



project

Email Client Project

Team Members

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Email Client

Project Overview:

This project implements a simple Email Client Application using Python that allows users to send and receive emails securely. The application uses SMTP for sending emails and IMAP for retrieving emails over encrypted SSL/TLS connections to ensure secure communication.

SMTP communication is performed on ports 465 or 587 using SSL or STARTTLS, while IMAP communication is handled on port 993 using SSL. The project also includes a TCP-based notification mechanism that sends a status message after each email operation.

Performance metrics such as latency, packet count, transmitted bytes, and throughput are measured for SMTP, IMAP, and notification TCP connections. Wireshark is used to capture and analyze the network traffic generated by the application.

As a bonus feature, a graphical user interface (GUI) is implemented using Tkinter, along with push notifications using the Pylar library to notify users when new emails arrive.

Part 1 — Email Client (SMTP + IMAP):

This part of the program provides a simple text-based menu that allows the user to choose between sending an email, reading the latest email, or exiting the application.

The program keeps running and displaying the menu until the user selects the exit option.

The screenshot shows a terminal window with the following content:

```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS
• (dl_env) PS C:\University\Semester 5\Computer Network\Computer Network Projects>Email Client Project> python email_client.py

Simple Email Client
1. Send Email (SMTP)
2. Read Latest Email (IMAP)
3. Exit
Choose an option [1-3]: 1
== Send Email (SMTP) ==
SMTP server: smtp.ethereal.email
SMTP port (465 for SSL, 587 for TLS) [587]: 587
SMTP username: nikko.herman55@ethereal.email
SMTP password:
Receiver email: cassaudralavender@airsworld.net
Subject: Wire 221
Body: 221 221 221B
Email sent successfully!
SMTP Latency: 2.307 seconds

Simple Email Client
1. Send Email (SMTP)
2. Read Latest Email (IMAP)
3. Exit
Choose an option [1-3]: 2
== Read Latest Email (IMAP) ==
IMAP server: smtp.ethereal.email
IMAP port [993]: 993
IMAP username: nikko.herman55@ethereal.email
IMAP password:
Subject: Wire 221
Body:
221 221 221B

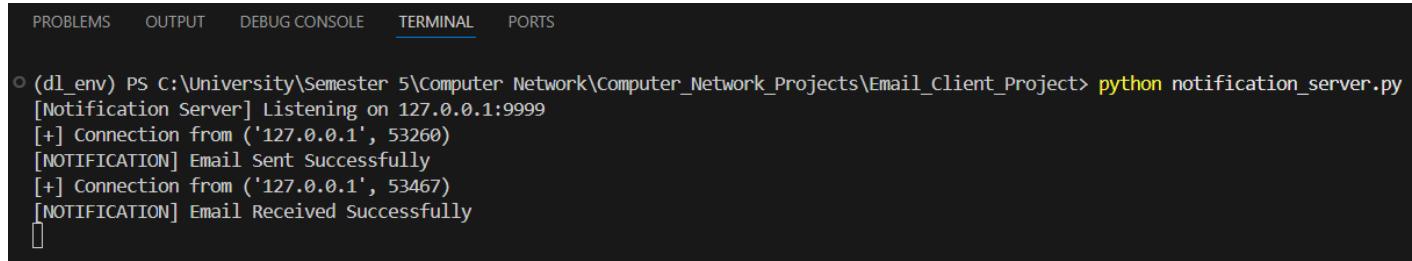
IMAP Latency: 9.289 seconds

Simple Email Client
1. Send Email (SMTP)
2. Read Latest Email (IMAP)
3. Exit
Choose an option [1-3]: 3
Goodbye.
○ (dl env) PS C:\University\Semester 5\Computer Network\Computer Network Projects>Email Client Project>
```

Note: The GUI was added in the final stage

Part 2 — TCP Notification Server:

The notification server listens for TCP messages from the email client and displays them as user notifications.



```
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

tcpEnv PS C:\University\Semester 5\Computer Network\Computer_Network_Projects>Email_Client_Project> python notification_server.py
[Notification Server] Listening on 127.0.0.1:9999
[+] Connection from ('127.0.0.1', 53260)
[NOTIFICATION] Email Sent Successfully
[+] Connection from ('127.0.0.1', 53467)
[NOTIFICATION] Email Received Successfully
```

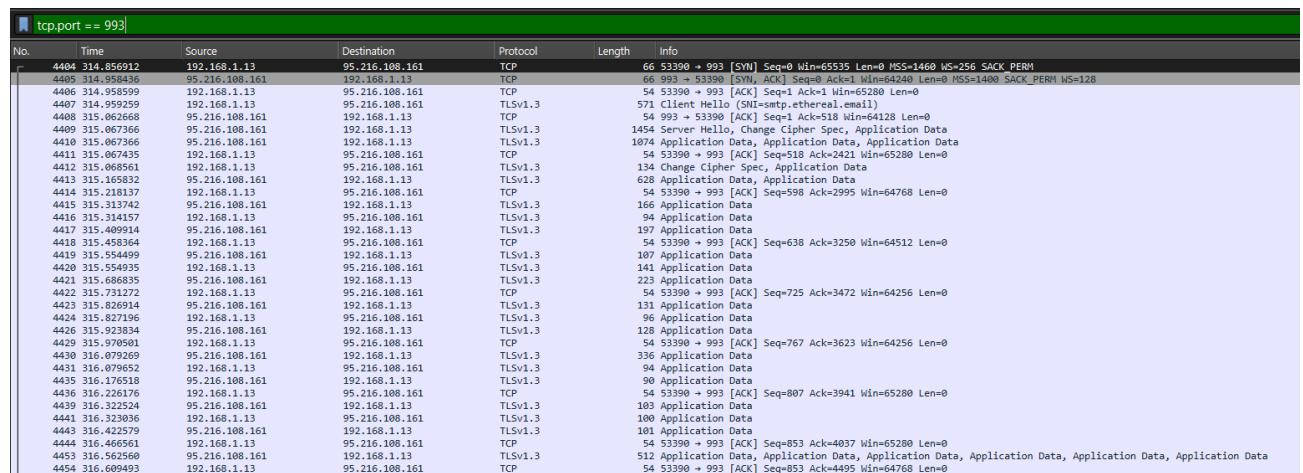
Part 3 — Wireshark Packet Capture & Analysis:

SMTP traffic: `tcp.port == 465` or `tcp.port == 587`.



No.	Time	Source	Destination	Protocol	Length	Info
3085	156.442178	192.168.1.13	95.216.108.161	TCP	66	51972 + 587 [SYN] Seq=0 Win=65535 Len=0 MSS=1460 WS=256 SACK_PERM
3086	156.542173	95.216.108.161	192.168.1.13	TCP	66	51972 + 51972 [SYN, ACK] Seq=1 Ack=1 Win=64240 Len=0 MSS=1400 SACK_PERM WS=128
3087	156.542279	192.168.1.13	95.216.108.161	TCP	54	51972 + 587 [ACK] Seq=1 Ack=1 Win=65280 Len=0
3088	156.748894	95.216.108.161	192.168.1.13	SMTP	109	5: 220 smtp.ethereal.email ESMTP Welcome to Ethereal MSA
3089	157.015552	192.168.1.13	95.216.108.161	SMTP	54	51972 + 587 [ACK] Seq=1 Ack=56 Win=65280 Len=0
3090	157.015552	192.168.1.13	95.216.108.161	SMTP	75	5: elo [192.168.1.13]
3091	157.114433	95.216.108.161	192.168.1.13	SMTP	195	5: 250-smtp.ethereal.email Nice to meet you, [154.237.216.143] PIPELINING 8BITMIME SMTPUTF8 AUTH LOGIN PLAIN STARTTLS
3092	157.114433	95.216.108.161	192.168.1.13	TCP	54	587 + 51972 [ACK] Seq=56 Ack=22 Win=64256 Len=0
3093	157.114663	192.168.1.13	95.216.108.161	TCP	54	51972 + 587 [ACK] Seq=22 Ack=197 Win=65280 Len=0
3094	157.114887	192.168.1.13	95.216.108.161	SMTP	64	C: STARTTLS
3095	157.212549	95.216.108.161	192.168.1.13	TCP	78	S: 220 Ready to start TLS
3096	157.213127	192.168.1.13	95.216.108.161	TLSv1.3	571	Client Hello (SNI=smtp.ethereal.email)
3097	157.315852	95.216.108.161	192.168.1.13	TLSv1.3	1454	Server Hello, Change Cipher Spec, Application Data
3098	157.315852	95.216.108.161	192.168.1.13	TLSv1.3	1073	Application Data, Application Data, Application Data
3099	157.315955	192.168.1.13	95.216.108.161	TCP	54	51972 + 587 [ACK] Seq=549 Ack=2640 Win=65280 Len=0
3100	157.321412	192.168.1.13	95.216.108.161	TLSv1.3	134	Change Cipher Spec, Application Data
3101	157.419146	95.216.108.161	192.168.1.13	TLSv1.3	628	Application Data, Application Data
3102	157.419224	192.168.1.13	95.216.108.161	TLSv1.3	97	Application Data
3103	157.516483	95.216.108.161	192.168.1.13	TLSv1.3	203	Application Data
3104	157.516793	192.168.1.13	95.216.108.161	TLSv1.3	157	Application Data
3105	157.625493	95.216.108.161	192.168.1.13	TLSv1.3	107	Application Data
3106	157.626030	192.168.1.13	95.216.108.161	TLSv1.3	128	Application Data
3107	157.626030	95.216.108.161	192.168.1.13	TLSv1.3	98	Application Data
3108	157.724044	192.168.1.13	95.216.108.161	TLSv1.3	118	Application Data
3109	157.821889	95.216.108.161	192.168.1.13	TLSv1.3	90	Application Data
3111	157.822091	192.168.1.13	95.216.108.161	TLSv1.3	82	Application Data
3113	157.918790	95.216.108.161	192.168.1.13	TLSv1.3	113	Application Data
3114	157.919059	192.168.1.13	95.216.108.161	TLSv1.3	301	Application Data
3116	158.025870	95.216.108.161	192.168.1.13	TLSv1.3	169	Application Data
3117	158.026163	192.168.1.13	95.216.108.161	TLSv1.3	82	Application Data
3119	158.122999	95.216.108.161	192.168.1.13	TLSv1.3	85	Application Data
3120	158.123293	95.216.108.161	192.168.1.13	TLSv1.3	78	Application Data
3121	158.123296	192.168.1.13	95.216.108.161	TCP	54	51972 + 587 [FIN, ACK] Seq=1208 Ack=3693 Win=64256 Len=0
3122	158.123326	192.168.1.13	95.216.108.161	TCP	54	51972 + 587 [RST, ACK] Seq=1209 Ack=3717 Win=0 Len=0
3123	158.221142	95.216.108.161	192.168.1.13	TCP	54	587 + 51972 [ACK] Seq=3718 Ack=1209 Win=64128 Len=0

IMAP traffic: `tcp.port == 993`.



No.	Time	Source	Destination	Protocol	Length	Info
4004	314.863912	192.168.1.13	95.216.108.161	TCP	66	53390 + 993 [SYN] Seq=0 Win=65335 Len=0 MSS=1460 WS=256 SACK_PERM
4005	314.863915	95.216.108.161	192.168.1.13	TCP	66	53390 + 53390 [SYN, ACK] Seq=1 Ack=1 Win=64240 Len=0 MSS=1400 SACK_PERM WS=128
4006	314.959599	192.168.1.13	95.216.108.161	TCP	54	53390 + 993 [ACK] Seq=1 Ack=1 Win=65280 Len=0
4007	314.959259	192.168.1.13	95.216.108.161	TLSv1.3	571	Client Hello (SNI=imap.ethereal.email)
4008	315.062668	95.216.108.161	192.168.1.13	TCP	54	993 + 53390 [ACK] Seq=518 Win=64128 Len=0
4009	315.067366	95.216.108.161	192.168.1.13	TLSv1.3	1454	Server Hello, Change Cipher Spec, Application Data
4010	315.067366	95.216.108.161	192.168.1.13	TLSv1.3	1074	Application Data, Application Data, Application Data
4011	315.067435	192.168.1.13	95.216.108.161	TCP	54	53390 + 993 [ACK] Seq=518 Ack=4241 Win=65280 Len=0
4012	315.068561	192.168.1.13	95.216.108.161	TLSv1.3	134	Change Cipher Spec, Application Data
4013	315.165832	192.168.1.13	95.216.108.161	TLSv1.3	628	Application Data, Application Data
4014	315.172372	192.168.1.13	95.216.108.161	TCP	54	53390 + 53390 [ACK] Seq=598 Ack=2995 Win=64768 Len=0
4015	315.313742	95.216.108.161	192.168.1.13	TLSv1.3	160	Application Data
4016	315.314157	192.168.1.13	95.216.108.161	TLSv1.3	94	Application Data
4017	315.409914	95.216.108.161	192.168.1.13	TLSv1.3	197	Application Data
4018	315.458364	192.168.1.13	95.216.108.161	TCP	54	53390 + 993 [ACK] Seq=638 Ack=3250 Win=64512 Len=0
4019	315.554499	95.216.108.161	192.168.1.13	TLSv1.3	107	Application Data
4020	315.554935	192.168.1.13	95.216.108.161	TLSv1.3	141	Application Data
4021	315.686835	95.216.108.161	192.168.1.13	TLSv1.3	223	Application Data
4022	315.731272	192.168.1.13	95.216.108.161	TCP	54	53390 + 993 [ACK] Seq=725 Ack=3472 Win=64256 Len=0
4023	315.731274	95.216.108.161	192.168.1.13	TLSv1.3	131	Application Data
4024	315.827106	192.168.1.13	95.216.108.161	TLSv1.3	96	Application Data
4025	315.923834	95.216.108.161	192.168.1.13	TLSv1.3	128	Application Data
4026	315.970951	192.168.1.13	95.216.108.161	TCP	54	53390 + 993 [ACK] Seq=767 Ack=3623 Win=64256 Len=0
4027	316.079269	95.216.108.161	192.168.1.13	TLSv1.3	336	Application Data
4028	316.079652	192.168.1.13	95.216.108.161	TLSv1.3	94	Application Data
4029	316.176518	95.216.108.161	192.168.1.13	TLSv1.3	90	Application Data
4030	316.226176	192.168.1.13	95.216.108.161	TCP	54	53390 + 993 [ACK] Seq=807 Ack=3941 Win=65280 Len=0
4031	316.322524	95.216.108.161	192.168.1.13	TLSv1.3	103	Application Data
4032	316.409305	192.168.1.13	95.216.108.161	TLSv1.3	100	Application Data
4033	316.422709	95.216.108.161	192.168.1.13	TLSv1.3	101	Application Data
4034	316.466561	192.168.1.13	95.216.108.161	TCP	54	53390 + 993 [ACK] Seq=853 Ack=4097 Win=65280 Len=0
4035	316.562568	95.216.108.161	192.168.1.13	TLSv1.3	512	Application Data, Application Data, Application Data, Application Data, Application Data, Application Data
4036	316.609493	192.168.1.13	95.216.108.161	TCP	54	53390 + 993 [ACK] Seq=853 Ack=4495 Win=64768 Len=0

Notification server traffic: tcp.port == 9999

tcp.port == 9999										
No.	Time	Source	Destination	Protocol	Length	Info				
3186	216.752632	127.0.0.1	127.0.0.1	TCP	56	53260 → 9999 [SYN] Seq=0 Win=65535 Len=0 MSS=65495 WS=256 SACK_PERM				
3187	216.752706	127.0.0.1	127.0.0.1	TCP	56	9999 → 53260 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=65495 WS=256 SACK_PERM				
3188	216.752748	127.0.0.1	127.0.0.1	TCP	44	53260 → 9999 [ACK] Seq=1 Ack=1 Win=65280 Len=0				
3189	216.752816	127.0.0.1	127.0.0.1	TCP	67	53260 → 9999 [PSH, ACK] Seq=1 Ack=1 Win=65280 Len=23				
3190	216.752838	127.0.0.1	127.0.0.1	TCP	44	9999 → 53260 [ACK] Seq=1 Ack=24 Win=65280 Len=0				
3191	216.752873	127.0.0.1	127.0.0.1	TCP	44	53260 → 9999 [FIN, ACK] Seq=24 Ack=1 Win=65280 Len=0				
3192	216.752891	127.0.0.1	127.0.0.1	TCP	44	9999 → 53260 [ACK] Seq=1 Ack=25 Win=65280 Len=0				
3193	216.753258	127.0.0.1	127.0.0.1	TCP	44	9999 → 53260 [FIN, ACK] Seq=1 Ack=25 Win=65280 Len=0				
3194	216.753292	127.0.0.1	127.0.0.1	TCP	44	53260 → 9999 [ACK] Seq=25 Ack=2 Win=65280 Len=0				
4914	342.382601	127.0.0.1	127.0.0.1	TCP	56	53467 → 9999 [SYN] Seq=0 Win=65535 Len=0 MSS=65495 WS=256 SACK_PERM				
4916	342.382680	127.0.0.1	127.0.0.1	TCP	56	9999 → 53467 [SYN, ACK] Seq=0 Ack=1 Win=65535 Len=0 MSS=65495 WS=256 SACK_PERM				
4918	342.382731	127.0.0.1	127.0.0.1	TCP	44	53467 → 9999 [ACK] Seq=1 Ack=1 Win=65280 Len=0				
4919	342.382811	127.0.0.1	127.0.0.1	TCP	71	53467 → 9999 [PSH, ACK] Seq=1 Ack=1 Win=65280 Len=27				
4921	342.382842	127.0.0.1	127.0.0.1	TCP	44	9999 → 53467 [ACK] Seq=1 Ack=28 Win=65280 Len=0				
4924	342.382877	127.0.0.1	127.0.0.1	TCP	44	53467 → 9999 [FIN, ACK] Seq=28 Ack=1 Win=65280 Len=0				
4926	342.382895	127.0.0.1	127.0.0.1	TCP	44	9999 → 53467 [ACK] Seq=1 Ack=29 Win=65280 Len=0				
4927	342.383609	127.0.0.1	127.0.0.1	TCP	44	9999 → 53467 [FIN, ACK] Seq=1 Ack=29 Win=65280 Len=0				
4928	342.383648	127.0.0.1	127.0.0.1	TCP	44	53467 → 9999 [ACK] Seq=29 Ack=2 Win=65280 Len=0				

Required Analysis (For Part4)

SMTP traffic: tcp.port == 587.

Ethernet · 1	IPv4 · 1	IPv6	TCP · 1	UDP	Port A	Address B	Port B	Packets	Bytes	Stream ID	Total Packets	Percent Filtered	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start
Address A					Port A	Address B	Port B	Packets	Bytes	Stream ID	Total Packets	Percent Filtered	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start
192.168.1.13					51972	95.216.108.161	587	35	7 kB	151	35	100.00%	18	2 kB	17	5 kB	156.442178

IMAP traffic: tcp.port == 993

Ethernet · 1	IPv4 · 1	IPv6	TCP · 1	UDP	Port A	Address B	Port B	Packets	Bytes	Stream ID	Total Packets	Percent Filtered	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start
Address A					Port A	Address B	Port B	Packets	Bytes	Stream ID	Total Packets	Percent Filtered	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start
192.168.1.13					53390	95.216.108.161	993	53	8 kB	170	53	100.00%	27	2 kB	26	6 kB	314.856912

Notification server traffic: tcp.port == 9999

Ethernet	IPv4 · 1	IPv6	TCP · 2	UDP	Port A	Address B	Port B	Packets	Bytes	Stream ID	Total Packets	Percent Filtered	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start
Address A					Port A	Address B	Port B	Packets	Bytes	Stream ID	Total Packets	Percent Filtered	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start
127.0.0.1					53260	127.0.0.1	9999	9	443 bytes	363	9	100.00%	5	255 bytes	4	188 bytes	216.752632
127.0.0.1					53467	127.0.0.1	9999	9	447 bytes	555	9	100.00%	5	259 bytes	4	188 bytes	342.382601

Observations about TLS encryption:

SMTP Send = STARTTLS

smtp										
No.	Time	Source	Destination	Protocol	Length	Info				
3088	156.740847	95.216.108.161	192.168.1.13	SMTP	109	S: 220 smtp.ethereal.email ESMTPL Welcome to Ethereal MSA				
3091	157.114433	95.216.108.161	192.168.1.13	SMTP	195	S: 250-smtp.ethereal.email Nice to meet you, [154.237.216.143] PIPELINING 8BITMIME SMTPUTF8 AUTH LOGIN PLAIN STARTTLS				
3095	157.212549	95.216.108.161	192.168.1.13	SMTP	78	S: 220 Ready to start TLS				
3099	157.015552	192.168.1.13	95.216.108.161	SMTP	75	C: ehlo [192.168.1.13]				
3094	157.114887	192.168.1.13	95.216.108.161	SMTP	64	C: STARTTLS				

IMAP Fetch = TLS(IMAPS)

tls										
No.	Time	Source	Destination	Protocol	Length	Info				
871	63.364136	192.168.1.13	104.16.248.249	TLSv1.3	571	C: Client Hello (SNI=cloudflare-dns.com)				
No.	Time	Source	Destination	Protocol	Length	Info				

No.	Time	Source	Destination	Protocol	Length	Info				
138	3.290331	172.64.148.235	192.168.1.13	TLSv1.2	78	C: Application Data				
153	4.036616	13.107.246.254	192.168.1.13	TLSv1.2	1454	S: Server Hello				

Notification = TCP Control (No TLS)

Note: TLS increases latency and packet count due to the additional handshake and encryption overhead.

Explanation of the packet flow:

SMTP Packet Flow (STARTTLS):

TCP three-way handshake (SYN, SYN/ACK, ACK)

SMTP session initialization (EHLO)

STARTTLS command

TLS handshake (Client Hello, Server Hello)

Encrypted SMTP commands and data exchange (MAIL FROM, RCPT TO, DATA as TLS Application Data)

TCP connection termination (FIN/ACK)

IMAP Packet Flow (TLS / IMAPS):

TCP three-way handshake (SYN, SYN/ACK, ACK)

TLS handshake (Client Hello, Server Hello)

Encrypted IMAP authentication and mailbox operations (LOGIN, SELECT, FETCH as TLS Application Data)

Encrypted server responses

TCP connection termination (FIN/ACK)

Notification Packet Flow (TCP):

Completion of data transmission

TCP connection teardown using FIN and ACK flags

Optional TCP reset (RST) or retransmission events

Part 4 — Performance Measurements:

Latency = End Time – Start Time

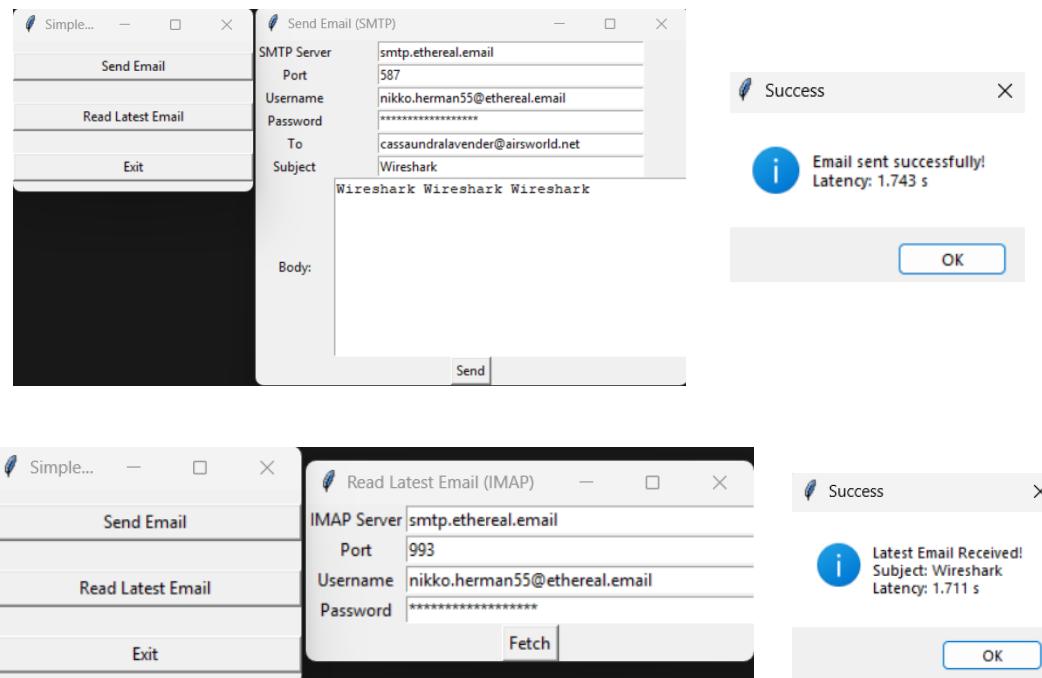
Throughput = total_bytes / Latency

Operation	Time	Packets	Bytes	Throughput
SMTP Send	1.743	35	6837~7kb	3922.547
IMAP Fetch	1.711	53	7987~8kb	4668.03
Notification TCP	6.6*10^(-4)	9	443	671212.12

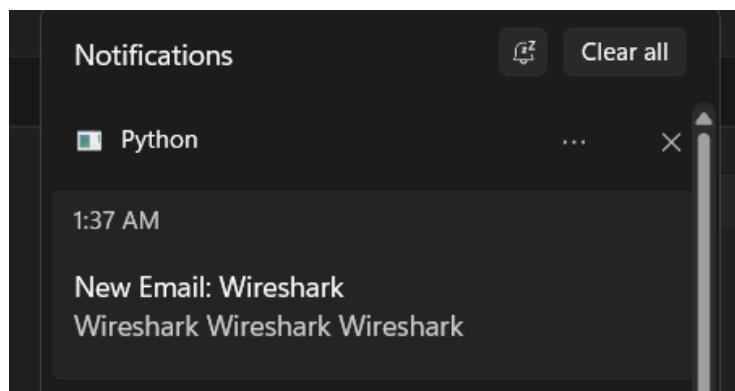
Part 5 — GUI & Push Notifications:

The application has a Tkinter GUI for sending and receiving emails and uses Plyer to notify users of new emails.

GUI (Tkinter):



Push Notifications (Plyer):



Source code:

[https://github.com/MuhammadAshraf221B/Computer_Network_Projects/tree/main/Email_Client_Project](https://github.com/MuhammadAshraf221B/Computer_Network_Projects/tree/main>Email_Client_Project)