

LAPORAN PRAKTIKUM PEMOGRAMAN JARINGAN



ULFA

(231401036)

Dosen Pengampuh : Ucok, S.Kom .,MT

Mata Kuliah : Bahasa Pemrograman Jaringan Komputer

PROGRAM STUDI TEKNIK INFORMATIKA

FAKULTAS ILMU KOMPUTER

UNIVERSITAS INDONESIA TIMUR

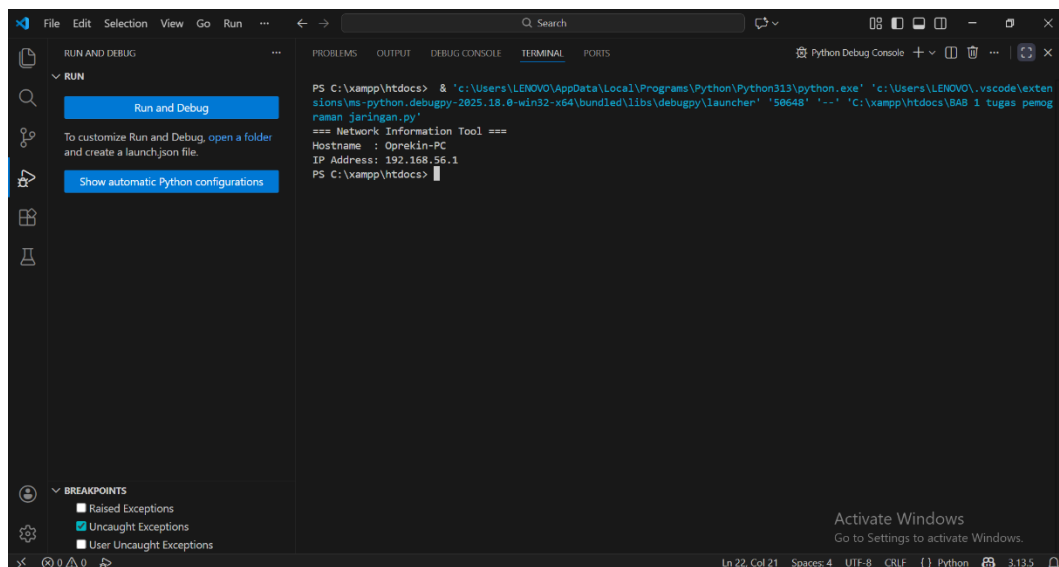
2026

BAB I

Konsep Dasar Pemrograman Jaringan

Praktikum Bab 1 Dimana script ini berguna saat mendeploy aplikasi ke Server Cloud untuk memastikan aplikasi berjalan di Hostname yang benar. konsep ini client dan server saling terhubung melalui jaringan

Hasil :



```
PS C:\xampp\htdocs> & 'c:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe' 'c:\Users\LENOVO\.vscode\extensions\ms-python.debugpy-2025.18.0-win32-x64\bundled\libs\debugpy\launcher' '5e648' '-' 'C:\xampp\htdocs\Bab 1 tugas pemograman jaringan.py'

=== Network Information Tool ===
Hostname : Oprekin-PC
IP Address: 192.168.56.1
PS C:\xampp\htdocs>
```

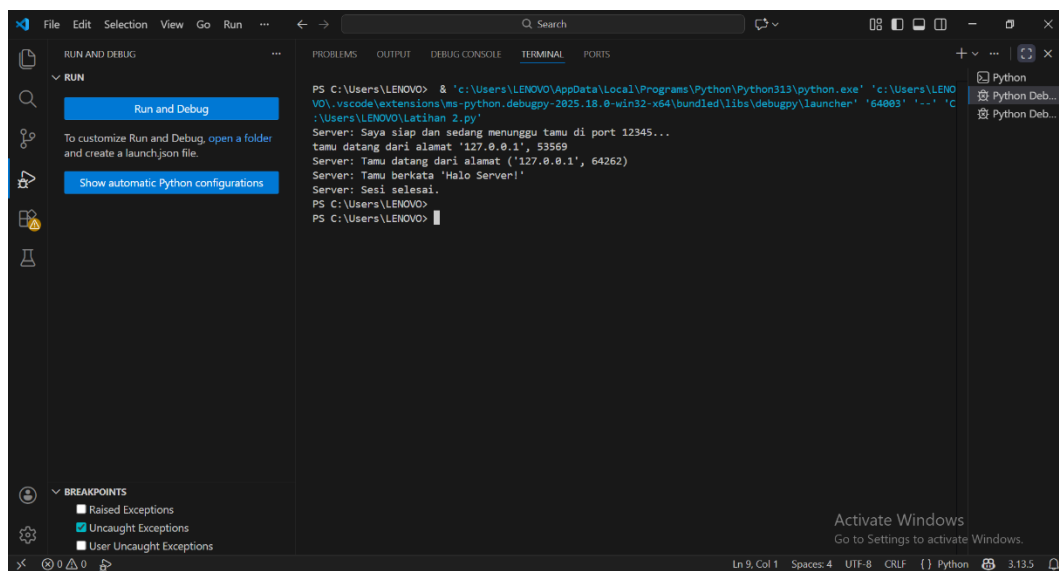
The screenshot shows the VS Code interface with the terminal panel active. The terminal displays the output of a Python script that runs a network information tool. The output shows the hostname as 'Oprekin-PC' and the IP address as '192.168.56.1'. The left sidebar shows the 'RUN AND DEBUG' section with options to 'Run and Debug' or 'Show automatic Python configurations'. The bottom status bar indicates the current file is 'Ln 22, Col 21' and the editor is using 'UTF-8' encoding with 'CRLF' line endings.

BAB II

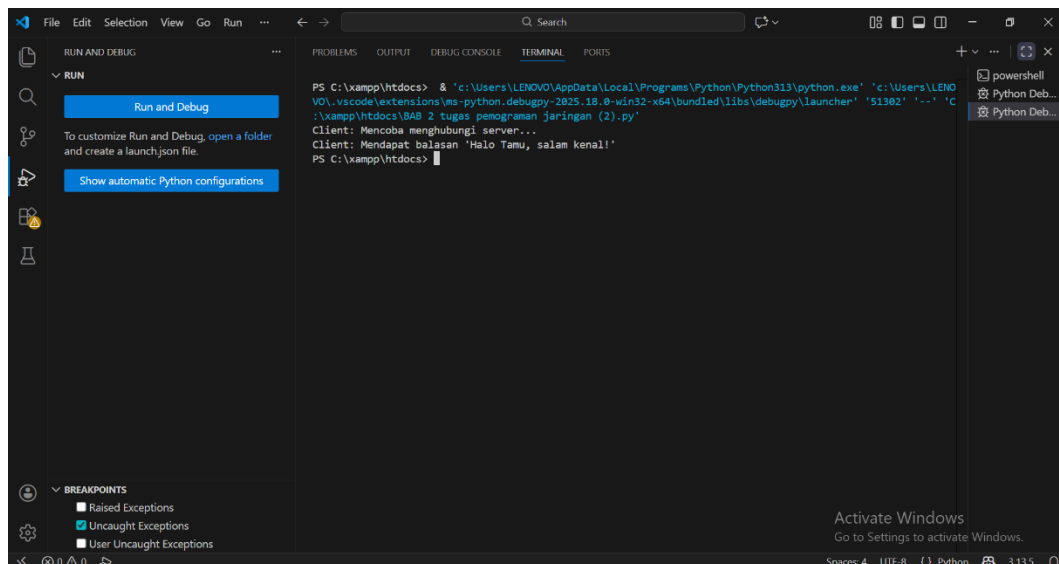
Socket API Dasar

Praktikum Bab 2 Menampilkan proses pembuatan socket, dimana server mengundang tamu yaitu client kemudian client siap menerima pesan.

Hasil :



```
PS C:\Users\LENOVO> & 'c:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe' 'c:\Users\LENOVO\.vscode\extensions\ms-python.debugpy-2025.18.0-win32-x64\bundled\libs\debugpy\launcher' '64803' '-.' 'C:\Users\LENOVO\Letihan 2.py'
Server: Saya siap dan sedang menunggu tamu di port 12345...
Server: Tamu datang dari alamat ('127.0.0.1', 53559)
Server: Tamu berkata 'Halo Server!'
Server: Sesi selesai.
PS C:\Users\LENOVO>
```



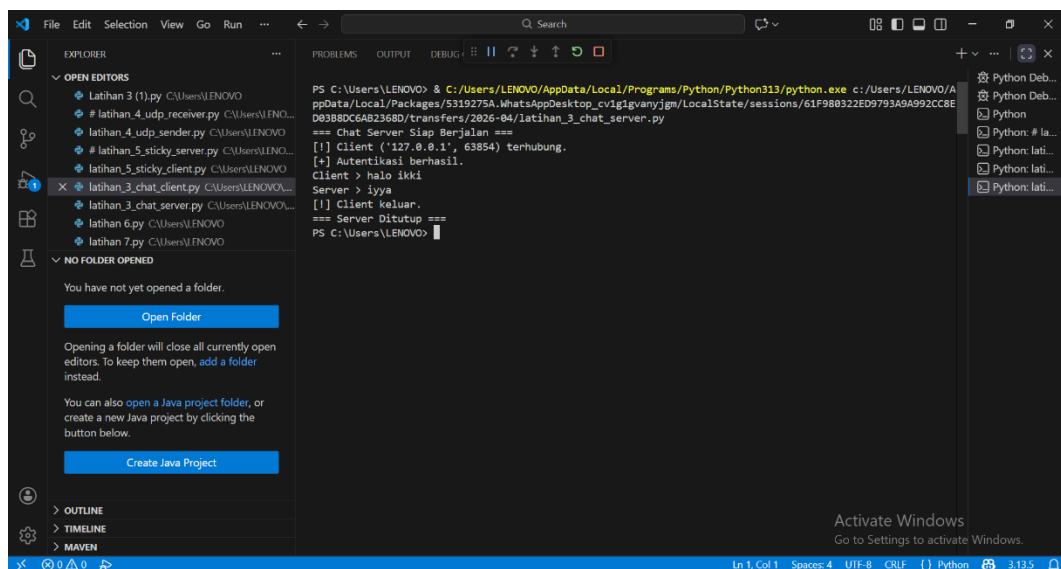
```
PS C:\xampp\htdocs> & 'c:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe' 'c:\Users\LENOVO\.vscode\extensions\ms-python.debugpy-2025.18.0-win32-x64\bundled\libs\debugpy\launcher' '51302' '-.' 'C:\xampp\htdocs\BAB 2 tugas pemograman jaringan (2).py'
Client: Mencoba menghubungi server...
Client: Mendapat balasan 'Halo Tamu, salam kenal!'
PS C:\xampp\htdocs>
```

BAB III

Protokol TCP (Aplikasi Chat)

