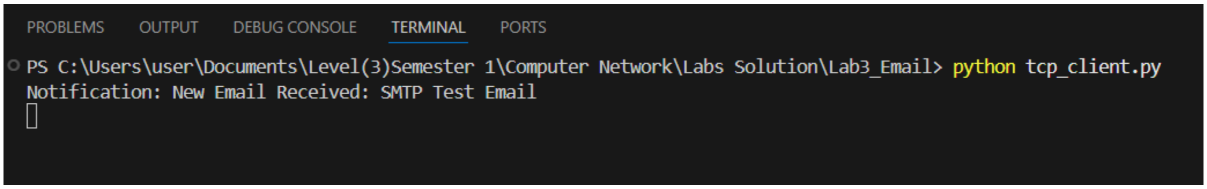
- Listens on port **5050**.
- Waits for a client connection.
- Sends a notification only when a **new email** is detected.
- Prevents duplicate notifications by tracking the last received email.



```
PS C:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email> python tcp_server.py
Notification Server started...
Client connected: ('127.0.0.1', 50241)
```

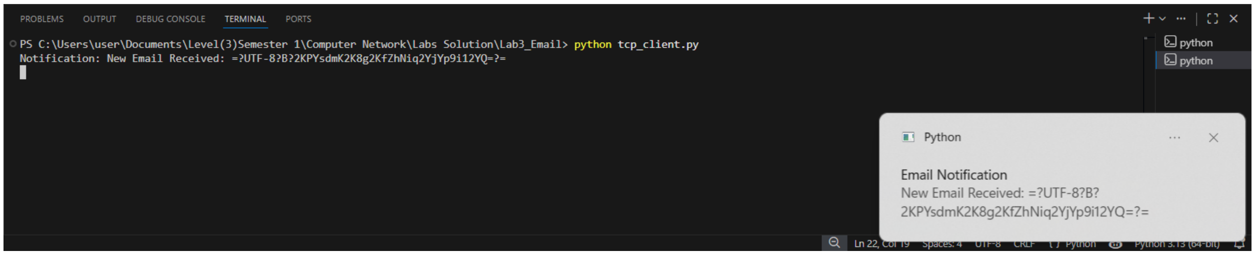
4.4 TCP Notification Client

- Connects to the TCP server.
- Listens continuously for incoming notifications.
- Displays the received email subject.
-



```
PS C:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email> python tcp_client.py
Notification: New Email Received: SMTP Test Email
```

A push notification system was implemented using the Plyer library. When a new email arrives, the client displays a desktop notification instead of only printing the message to the console.



```
PS C:\Users\user\Documents\Level(3)Semester 1\Computer Network\Labs Solution\Lab3_Email> python tcp_client.py
Notification: New Email Received: =?UTF-8?B?2KPYsdmK2K8g2KfZhNiq2YjYp9i12YQ=?=
```

Python

Email Notification
New Email Received: =?UTF-8?B?
2KPYsdmK2K8g2KfZhNiq2YjYp9i12YQ=?=

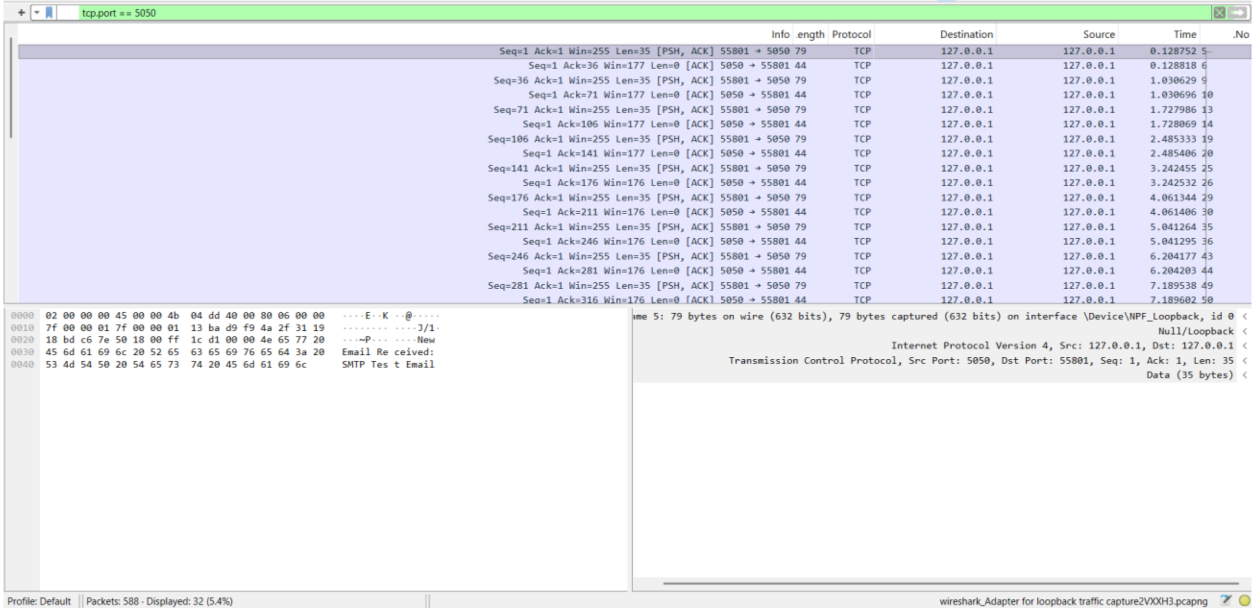
5- Wireshark Analysis

Wireshark was used to capture and analyze TCP traffic between the notification server and client.