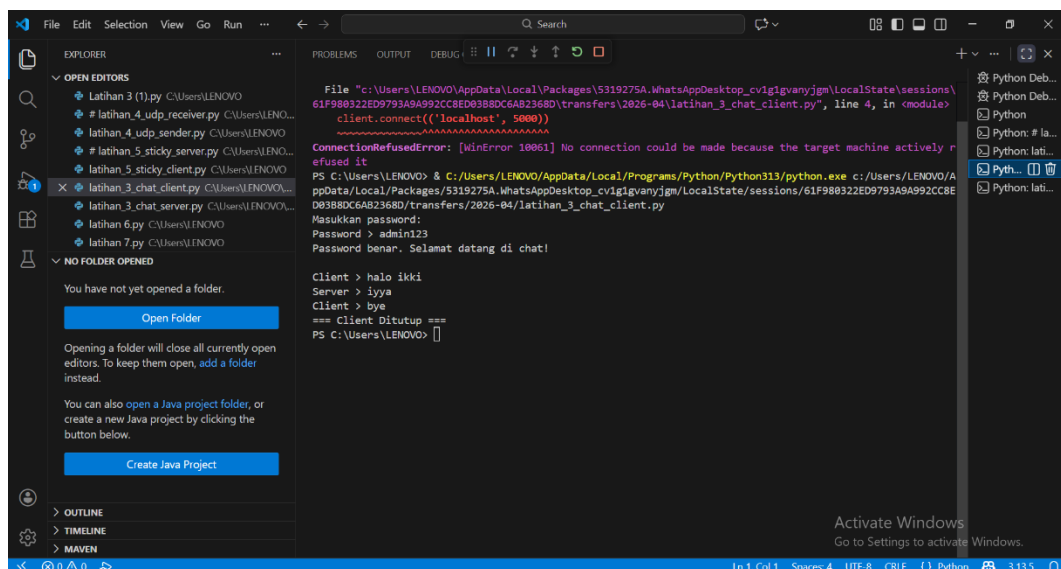
Praktikum Bab 3 dimana membangun aplikasi chat sederhana dua arah (client-server) menggunakan protokol TCP, aplikasi ini berjalan seperti mengirim surat : Client mengirim pesan, kemudian server menerima dan membalas, lalu koneksi ditutup (hang up) selesai.

Hasil :



The screenshot shows the Visual Studio Code interface with the 'latihan_3_chat_server.py' file open. The terminal output displays the following sequence of events:

```
PS C:\Users\LENOVO> & C:/Users/LENOVO/AppData/Local/Programs/Python/Python313/python.exe c:/Users/LENOVO/AppData/Local/Packages/5319275A.WhatsAppDesktop_cv1g1gvanyjgm/LocalState/sessions/61F988322ED9793A9A992CCBE/D8388DC6AB2368D/transfers/2026-04/latihan_3_chat_server.py
=== Chat Server Siap Berjalan ===
[!] client ('127.0.0.1', 63854) terhubung.
[+] Autentikasi berhasil.
Client > halo ikki
Server > iyya
[!] client keluar.
=== Server Ditutup ===
PS C:\Users\LENOVO>
```



The screenshot shows the Visual Studio Code interface with the 'latihan_3_chat_client.py' file open. The terminal output displays the following sequence of events:

```
File "c:\Users\LENOVO\AppData\Local\Packages\5319275A.WhatsAppDesktop_cv1g1gvanyjgm\LocalState\sessions\61F988322ED9793A9A992CCBE\transfers\2026-04\latihan_3_chat_client.py", line 4, in <module>
    client.connect(('localhost', 5000))
ConnectionRefusedError: [WinError 10061] No connection could be made because the target machine actively refused it
PS C:\Users\LENOVO> & C:/Users/LENOVO/AppData/Local/Programs/Python/Python313/python.exe c:/Users/LENOVO/AppData/Local/Packages/5319275A.WhatsAppDesktop_cv1g1gvanyjgm/LocalState/sessions/61F988322ED9793A9A992CCBE/D8388DC6AB2368D/transfers/2026-04/latihan_3_chat_client.py
Masukkan password:
Password > admin123
Password benar. Selamat datang di chat!

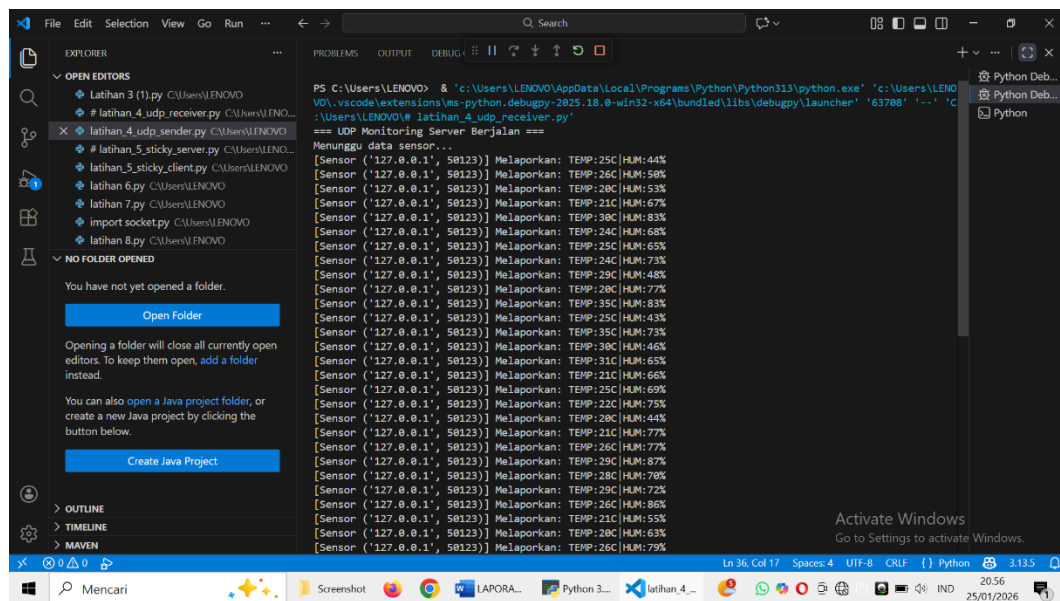
Client > halo ikki
Server > iyya
Client > bye
=== Client Ditutup ===
PS C:\Users\LENOVO>
```

BAB IV

Protokol UDP (Streaming & Broadcasting)

Praktikum Bab 4 kita akan menipulasikan lingkungan industri yaitu *Sender(client): Sebuah sensor suhu cerdas yang membaca data lingkungan dan menambahkannya ke server pusat setiap detik. *Receiver(server): Komputer pusat yang menampung data dari sebagai sensor. Dibawa ini adalah tampilan percobaan sederhana untuk membuktikan sifat UDP.

Hasil :

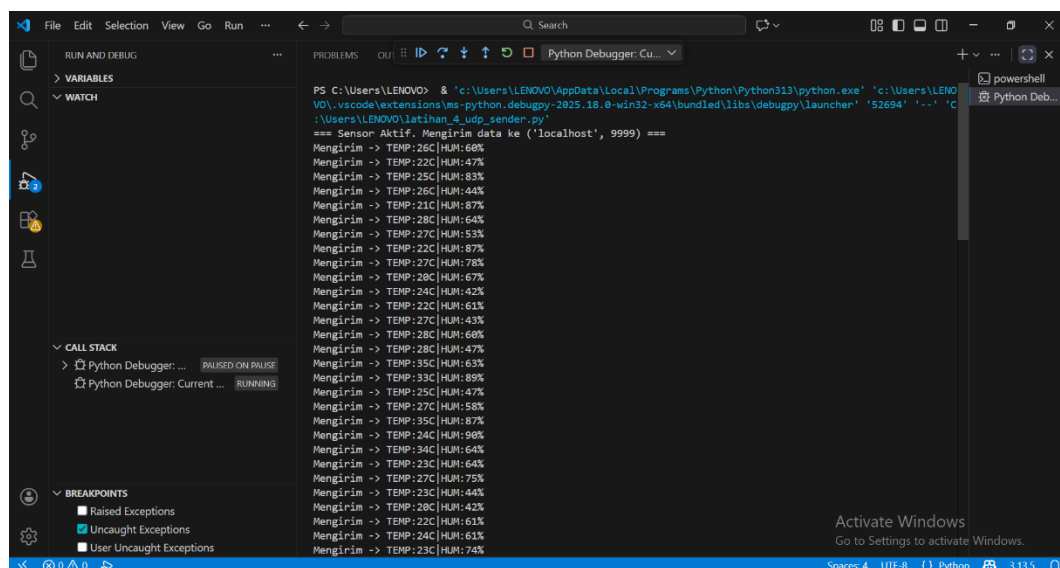


The screenshot shows the Visual Studio Code editor with a Python script named 'latihan_4_udp_receiver.py'. The script is a UDP monitoring server that listens for data from a client. It uses the 'socket' module to create a UDP socket and bind it to a specific IP address and port. The script then enters a loop where it receives data from the client and prints it to the console. The output shows a series of sensor data points, including temperature and humidity, received from a client at IP '127.0.0.1'.

```
PS C:\Users\LENOVO> & "c:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe" "c:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe" -c "import sys; sys.path.append('C:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe'); import latihan_4_udp_receiver; latihan_4_udp_receiver.run()"

=== UDP Monitoring Server Berjalan ===

Menunggu data sensor...
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:25C|HUM:44%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:26C|HUM:50%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:28C|HUM:53%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:21C|HUM:67%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:30C|HUM:83%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:24C|HUM:68%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:25C|HUM:65%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:24C|HUM:73%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:29C|HUM:48%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:28C|HUM:77%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:35C|HUM:83%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:25C|HUM:43%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:35C|HUM:73%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:30C|HUM:46%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:31C|HUM:63%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:21C|HUM:66%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:25C|HUM:69%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:22C|HUM:75%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:28C|HUM:44%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:21C|HUM:77%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:26C|HUM:77%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:29C|HUM:87%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:28C|HUM:70%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:29C|HUM:72%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:26C|HUM:86%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:21C|HUM:55%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:20C|HUM:63%
[Sensor ('127.0.0.1', 50123)] Melaporkan: TEMP:26C|HUM:79%
```



The screenshot shows the Visual Studio Code editor with a Python script named 'latihan_4_udp_sender.py'. The script is a UDP monitoring client that sends data to a server. It uses the 'socket' module to create a UDP socket and connect it to a specific IP address and port. The script then enters a loop where it sends data to the server and prints it to the console. The output shows a series of sensor data points, including temperature and humidity, sent to a server at IP 'localhost'.

```
PS C:\Users\LENOVO> & "c:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe" "c:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe" -c "import sys; sys.path.append('C:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe'); import latihan_4_udp_sender; latihan_4_udp_sender.run()"

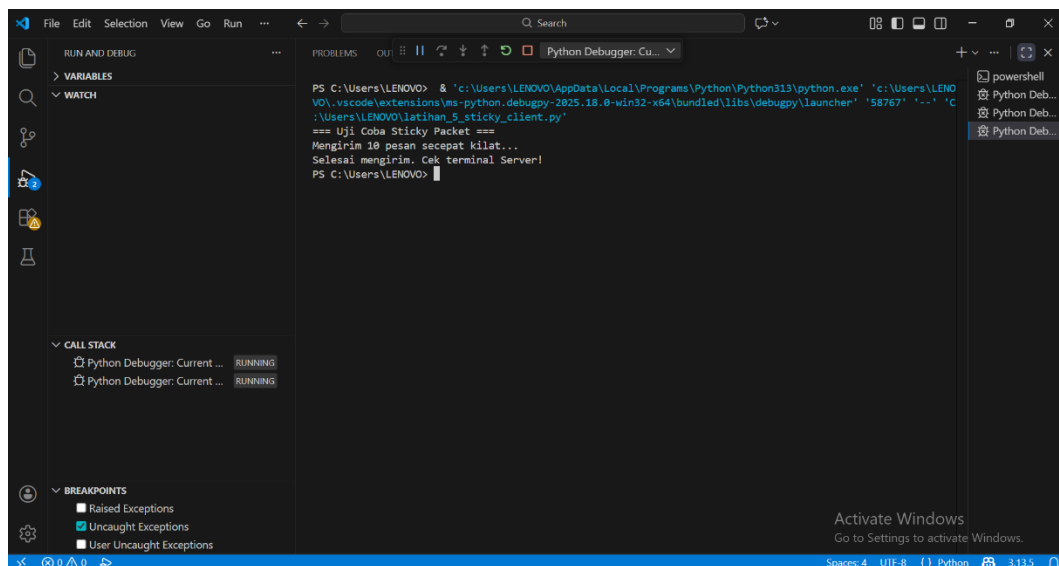
=== Sensor Aktif. Mengirim data ke ('localhost', 9999) ===
Mengirim -> TEMP:26C|HUM:60%
Mengirim -> TEMP:22C|HUM:47%
Mengirim -> TEMP:25C|HUM:83%
Mengirim -> TEMP:26C|HUM:44%
Mengirim -> TEMP:21C|HUM:87%
Mengirim -> TEMP:28C|HUM:64%
Mengirim -> TEMP:27C|HUM:53%
Mengirim -> TEMP:22C|HUM:87%
Mengirim -> TEMP:27C|HUM:78%
Mengirim -> TEMP:28C|HUM:67%
Mengirim -> TEMP:24C|HUM:42%
Mengirim -> TEMP:22C|HUM:61%
Mengirim -> TEMP:27C|HUM:43%
Mengirim -> TEMP:28C|HUM:60%
Mengirim -> TEMP:28C|HUM:47%
Mengirim -> TEMP:35C|HUM:63%
Mengirim -> TEMP:33C|HUM:89%
Mengirim -> TEMP:25C|HUM:47%
Mengirim -> TEMP:27C|HUM:58%
Mengirim -> TEMP:35C|HUM:87%
Mengirim -> TEMP:24C|HUM:90%
Mengirim -> TEMP:34C|HUM:64%
Mengirim -> TEMP:23C|HUM:64%
Mengirim -> TEMP:27C|HUM:55%
Mengirim -> TEMP:29C|HUM:44%
Mengirim -> TEMP:28C|HUM:42%
Mengirim -> TEMP:22C|HUM:61%
Mengirim -> TEMP:24C|HUM:61%
Mengirim -> TEMP:23C|HUM:74%
```

BAB V

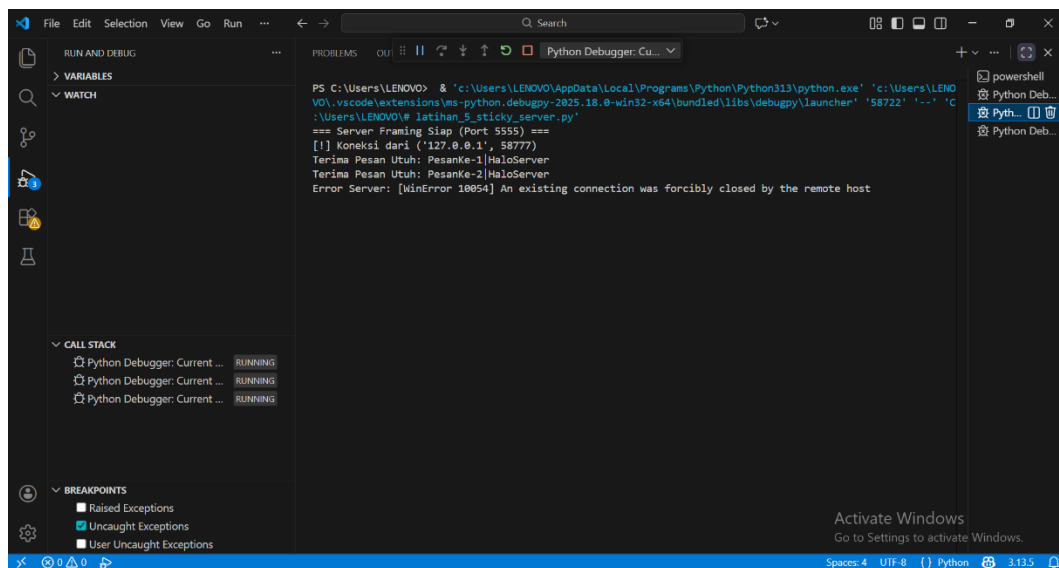
Error Handling & Framing Data

Praktikum Bab 5 kita belajar Framing dimana adalah seni membungkus data agar penerima tahu “oh,pesan dimulai di sini dan berakhir di sini”. Kemudian pada gambar ini akan sengaja mengirim banyak pesan dengan cepat untuk memaksa terjadinya Sticky Packet.

Hasil :



```
PS C:\Users\LENOVO> & 'c:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe' 'c:\Users\LENOVO\.vscode\extensions\ms-python.debugpy-2025.18.0-win32-x64\bundled\libs\debugpy\launcher' '58767' '-.' 'C:\Users\LENOVO\latihan_5_sticky_client.py'
=== Uji Coba Sticky Packet ===
Mengirim 10 pesan secepat kilat...
Selesai mengirim. Cek terminal Server!
PS C:\Users\LENOVO>
```



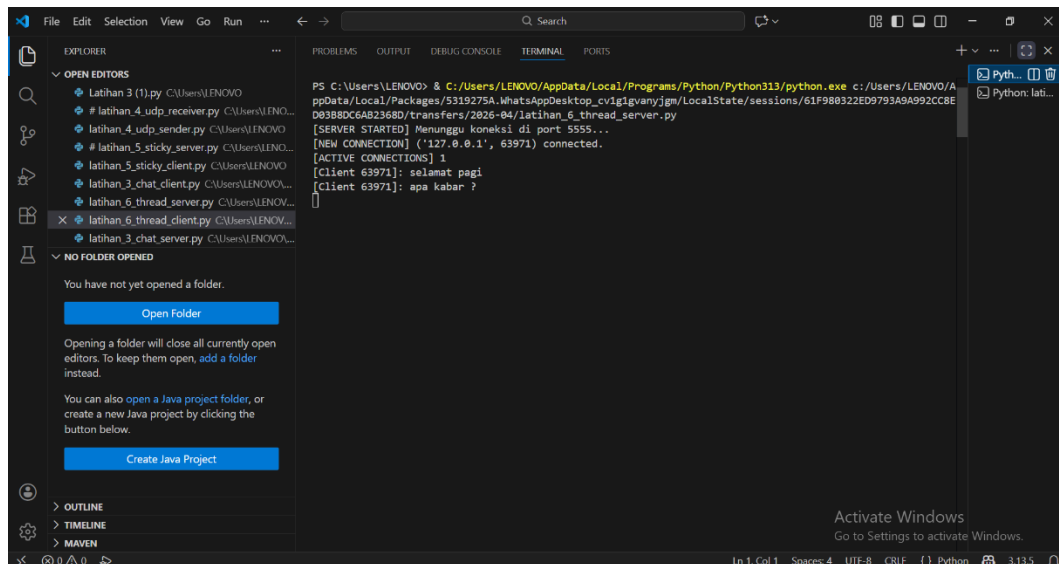
```
PS C:\Users\LENOVO> & 'c:\Users\LENOVO\AppData\Local\Programs\Python\Python313\python.exe' 'c:\Users\LENOVO\.vscode\extensions\ms-python.debugpy-2025.18.0-win32-x64\bundled\libs\debugpy\launcher' '58722' '-.' 'C:\Users\LENOVO\latihan_5_sticky_server.py'
=== Server Framing Siap (Port 5555) ===
[!] koneksi dari ('127.0.0.1', 58777)
Terima Pesan Utuh: Pesanke-1|HaloServer
Terima Pesan Utuh: Pesanke-2|HaloServer
Error Server: [WinError 10054] An existing connection was forcibly closed by the remote host
```

BAB VI

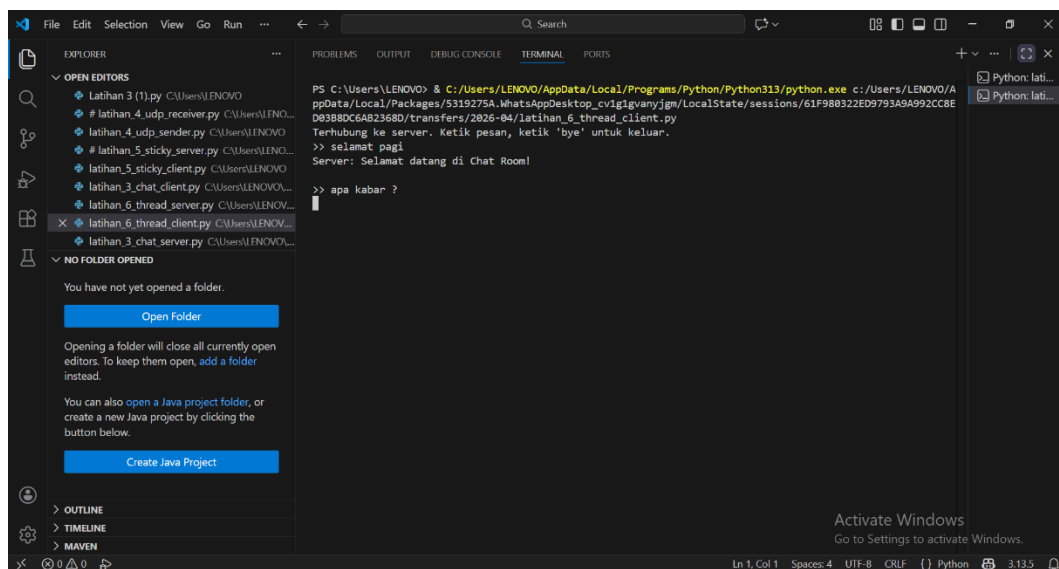
Concurrency Part I – Threading

Praktikum Bab ini mempelajari bagaimana cara termudah menggunakan Threading, dibawah ini dimana membuat server sederhana *Fitur: Setiap pesan dari Client A akan diteruskan ke Client B, C, dan D. *Tantangan: Daftar clients adalah shared resource. Kita harus hati-hati saat menambahkan/menghapus anggota agar tidak tabrakan dengan proses broadcast. Gambar dibawa ini proses sederhana dari Thread jalankan server.

Hasil :



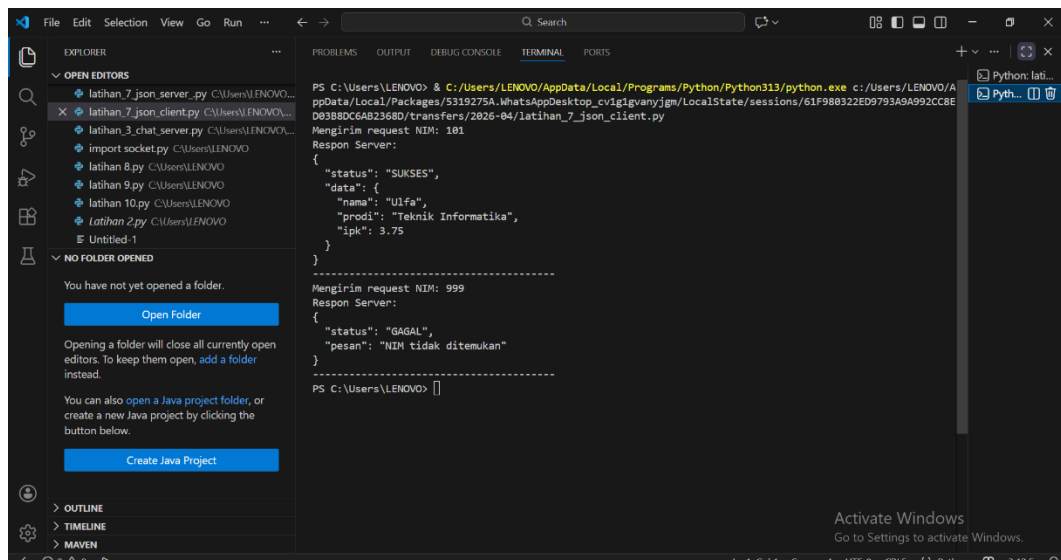
```
PS C:\Users\LENOVO> & C:/Users/LENOVO/AppData/Local/Programs/Python/Python313/python.exe c:/Users/LENOVO/AppData/Local/Packages/5319275A.WhatsAppDesktop_cv1g1gvanyjgm/LocalState/sessions/61F98B322ED9793A9A992CCBE/D038BDC6AB2368D/transfers/2026-04/latihan_6_thread_server.py
[SERVER STARTED] Menunggu koneksi di port 5555...
[NEW CONNECTION] ('127.0.0.1', 63971) connected.
[ACTIVE CONNECTIONS] 1
[Client 63971]: selamat pagi
[Client 63971]: apa kabar ?
```



```
PS C:\Users\LENOVO> & C:/Users/LENOVO/AppData/Local/Programs/Python/Python313/python.exe c:/Users/LENOVO/AppData/Local/Packages/5319275A.WhatsAppDesktop_cv1g1gvanyjgm/LocalState/sessions/61F98B322ED9793A9A992CCBE/D038BDC6AB2368D/transfers/2026-04/latihan_6_thread_client.py
Terhubung ke server. Ketik pesan, ketik 'bye' untuk keluar.
>> selamat pagi
Server: Selamat datang di Chat Room!
>> apa kabar ?
```

Serialisasi Data (JSON & Pickle)

Hasil :

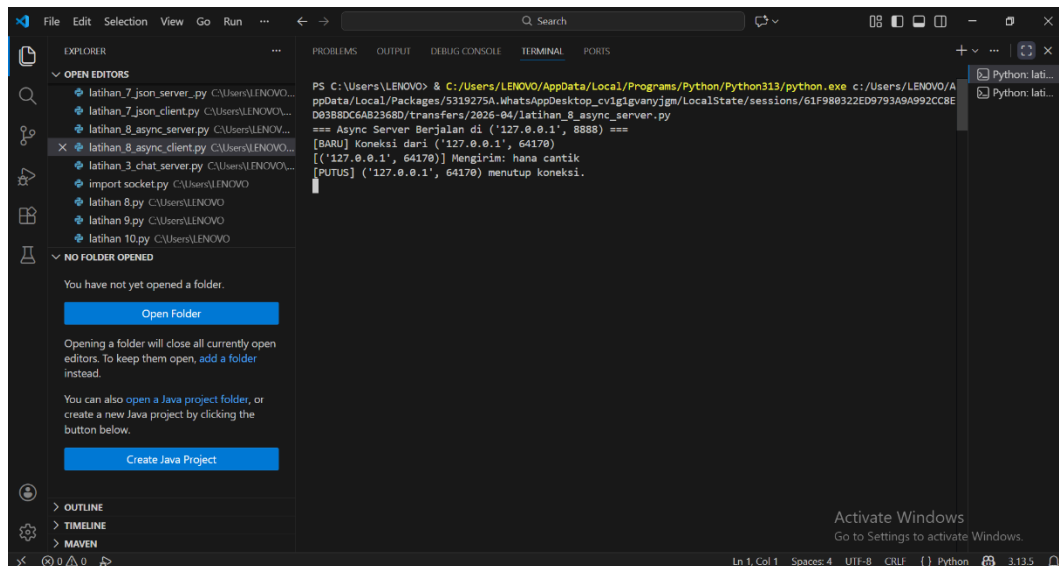


BAB VIII

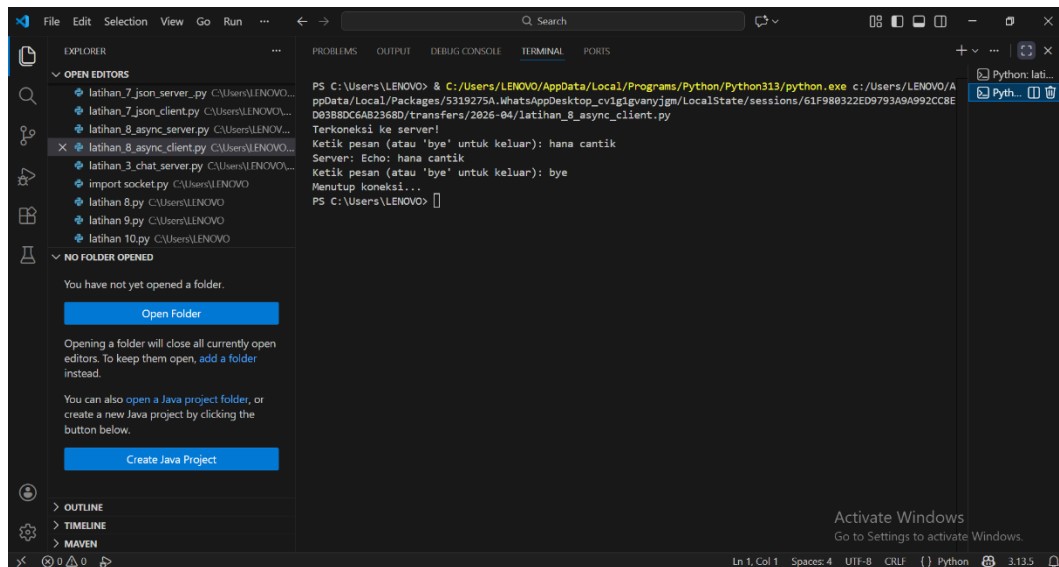
Asynchronous I/O (Concurrency Part II)

Praktikum Bab 8 ini dimana mengimplementasikan server non-blocking menggunakan pustaka asyncio Python, mendiagnosa kesalahan umum dalam pemrograman async seperti Blocking Code yang memastikan Event Loop. Dibawa ini konsep Kirim pesan dari Client A lalu Client B berkomunikasi lancar tanpa jeda.

Hasil :



```
PS C:\Users\LENOVO> & C:/Users/LENOVO/AppData/Local/Programs/Python/Python313/python.exe c:/Users/LENOVO/AppData/Local/Packages/5319275A.WhatsAppDesktop_cv1g1gvanyjgm/LocalState/sessions/61F98B322ED9793A9A992CCBE0038BDC6AB2368D/transfers/2026-04/latihan_8_async_server.py
== Async Server Berjalan di ('127.0.0.1', 8888) ==
[BARU] Koneksi dari ('127.0.0.1', 64170)
[['127.0.0.1', 64170]] Mengirim: hana cantik
[PUTUS] ('127.0.0.1', 64170) menutup koneksi.
```



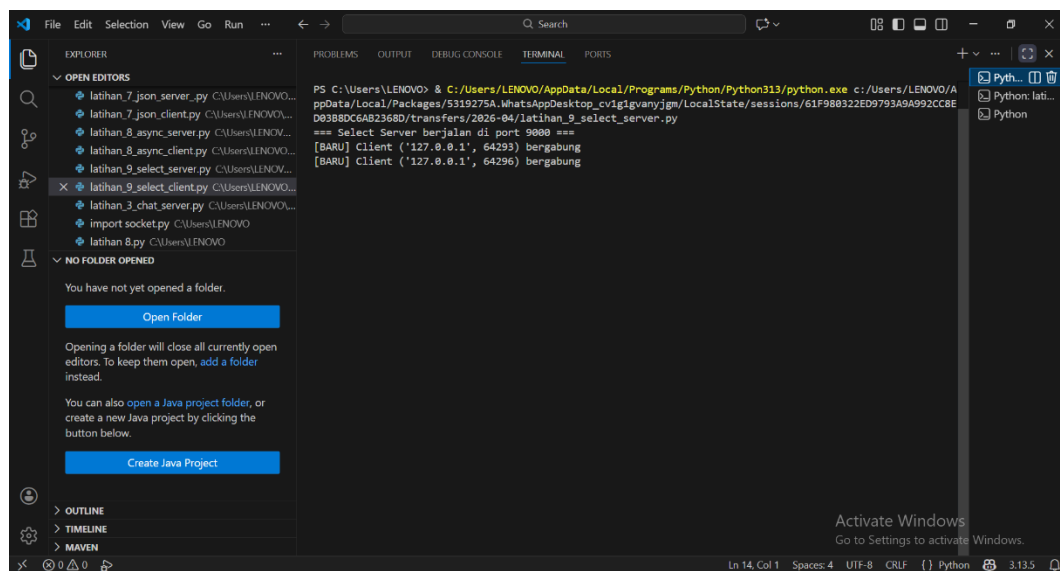
```
PS C:\Users\LENOVO> & C:/Users/LENOVO/AppData/Local/Programs/Python/Python313/python.exe c:/Users/LENOVO/AppData/Local/Packages/5319275A.WhatsAppDesktop_cv1g1gvanyjgm/LocalState/sessions/61F98B322ED9793A9A992CCBE0038BDC6AB2368D/transfers/2026-04/latihan_8_async_client.py
Terkoneksi ke server!
Ketik pesan (atau 'bye' untuk keluar): hana cantik
Server: Echo: hana cantik
Ketik pesan (atau 'bye' untuk keluar): bye
Menutup koneksi...
PS C:\Users\LENOVO>
```

BAB IX

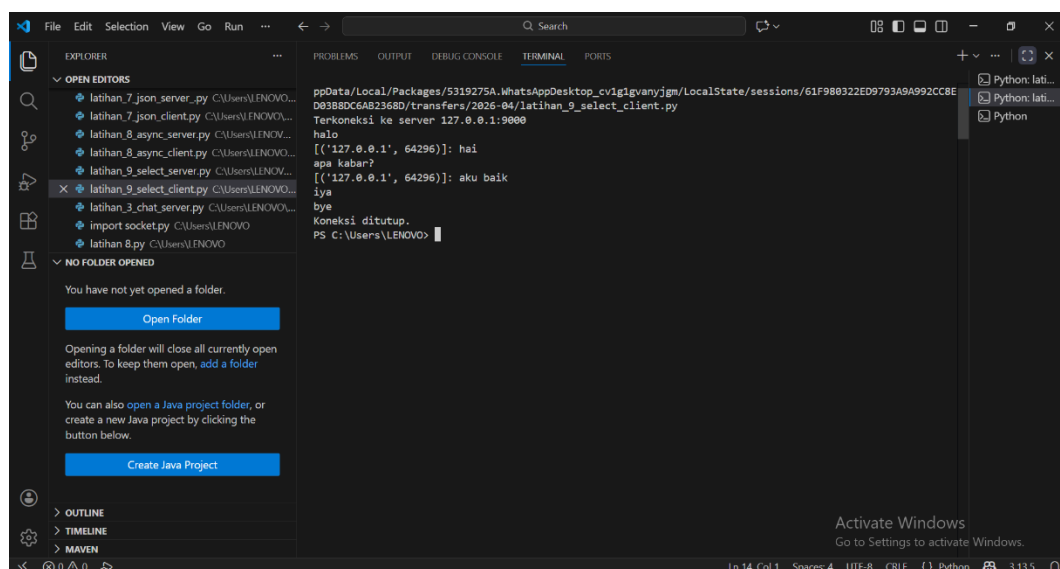
I/O Multiplexing (select & poll)

Praktikum di Bab ini dimana menjelaskan mekanisme dasar kernel OS dalam memantau deskriptor file menggunakan select. Dibawa ini menunjukkan satu proses menangani banyak koneksi.

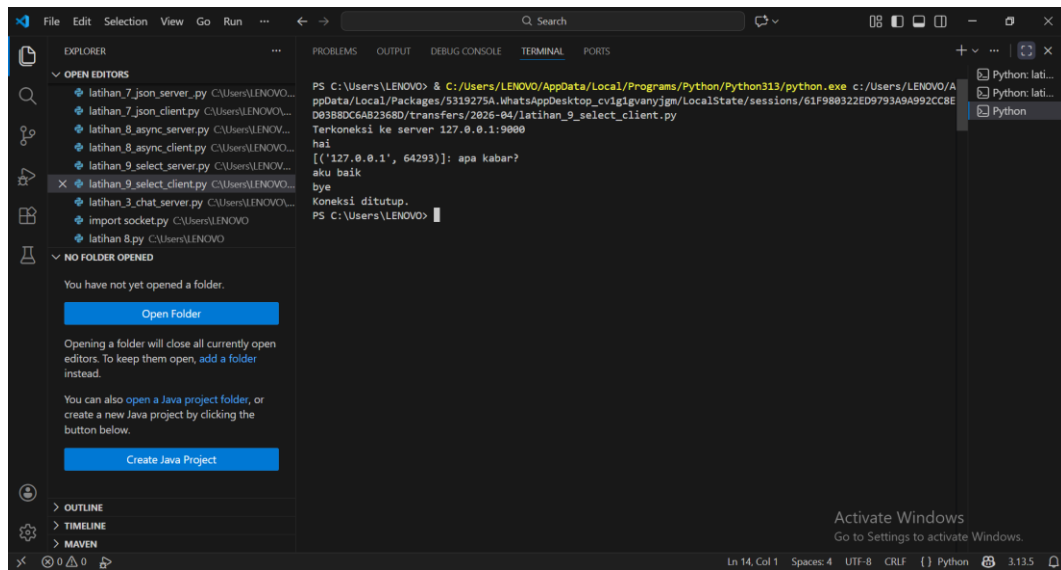
Hasil :



```
PS C:\Users\LENOVO> & C:/Users/LENOVO/AppData/Local/Programs/Python/Python313/python.exe c:/Users/LENOVO/A
ppData/Local/Packages/5319275A.WhatsAppDesktop_cv1g1gvanyjgm/LocalState/sessions/61F980322ED9793A9A992CC8E
D038BDC6AB2368D/transfers/2026-04/latihan_9_select_server.py
=== Select Server berjalan di port 9000 ===
[BARU] Client ('127.0.0.1', 64293) bergabung
[BARU] Client ('127.0.0.1', 64296) bergabung
```



```
ppData/Local/Packages/5319275A.WhatsAppDesktop_cv1g1gvanyjgm/LocalState/sessions/61F980322ED9793A9A992CC8E
D038BDC6AB2368D/transfers/2026-04/latihan_9_select_client.py
Terkoneksi ke server 127.0.0.1:9000
halo
[['127.0.0.1', 64296]]: hai
apa kabar?
[['127.0.0.1', 64296]]: aku baik
iya
bye
Koneksi ditutup.
PS C:\Users\LENOVO>
```

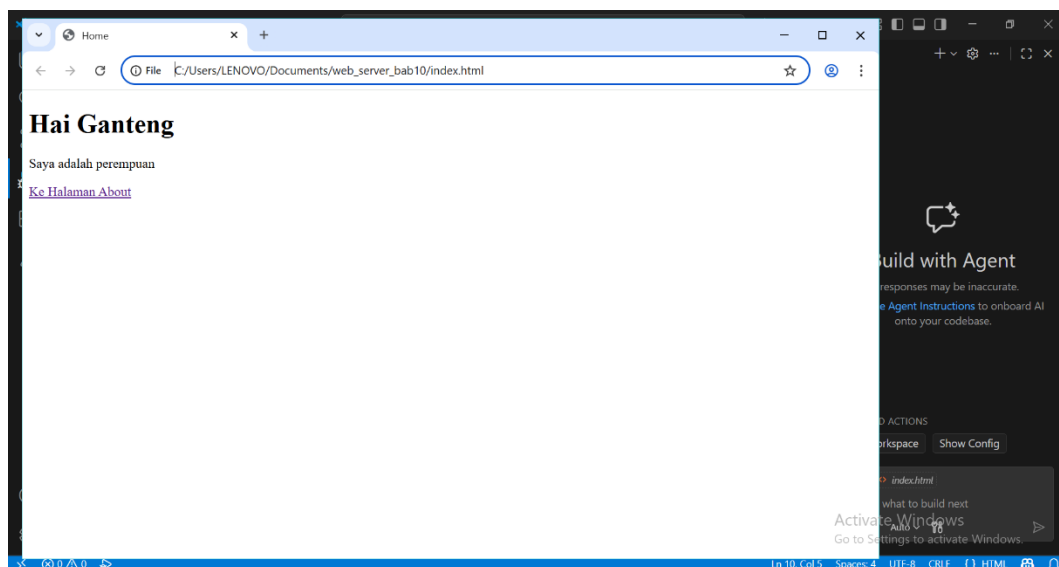
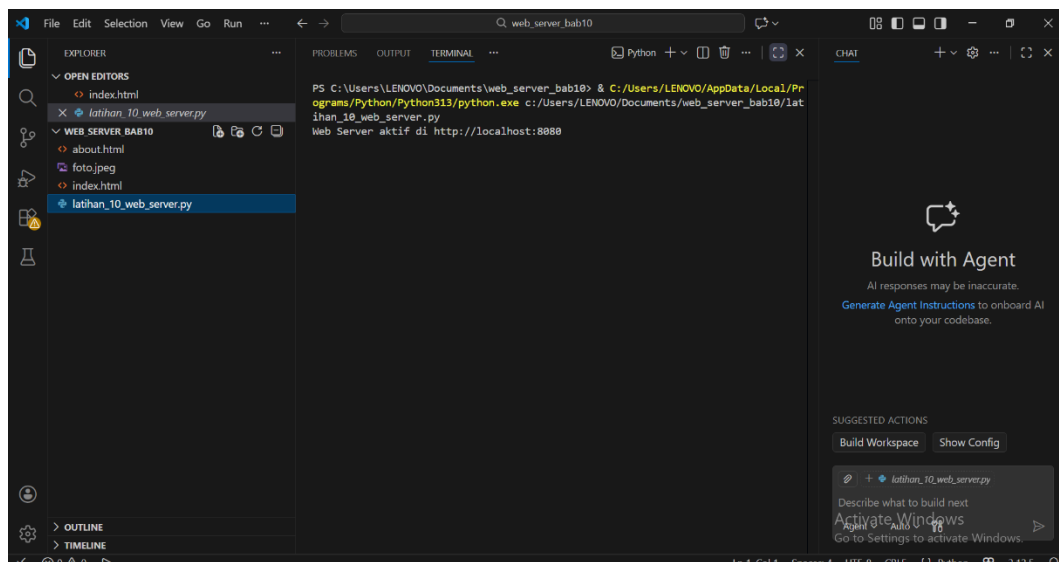


BAB X

Protokol HTTP & Web Server

Pada praktikum Bab 10 ini kita membangun Web server sederhana, kemudian menguraikan struktur paket HTTP (header, body, status code, methods) secara mendetail. Dibawah ini HTTP bekerja dengan model request-response, gambar dibawah ini berhasil menyajikan dan memodifikasi server dengan format.

Hasil :

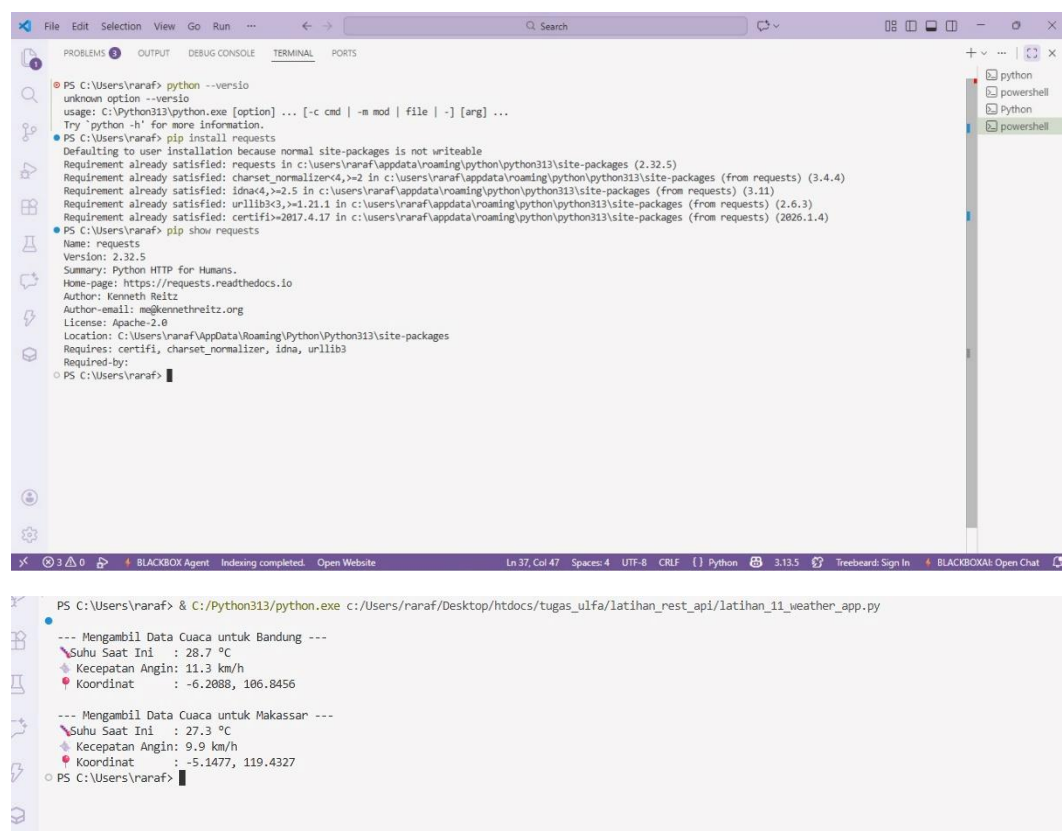


BAB XI

REST API & Web Services

Pada praktikum Bab ini dimana menjelaskan konsep dasar Web Service dan aritektur REST (representational state transfer). Gambar dibawa ini menunjukkan bahwa tampilan rspons server terhadap permintaan client.

Hasil :



```
PS C:\Users\raraf> python --versio
unknown option --versio
usage: C:\Python313\python.exe [option] ... [-c cmd | -m mod | file | -] [arg] ...
Try 'python -h' for more information.

PS C:\Users\raraf> pip install requests
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: requests in c:\users\raraf\appdata\roaming\python\python313\site-packages (2.32.5)
Requirement already satisfied: charset_normalizer<4,>=2 in c:\users\raraf\appdata\roaming\python\python313\site-packages (from requests) (3.4.4)
Requirement already satisfied: idna<4,>=2.5 in c:\users\raraf\appdata\roaming\python\python313\site-packages (from requests) (3.11)
Requirement already satisfied: urllib3<3,>=1.21.1 in c:\users\raraf\appdata\roaming\python\python313\site-packages (from requests) (2.6.3)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\raraf\appdata\roaming\python\python313\site-packages (from requests) (2026.1.4)

PS C:\Users\raraf> pip show requests
Name: requests
Version: 2.32.5
Summary: Python HTTP for Humans.
Home-page: https://requests.readthedocs.io
Author: Kenneth Reitz
Author-email: me@kennethreitz.org
License: Apache-2.0
Location: C:\Users\raraf\AppData\Roaming\Python\Python313\site-packages
Requires: certifi, charset_normalizer, idna, urllib3
Required-by:

PS C:\Users\raraf>

PS C:\Users\raraf> & C:/Python313/python.exe c:/Users/raraf/Desktop/htdocs/tugas_ulfa/latihan_rest_api/latihan_11_weather_app.py

--- Mengambil Data Cuaca untuk Bandung ---
Suhu Saat Ini : 28.7 °C
Kecepatan Angin: 11.3 km/h
Koordinat : -6.2888, 106.8456

--- Mengambil Data Cuaca untuk Makassar ---
Suhu Saat Ini : 27.3 °C
Kecepatan Angin: 9.9 km/h
Koordinat : -5.1477, 119.4327

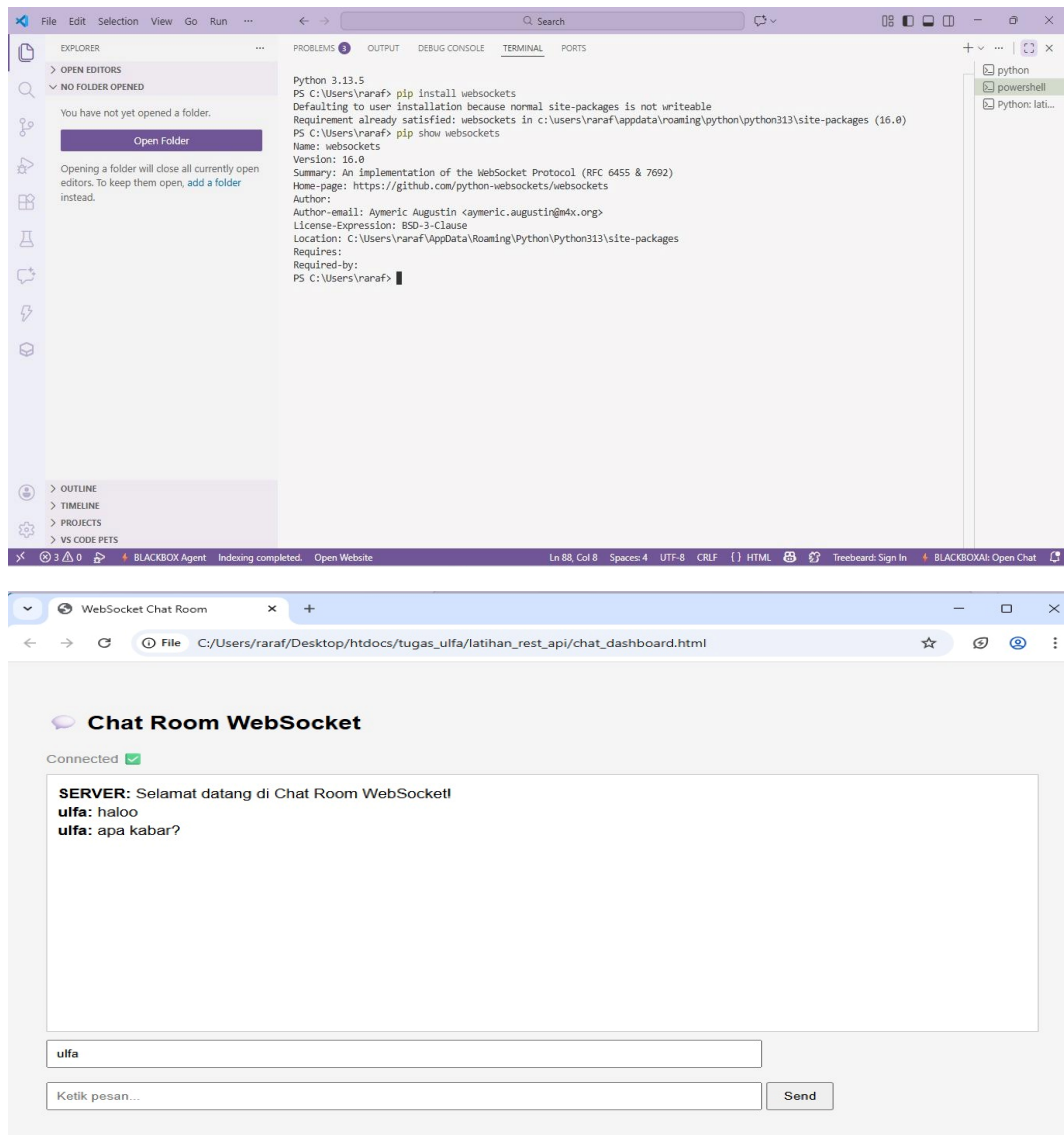
PS C:\Users\raraf>
```

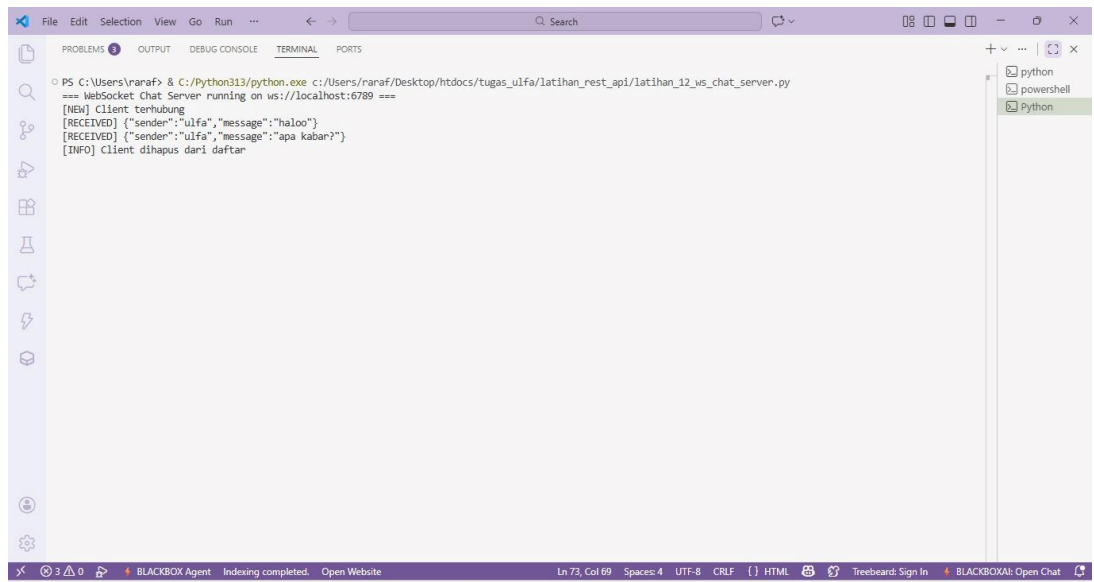
BAB XII

Real-time Communication (WebSocket)

Praktikum Bab 12 ini dimana membangun server WebSocket yang mampu melakukan Push Notification data secara real-time, dibawah ini mengintegrasikan Backend python dengan Frontend HTML/JS untuk visualisasi data langsung. Gambar dibawa ini adalah desain untuk dokumentasi statis client minta server.

Hasil :





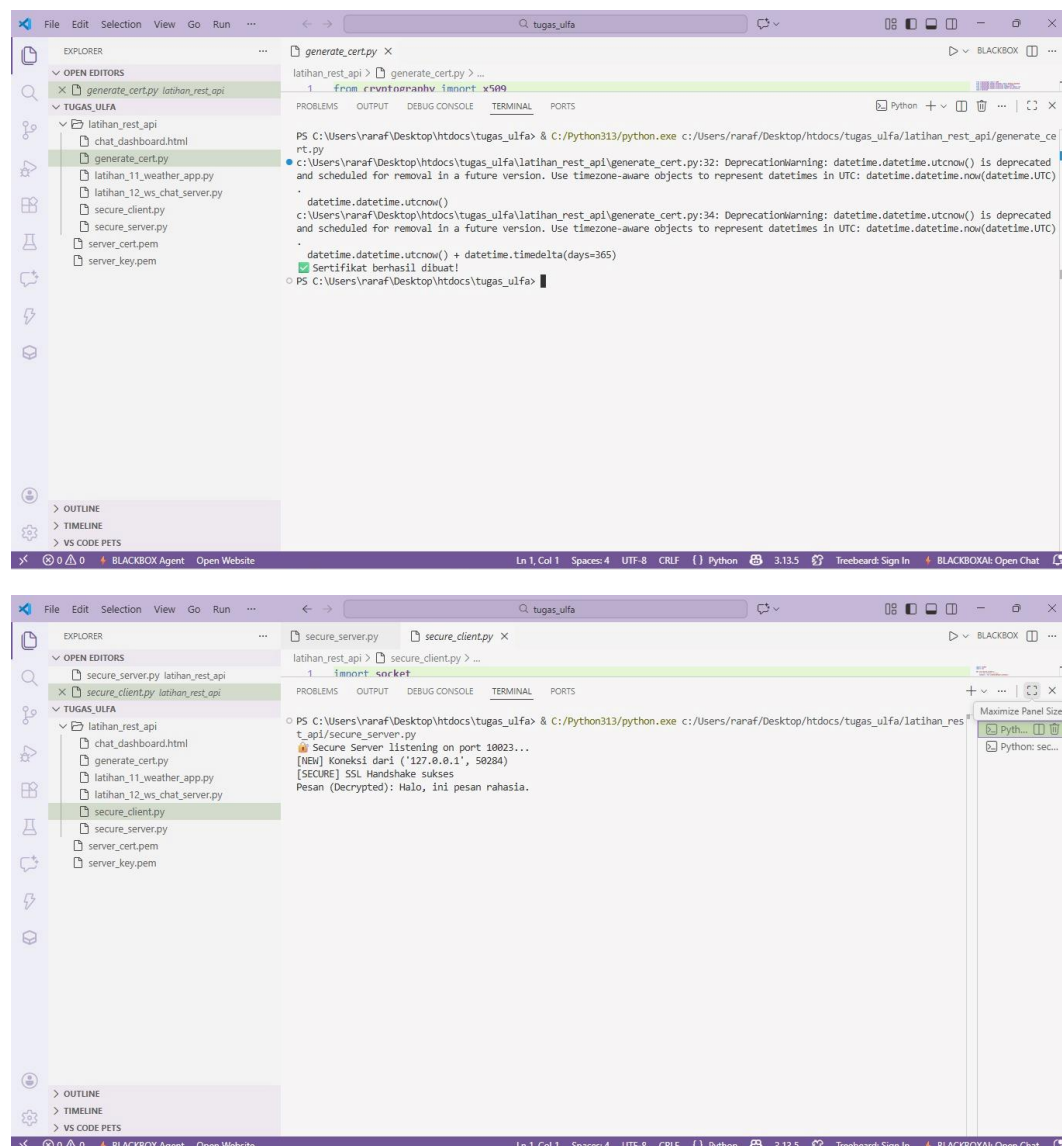
```
PS C:\Users\raraf> & C:/Python313/python.exe c:/Users/raraf/Desktop/htdocs/tugas_ulfa/latihan_rest_api/latihan_12_ws_chat_server.py
=== WebSocket Chat Server running on ws://localhost:6789 ===
[NEW] Client terhubung
[RECEIVED] {"sender":"ulfa","message":"haloo"}
[RECEIVED] {"sender":"ulfa","message":"apa kabar?"}
[INFO] Client dihapus dari daftar
```

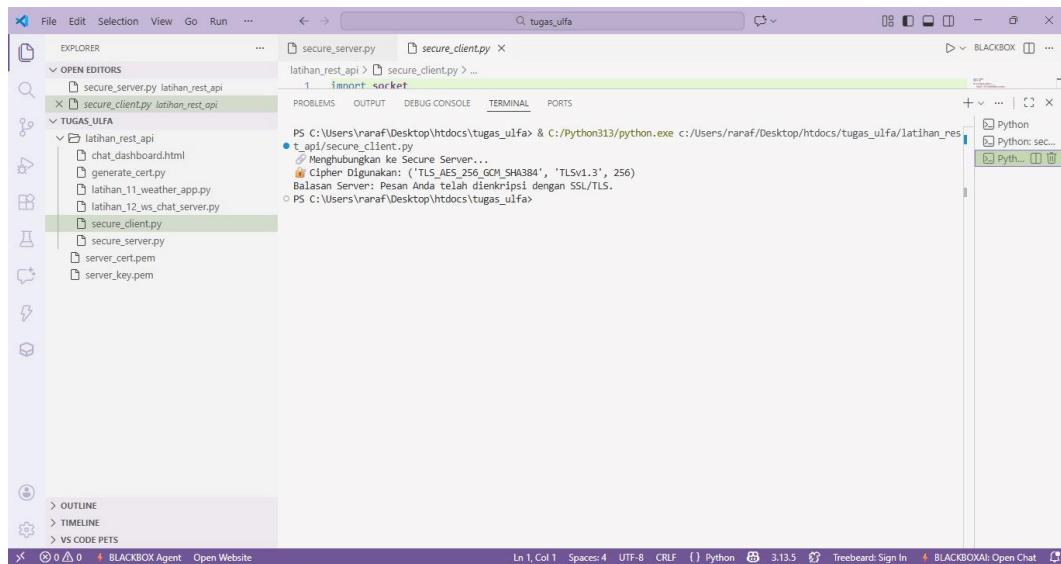
The screenshot shows a Visual Studio Code window with a terminal pane at the bottom. The terminal is running a Python script that acts as a WebSocket chat server. The output shows the server is running on ws://localhost:6789. A new client connects, sends a message "haloo", and then the client is disconnected. The status bar at the bottom indicates the file is at line 73, column 69, with 5 spaces, UTF-8 encoding, and CRLF line endings. It also shows the HTML language mode and the Treebeard extension.

Keamanan Jaringan (Network Security)

Praktikum Bab ini menganalisis kerentanan komunikasi data plaintext terhadap serangan sniffing dan man-in-the-meddle. Dibawah ini tampilan mendemonstrasikan penggunaan modul python untuk mengenkripsi lalu lintas aplikasi Client-Server.

Hasil :



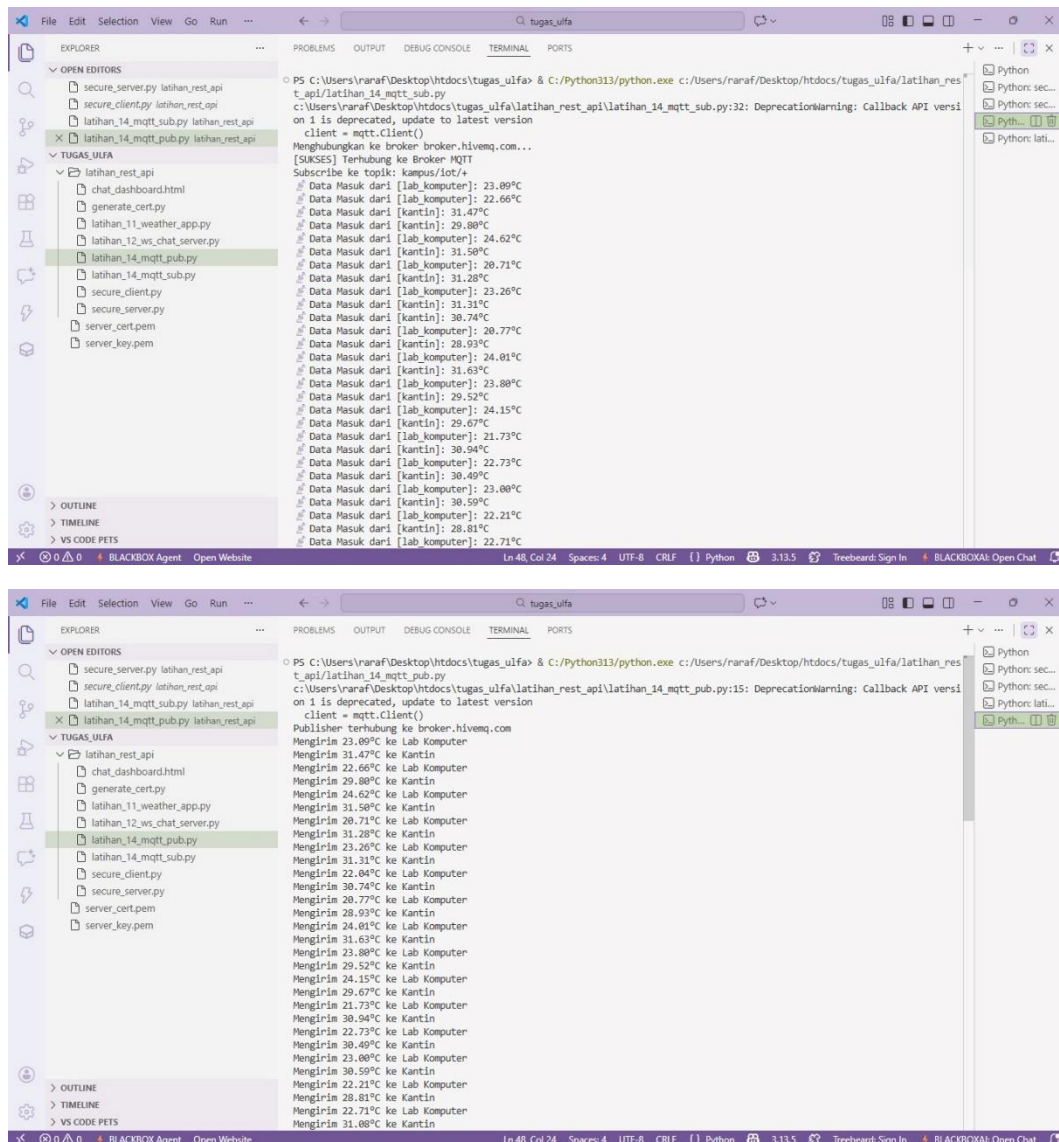


BAB XIV

Arsitektur Sistem Terdistribusi & IoT (MQTT)

Praktikum Bab ini dimana pelaksanaan proses sederhana dalam peran Broker sebagai perantara pesan dalam sistem terdistribusi. Gambar ini menunjukkan pengimplementasian komunikasi data sensor menggunakan protokol MQLL dan pustaka paho-mqtt dan mengevaluasi tingkat keandalan data.

Hasil :



The image displays two screenshots of a Visual Studio Code (VS Code) terminal window, showing the execution of an MQTT client and publisher. The terminal output is as follows:

Terminal 1 (MQTT Client):

```
PS C:\Users\raraf\Desktop\htdocs\tugas_ulfa> & C:/Python313/python.exe c:/Users/raraf/Desktop/htdocs/tugas_ulfa/latihan_rest_api/latihan_14_mqtt_sub.py
c:\Users\raraf\Desktop\htdocs\tugas_ulfa\latihan_rest_api\latihan_14_mqtt_sub.py:32: DeprecationWarning: Callback API version 1 is deprecated, update to latest version
client = mqtt.Client()
Menghubungkan ke broker broker.hivemq.com...
[SUKSES] Terhubung ke Broker MQTT
Subscribe ke topik: kampus/iot/4
Data Masuk dari [lab_komputer]: 23.09°C
Data Masuk dari [kantin]: 31.47°C
Data Masuk dari [kantin]: 29.80°C
Data Masuk dari [lab_komputer]: 24.62°C
Data Masuk dari [kantin]: 31.50°C
Data Masuk dari [lab_komputer]: 20.71°C
Data Masuk dari [kantin]: 31.28°C
Data Masuk dari [lab_komputer]: 23.26°C
Data Masuk dari [kantin]: 31.31°C
Data Masuk dari [kantin]: 30.74°C
Data Masuk dari [lab_komputer]: 20.77°C
Data Masuk dari [kantin]: 28.03°C
Data Masuk dari [lab_komputer]: 24.01°C
Data Masuk dari [kantin]: 31.63°C
Data Masuk dari [lab_komputer]: 23.80°C
Data Masuk dari [kantin]: 29.52°C
Data Masuk dari [lab_komputer]: 24.15°C
Data Masuk dari [kantin]: 29.67°C
Data Masuk dari [lab_komputer]: 21.73°C
Data Masuk dari [kantin]: 30.94°C
Data Masuk dari [lab_komputer]: 22.73°C
Data Masuk dari [kantin]: 30.49°C
Data Masuk dari [lab_komputer]: 23.00°C
Data Masuk dari [kantin]: 30.59°C
Data Masuk dari [lab_komputer]: 22.21°C
Data Masuk dari [kantin]: 28.81°C
Data Masuk dari [lab_komputer]: 22.71°C
```

Terminal 2 (MQTT Publisher):

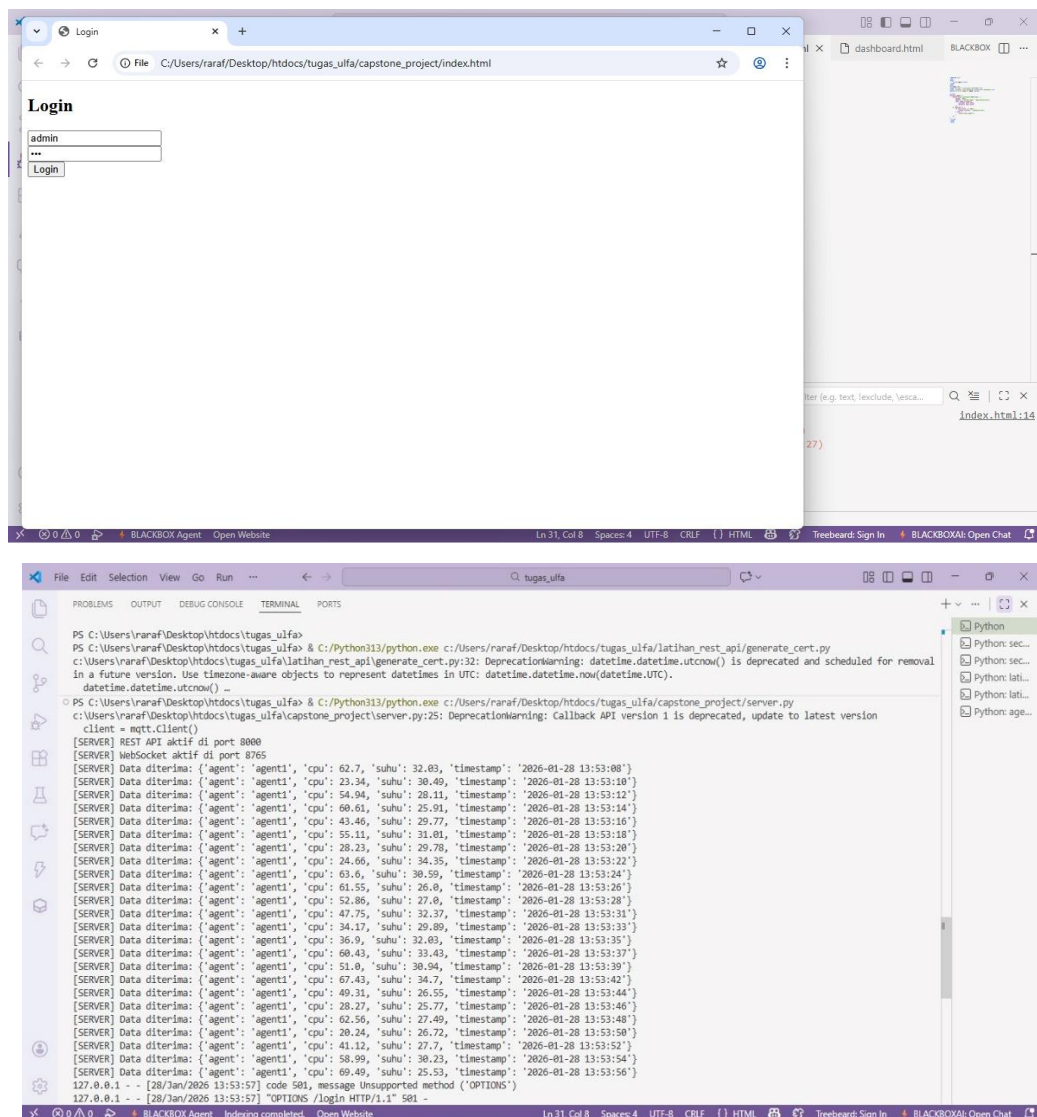
```
PS C:\Users\raraf\Desktop\htdocs\tugas_ulfa> & C:/Python313/python.exe c:/Users/raraf/Desktop/htdocs/tugas_ulfa/latihan_rest_api/latihan_14_mqtt_pub.py
c:\Users\raraf\Desktop\htdocs\tugas_ulfa\latihan_rest_api\latihan_14_mqtt_pub.py:15: DeprecationWarning: Callback API version 1 is deprecated, update to latest version
client = mqtt.Client()
Publisher terhubung ke broker.hivemq.com
Mengirim 23.09°C ke Lab Komputer
Mengirim 31.47°C ke Kantin
Mengirim 22.66°C ke Lab Komputer
Mengirim 29.80°C ke Kantin
Mengirim 24.62°C ke Lab Komputer
Mengirim 31.50°C ke Kantin
Mengirim 20.71°C ke Lab Komputer
Mengirim 31.28°C ke Kantin
Mengirim 23.26°C ke Lab Komputer
Mengirim 31.31°C ke Kantin
Mengirim 22.04°C ke Lab Komputer
Mengirim 30.74°C ke Kantin
Mengirim 20.77°C ke Lab Komputer
Mengirim 28.03°C ke Kantin
Mengirim 24.01°C ke Lab Komputer
Mengirim 31.63°C ke Kantin
Mengirim 23.80°C ke Lab Komputer
Mengirim 29.52°C ke Kantin
Mengirim 24.15°C ke Lab Komputer
Mengirim 29.67°C ke Kantin
Mengirim 21.73°C ke Lab Komputer
Mengirim 30.94°C ke Kantin
Mengirim 22.73°C ke Lab Komputer
Mengirim 30.49°C ke Kantin
Mengirim 23.00°C ke Lab Komputer
Mengirim 30.59°C ke Kantin
Mengirim 22.21°C ke Lab Komputer
Mengirim 28.81°C ke Kantin
Mengirim 22.71°C ke Lab Komputer
Mengirim 31.08°C ke Kantin
```

BAB XV

Penutup & Proyek Akhir (Capstone Project)

Praktikum pada Bab 15 ini dimana proses sederhana merancang arsitektur sistem jaringan berskala kompleks yang mengintegrasikan minimal 3 protokol berbeda (HTTP, WebSocket, TCP), Gambar dibawah ini menunjukkan berhasilnya mengevaluasi performa dan keamanan sistem jaringan yang telah dibangun hasil susunan rancang dari pengembangan diri untuk karier dibidang Network Engineering atau Backend Development.

Hasil :



```
File Edit Selection View Go Run ... tugas_uifa
PROBLEMS OUTPUT DEBUG CONSOLE TERMINAL PORTS

PS C:\Users\raraf\Desktop\htdocs\tugas_uifa> & C:/Python313/python.exe c:/Users/raraf/Desktop/htdocs/tugas_uifa/capstone_project/agent.py
c:\Users\raraf\Desktop\htdocs\tugas_uifa\capstone_project\agent.py:10: DeprecationWarning: Callback API version 1 is deprecated, update to latest version
client = mqtt.Client()

[AGENT] Sensor berjalan...
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 62.7, 'suhu': 32.03, 'timestamp': '2026-01-28 13:53:08'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 23.34, 'suhu': 30.49, 'timestamp': '2026-01-28 13:53:10'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 54.94, 'suhu': 28.11, 'timestamp': '2026-01-28 13:53:12'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 60.61, 'suhu': 25.91, 'timestamp': '2026-01-28 13:53:14'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 43.46, 'suhu': 29.77, 'timestamp': '2026-01-28 13:53:16'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 55.11, 'suhu': 31.01, 'timestamp': '2026-01-28 13:53:18'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 28.23, 'suhu': 29.78, 'timestamp': '2026-01-28 13:53:20'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 24.66, 'suhu': 34.35, 'timestamp': '2026-01-28 13:53:22'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 63.6, 'suhu': 30.59, 'timestamp': '2026-01-28 13:53:24'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 61.55, 'suhu': 26.0, 'timestamp': '2026-01-28 13:53:26'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 52.86, 'suhu': 27.0, 'timestamp': '2026-01-28 13:53:28'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 47.75, 'suhu': 32.37, 'timestamp': '2026-01-28 13:53:31'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 34.17, 'suhu': 29.09, 'timestamp': '2026-01-28 13:53:33'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 36.9, 'suhu': 32.03, 'timestamp': '2026-01-28 13:53:35'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 60.43, 'suhu': 33.43, 'timestamp': '2026-01-28 13:53:37'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 51.0, 'suhu': 30.94, 'timestamp': '2026-01-28 13:53:39'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 67.43, 'suhu': 34.7, 'timestamp': '2026-01-28 13:53:42'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 49.31, 'suhu': 26.55, 'timestamp': '2026-01-28 13:53:44'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 28.27, 'suhu': 25.77, 'timestamp': '2026-01-28 13:53:46'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 62.56, 'suhu': 27.49, 'timestamp': '2026-01-28 13:53:48'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 20.24, 'suhu': 26.72, 'timestamp': '2026-01-28 13:53:50'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 41.12, 'suhu': 27.7, 'timestamp': '2026-01-28 13:53:52'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 58.99, 'suhu': 30.23, 'timestamp': '2026-01-28 13:53:54'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 69.49, 'suhu': 25.53, 'timestamp': '2026-01-28 13:53:56'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 24.95, 'suhu': 31.06, 'timestamp': '2026-01-28 13:53:58'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 57.83, 'suhu': 30.15, 'timestamp': '2026-01-28 13:54:00'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 33.26, 'suhu': 31.28, 'timestamp': '2026-01-28 13:54:02'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 50.5, 'suhu': 34.09, 'timestamp': '2026-01-28 13:54:04'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 36.03, 'suhu': 31.77, 'timestamp': '2026-01-28 13:54:07'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 49.79, 'suhu': 27.48, 'timestamp': '2026-01-28 13:54:09'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 50.8, 'suhu': 31.45, 'timestamp': '2026-01-28 13:54:11'}
[AGENT] Kirim: {'agent': 'agent1', 'cpu': 21.55, 'suhu': 32.17, 'timestamp': '2026-01-28 13:54:13'}

Ln 31, Col 8 Spaces: 4 UTF-8 CRLF {} HTML Treebeard: Sign In BLACKBOX: Open Chat
```