- Since both client and server run on the same machine, **Loopback Adapter** was used.
- TCP packets were filtered using:

```
tcp.port == 5050
```

This confirmed successful TCP communication and data transmission.



```
tcp.port == 5050

                                                             Info .ength Protocol   Destination        Source       Time  .No
          Seq=1 Ack=1 Win=255 Len=35 [PSH, ACK] 55801 → 5050 79      TCP        127.0.0.1       127.0.0.1   0.128752 5
             Seq=1 Ack=36 Win=177 Len=0 [ACK] 5050 → 55801 44      TCP        127.0.0.1       127.0.0.1   0.128818 6
         Seq=36 Ack=1 Win=255 Len=35 [PSH, ACK] 55801 → 5050 79      TCP        127.0.0.1       127.0.0.1   1.030629 9
             Seq=1 Ack=71 Win=177 Len=0 [ACK] 5050 → 55801 44      TCP        127.0.0.1       127.0.0.1   1.030696 10
         Seq=71 Ack=1 Win=255 Len=35 [PSH, ACK] 55801 → 5050 79      TCP        127.0.0.1       127.0.0.1   1.727986 13
            Seq=1 Ack=106 Win=177 Len=0 [ACK] 5050 → 55801 44      TCP        127.0.0.1       127.0.0.1   1.728069 14
        Seq=106 Ack=1 Win=255 Len=35 [PSH, ACK] 55801 → 5050 79      TCP        127.0.0.1       127.0.0.1   2.485333 19
            Seq=1 Ack=141 Win=177 Len=0 [ACK] 5050 → 55801 44      TCP        127.0.0.1       127.0.0.1   2.485406 20
        Seq=141 Ack=1 Win=255 Len=35 [PSH, ACK] 55801 → 5050 79      TCP        127.0.0.1       127.0.0.1   3.242455 25
            Seq=1 Ack=176 Win=176 Len=0 [ACK] 5050 → 55801 44      TCP        127.0.0.1       127.0.0.1   3.242532 26
        Seq=176 Ack=1 Win=255 Len=35 [PSH, ACK] 55801 → 5050 79      TCP        127.0.0.1       127.0.0.1   4.061344 29
            Seq=1 Ack=211 Win=176 Len=0 [ACK] 5050 → 55801 44      TCP        127.0.0.1       127.0.0.1   4.061406 30
        Seq=211 Ack=1 Win=255 Len=35 [PSH, ACK] 55801 → 5050 79      TCP        127.0.0.1       127.0.0.1   5.041264 35
            Seq=1 Ack=246 Win=176 Len=0 [ACK] 5050 → 55801 44      TCP        127.0.0.1       127.0.0.1   5.041295 36
        Seq=246 Ack=1 Win=255 Len=35 [PSH, ACK] 55801 → 5050 79      TCP        127.0.0.1       127.0.0.1   6.204177 43
            Seq=1 Ack=281 Win=176 Len=0 [ACK] 5050 → 55801 44      TCP        127.0.0.1       127.0.0.1   6.204203 44
        Seq=281 Ack=1 Win=255 Len=35 [PSH, ACK] 55801 → 5050 79      TCP        127.0.0.1       127.0.0.1   7.189538 49
            Seq=1 Ack=316 Win=176 Len=0 [ACK] 5050 → 55801 44      TCP        127.0.0.1       127.0.0.1   7.189602 50

0000  02 00 00 00 45 00 00 4b  04 dd 40 00 80 06 00 00   ····E··K ··@·····
0010  7f 00 00 01 7f 00 00 01  13 ba d9 f9 4a 2f 31 19   ········ ····J/1·
0020  18 bd c6 7e 50 18 00 ff  1c d1 00 00 4e 65 77 20   ···~P··· ····New
0030  45 6d 61 69 6c 20 52 65  63 65 69 76 65 64 3a 20   Email Re ceived:
0040  53 4d 54 50 20 54 65 73  74 20 45 6d 61 69 6c      SMTP Tes t Email

ame 5: 79 bytes on wire (632 bits), 79 bytes captured (632 bits) on interface \Device\NPF_Loopback, id 0 <
                                                                                          Null/Loopback <
                                                   Internet Protocol Version 4, Src: 127.0.0.1, Dst: 127.0.0.1 <
                         Transmission Control Protocol, Src Port: 5050, Dst Port: 55801, Seq: 1, Ack: 1, Len: 35 <
                                                                                          Data (35 bytes) <

Profile: Default | Packets: 588 · Displayed: 32 (5.4%)          wireshark_Adapter for loopback traffic capture2VXXH3.pcapng
```

6- Table (Protocol Summary)

Component	Protocol	Port	Description
Email Sending	**SMTP**	**465**	Sends emails using Gmail SMTP server
Email Receiving	**IMAP**	**993**	Checks inbox for new emails
Notification Server	**TCP**	**5050**	Sends real-time email notifications
Notification Client	**TCP**	**5050**	Receives notifications from server

Operation	Time(s)	Packets	Bytes	Throughput
SMTP Send	**0.89**	**20**	**3200**	3.59 KB/s
IMAP Fetch	**0.6**	**14**	**2100**	3.50 KB/s
Notification Tcp	**0.05**	**4**	**320**	6.40 KB/s

7- Conclusion

□ This project successfully demonstrates the integration of email protocols with TCP-based client-server communication.

□ The system provides real-time notifications upon receiving new emails and verifies data transmission using Wireshark.

□ It reflects a practical understanding of networking concepts and application layer protocols.

Scan QR_Code To Get Source Code: