Table of Content

Distributed Computing Assignment

Language used for the Implementation

Python 3.

System Overview

We implemented the required client–server distributed file service with one client, SERVER1 (coordinator), and SERVER2 (peer file server). Both servers maintain a replica directory `~/file_storage`. Due to possible update delays, SERVER1 always cross-checks with SERVER2 before replying to the client.

Protocol

- Client → SERVER1 (TCP:5001): `GET <pathname>\n`
- SERVER1 → SERVER2 (TCP:5002): `GET <pathname>\n`
- SERVER2 → SERVER1:
  - `FOUND <length>\n` followed by `<length>` bytes, or
  - `NOTFOUND\n`.
- SERVER1 → Client:
  - `OK ONE <length>\n` followed by one file copy, or
  - `OK BOTH <length1> <length2>\n` followed by two file copies (SERVER1 then SERVER2), or
  - `ERROR NOTFOUND\n` when neither server has the file, or invalid request.

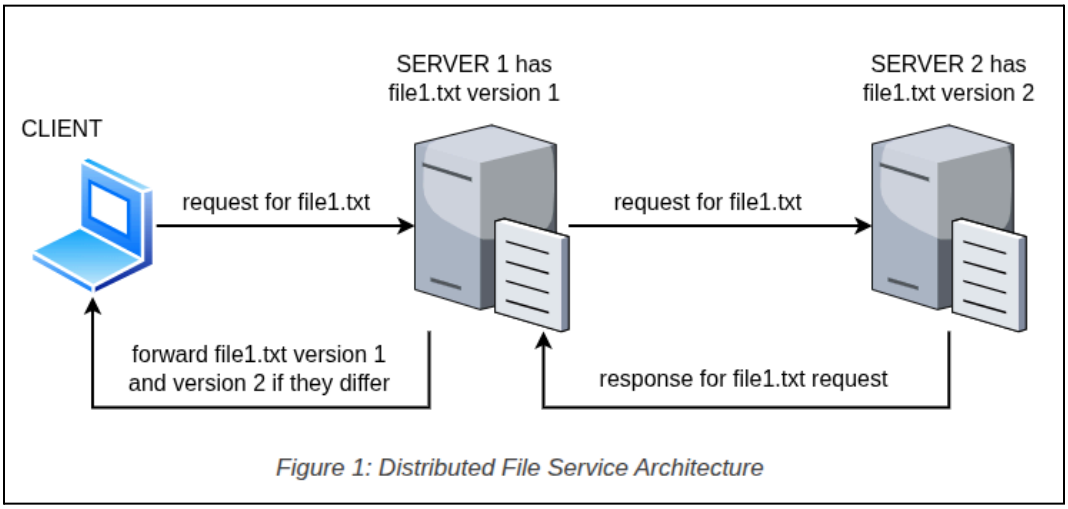


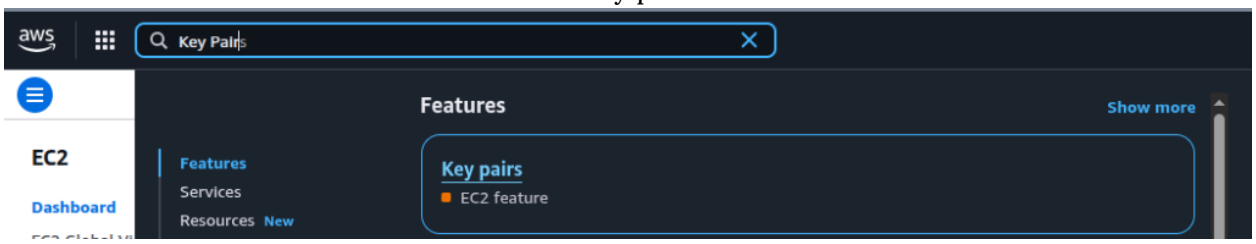
Figure 1: Distributed File Service Architecture

Step-by-Step Work Flow

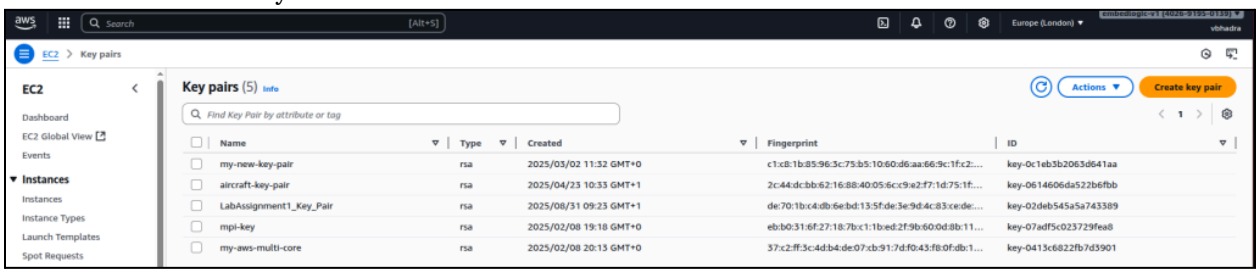
1) Setting up the AWS infrastructure

Create key pairs

- Go to the AWS dashboard and search for key pairs.



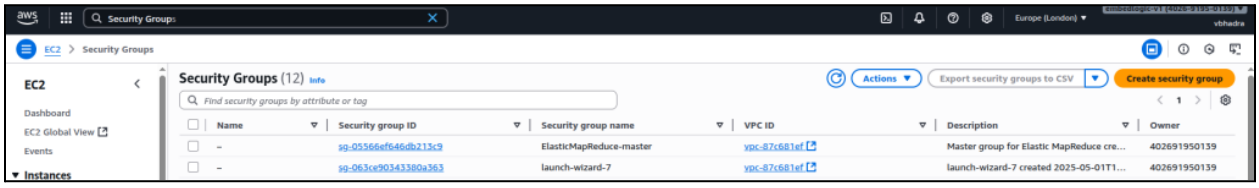
- Click on Create Key Pair.



- Name the key pair (e.g., MyFileSystemKeyPair). Leave the remaining fields at their default values and click Create key pair.
- Keep the .pem safe as this will be used to SSH into the AWS instances.

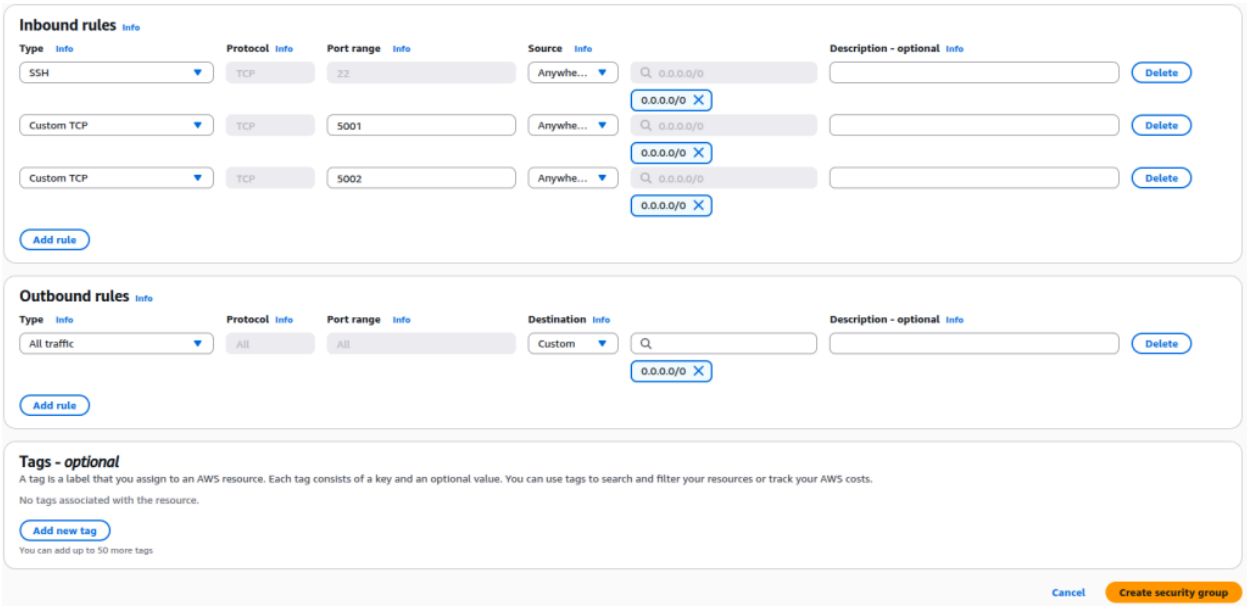
Create a Security Group

- Search for security groups. On the Security Group page, click on the Create security group button.

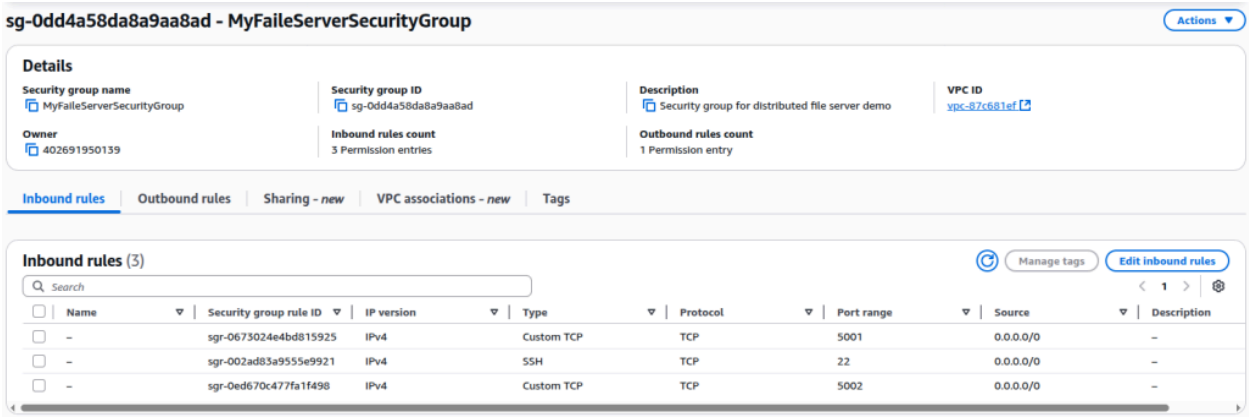


- Name the new security group (e.g., MyFileServerSecurityGroup).
- On the inbound rules, open TCP port **22** for SSH, TCP port **5001** (SERVER1), TCP port **5002** (SERVER2).
- For the demonstration, keep **Source = Anywhere.**

- On the outbound rules, allow all traffic.



- Create a security group. Once the group is created, it should look somewhat like the example shown below:



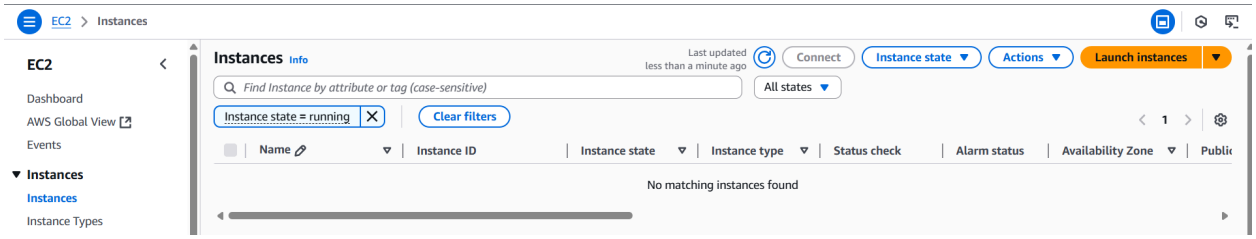
- This security group will be shared by Server 1, Server 2, and the Client.

Launch EC2 instances

- We will need at least three EC2 instances—one for the client and one for each of the two servers.
- Let's create three identical EC2 instances with the following details:

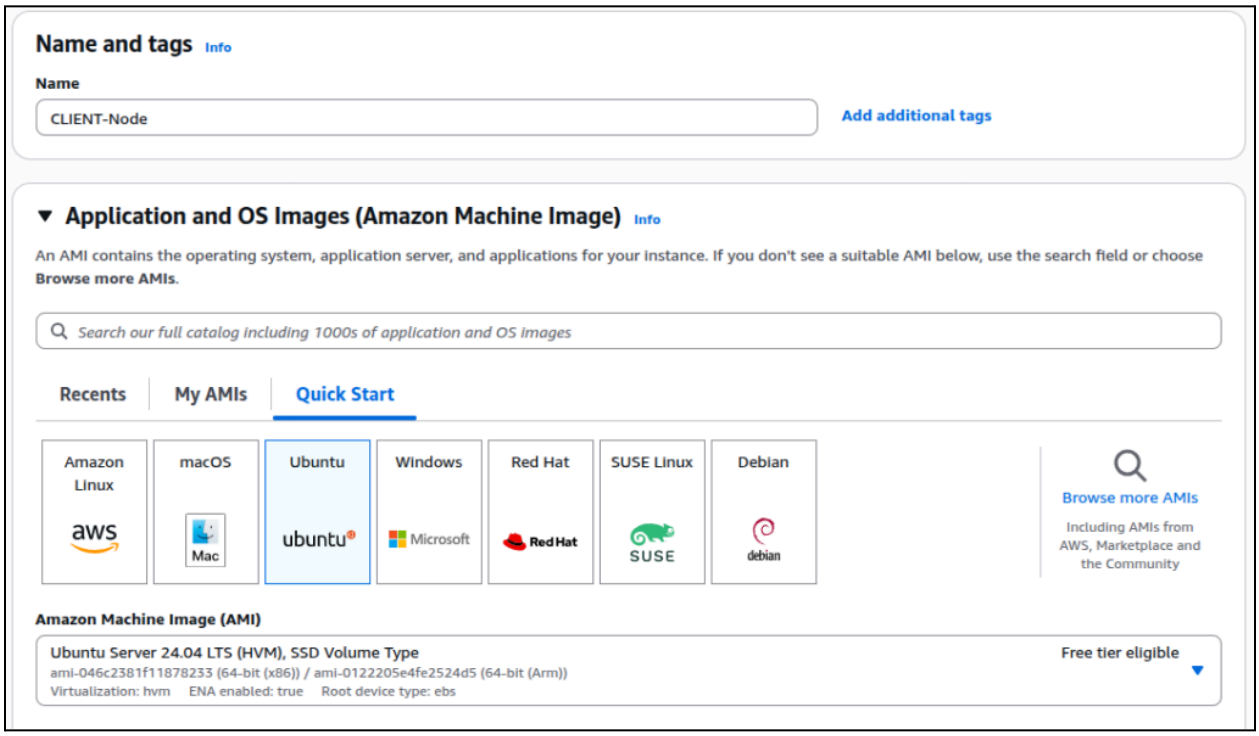
```
Name(s): CLIENT-Node, SERVER1, SERVER2
Security Group: MyFaileServerSecurityGroup
Key Pair: MyFileSystemKeyPair
AWS ASI Type: Ubuntu 22.04 t3.micro or t2.micro
```

- Go to EC2 Dashboard -> Instances -> Launch Instance.

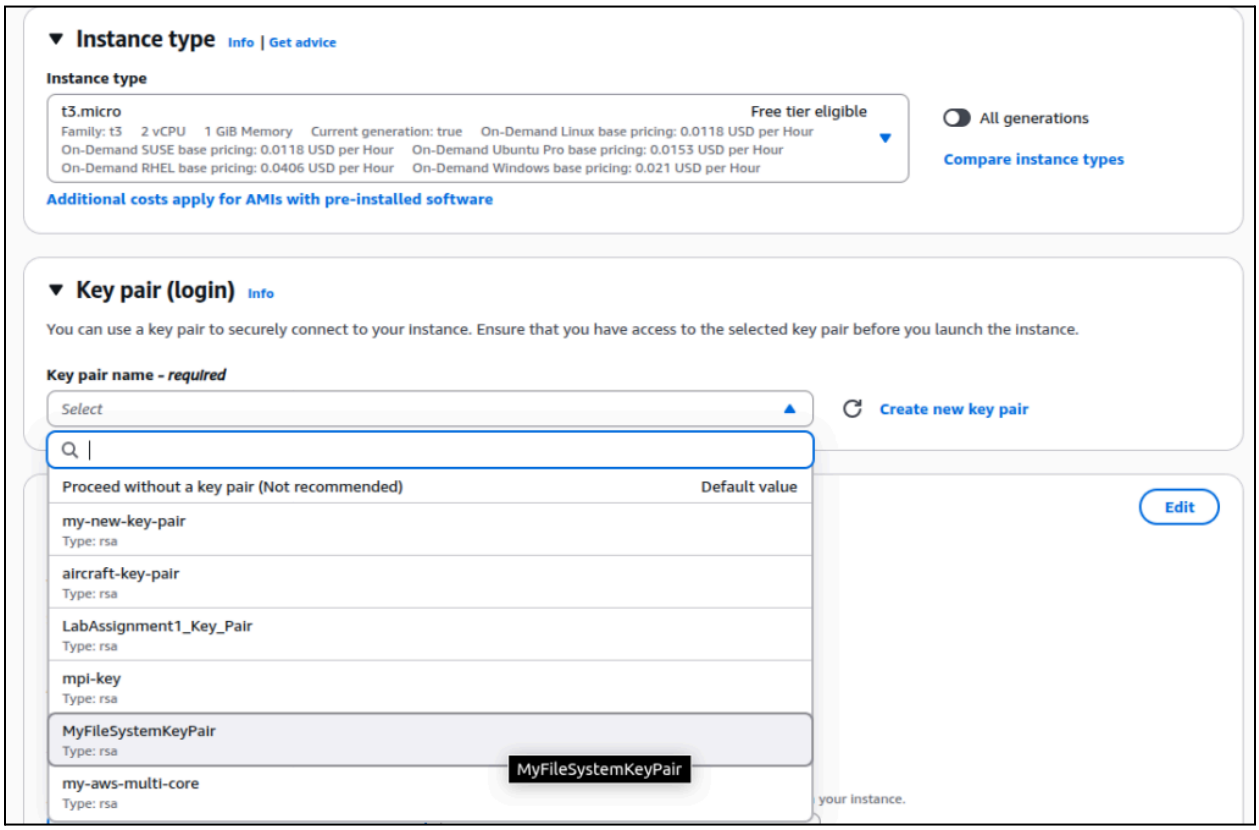


- Choose Ubuntu as the OS image.

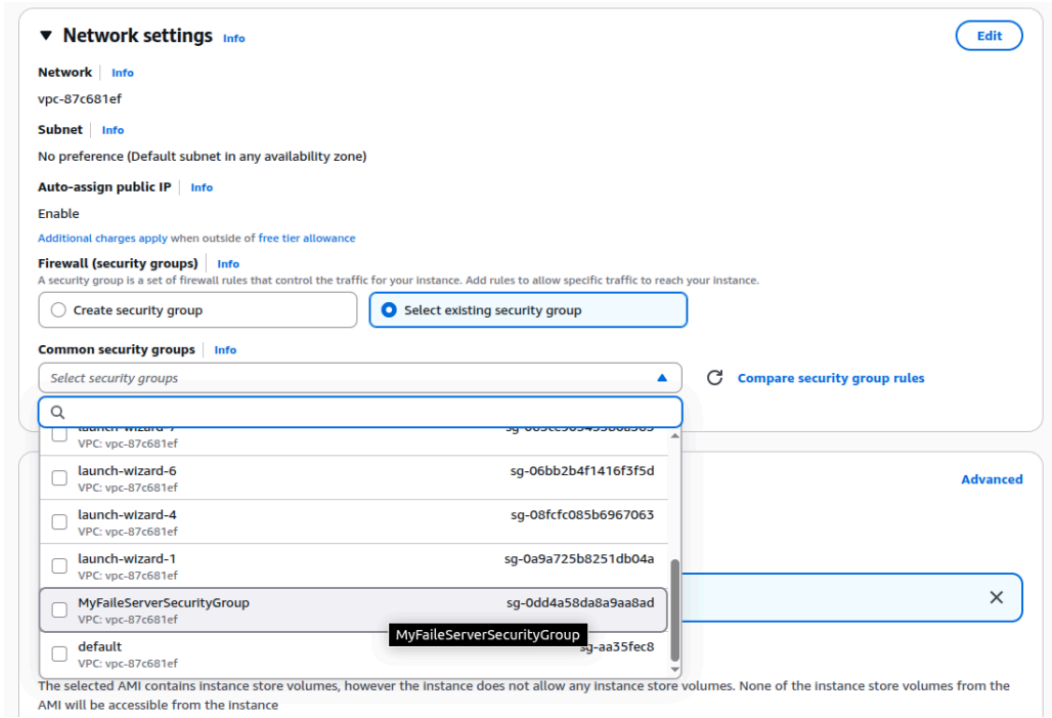
- Select Ubuntu 24.04 as the AMI. Select the instance type (t3.micro).



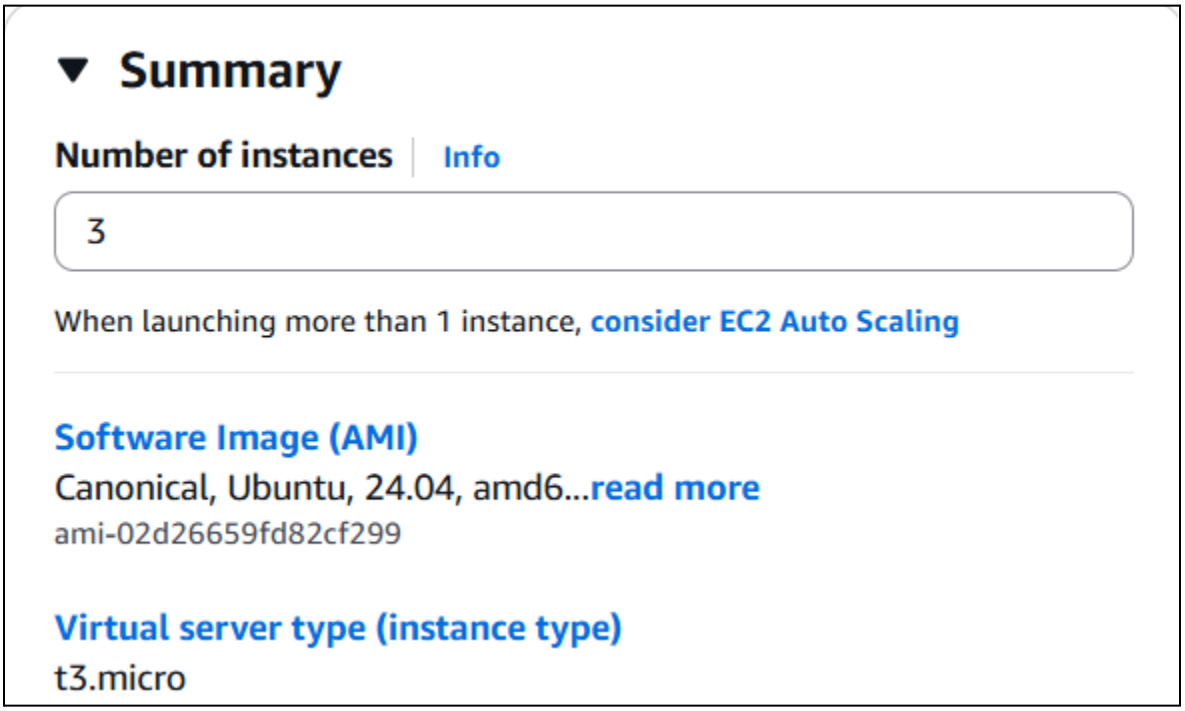
- Select the previously created key pair.



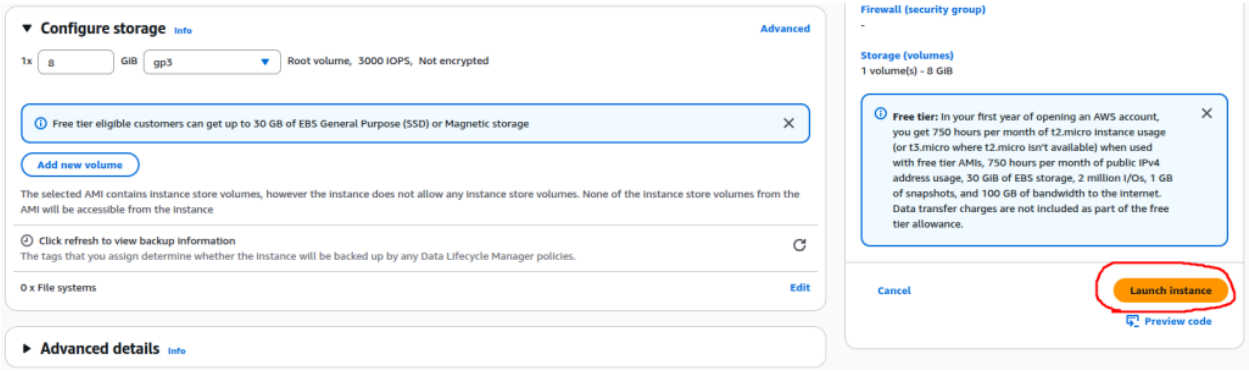
- Attach the created security group under Network settings.



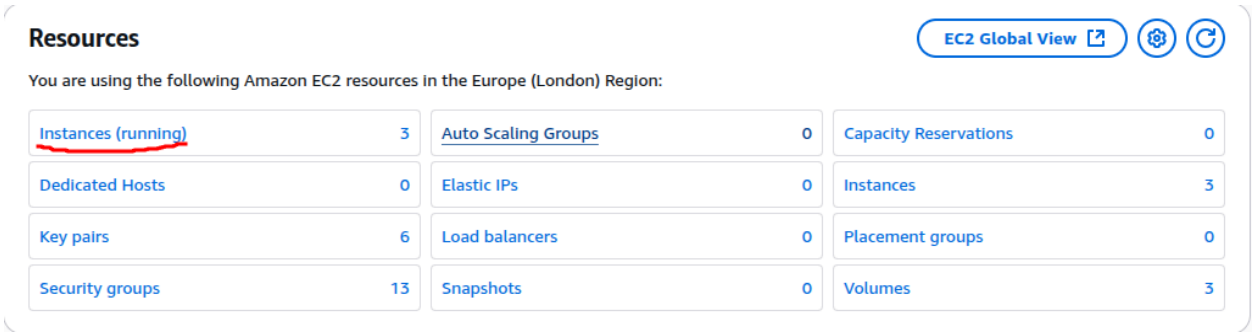
- Since we need three EC2 instances with the same base configurations, under Summary on the right hand side set the number of instances to 3.



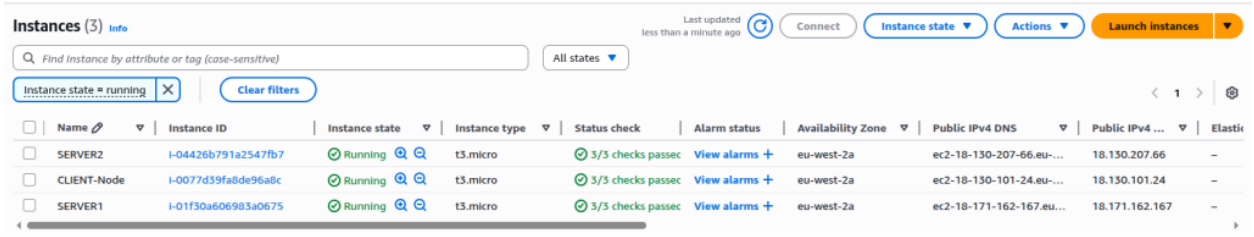
- Finally Click the Launch instance.



- This will create three EC2 instances with the selected configurations.
- After the instances are created, go to the EC2 page. You should be able to see all three instances running.



- Name all the instances for easy identification.



Record Public & Private IPs for all instances (used in scripts)

- These addresses will be required later when we write the scripts to establish communication between the client and the servers.
- In this case, the following are the Private and Public IPs of each instance:

```
CLINET-Node:
Public IPv4 address: 18.130.101.24
Private IPv4 addresses: 172.31.24.111

SERVER1:
Public IPv4 address: 18.171.162.167
Private IPv4 addresses: 172.31.16.124

SERVER2:
Public IPv4 address: 18.130.207.66
Private IPv4 addresses: 172.31.26.202
```

SSH & Install the necessary tools

- First, we need to change the file permissions of the key pair file (downloaded in one of the previous steps) by running the following command.

```
chmod 400 ~/Downloads/MyFileSystemKeyPair.pem
```

- The sample SSH command will be lie:

```
ssh -i ~/Downloads/MyFileSystemKeyPair.pem ubuntu@<EC2 Public IPv4 Addr>
```

- Let's SSH into the Client-Node and install the necessary packages:

```
~$ ssh -i ~/Downloads/MyFileSystemKeyPair.pem ubuntu@18.130.101.24
ubuntu@ip-172-31-24-111:~$ sudo apt update
ubuntu@ip-172-31-24-111:~$ sudo apt install netcat-openbsd -y
ubuntu@ip-172-31-24-111:~$ which nc
/usr/bin/nc
```

- Similarly, SSH into the Server 1 instance and run the commands

```
~$ ssh -i ~/Downloads/MyFileSystemKeyPair.pem ubuntu@18.171.162.167
~$ sudo apt update
~$ sudo apt install netcat-openbsd -y
~$ which nc
/usr/bin/nc
```

- Follow the exact set of steps for Server 2 as well.

```
~$ ssh -i ~/Downloads/MyFileSystemKeyPair.pem ubuntu@18.130.207.66
~$ sudo apt update
~$ sudo apt install netcat-openbsd -y
~$ which nc
/usr/bin/nc
```

- Now, all three instances are configured and ready for a quick connectivity check.

Connectivity check

- Before we move into the actual File Service server implementation, let's check the connections between the instances to make sure everything is set up correctly.
- Run the following on SERVER1:

```
ubuntu@ip-172-31-26-202:~$ nc -l -p 5002
```

- Then run the following on the CLIENT:

```
ubuntu@ip-172-31-24-111:~$ echo "hello from CLIENT to SERVER1" | nc
172.31.16.124 5002
```

- You should be able to see the message from the client displayed on SERVER1:

```
ubuntu@ip-172-31-16-124:~$ nc -l -p 5002
```

```
hello from CLIENT to SERVER1
```

- This confirms that the connection between the CLIENT-Node and SERVER1 is working correctly. We could also have used port 5001, since both ports 5001 and 5002 are open for TCP connections.
- You can repeat the same steps to test the connection between SERVER1 and SERVER2.

2) Writing the CLIENT script

The `client.py` program is the interface for users to request files from our distributed file service. Its job is simple: connect to SERVER1 (the coordinator), request a file, and handle the response. It doesn't interact with SERVER2 directly — it trusts SERVER1 to coordinate and return the correct data.

Protocol Overview

When the client connects to SERVER1 on port `5001`, it sends a request in the form:

```
GET filename
```

SERVER1 then processes the request — including checking with SERVER2 — and replies with a structured response, followed by file data if available. The client parses this response and prints the result.

Expected responses from SERVER1

- `OK ONE <length>` — a single version of the file follows.
- `OK BOTH <length1> <length2>` — two versions follow (from SERVER1 and SERVER2).
- `ERROR NOTFOUND` — the file doesn't exist on either server.

Code Overview

The script uses two helper functions:

- `recv_line(conn)`: Reads a line from the socket (used for headers).
- `recv_exact(conn, n)`: Reads exactly n bytes (used for file contents).

Main execution flow

1. Parses the filename from command-line args (defaults to `"file1.txt"`).
2. Connects to SERVER1 over TCP.
3. Send a GET request.
4. Reads and interprets the response header.

5. Receives and displays file data based on the response type.

Source Code Listing

```
#!/usr/bin/env python3
# client.py
import socket, sys

SERVER1_IP = "172.31.16.124"  # <-- PUT SERVER1 PRIVATE IP HERE
SERVER1_PORT = 5001
filename = sys.argv[1] if len(sys.argv) > 1 else "file1.txt"

def recv_line(conn):
    buf = bytearray()
    while True:
        b = conn.recv(1)
        if not b:
            break
        buf += b
        if buf.endswith(b"\n"):
            break
    return bytes(buf).decode(errors="replace").rstrip("\n")

def recv_exact(conn, n):
    buf = bytearray()
    while len(buf) < n:
        chunk = conn.recv(n - len(buf))
        if not chunk:
            raise ConnectionError("socket closed while reading body")
        buf += chunk
    return bytes(buf)

with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
    s.connect((SERVER1_IP, SERVER1_PORT))
    s.sendall(f"GET {filename}\n".encode())

    header = recv_line(s)  # e.g., OK ONE <len> / OK BOTH <l1> <l2> / ERROR
NOTFOUND
    parts = header.split()
    if parts[:2] == ["OK", "ONE"]:
        length = int(parts[2]); data = recv_exact(s, length)
        print("[CLIENT] Received ONE copy:")
        print(data.decode(errors="ignore"))
```

```
        # Optionally save:
        # open("out_one.txt","wb").write(data)
    elif parts[:2] == ["OK", "BOTH"]:
        l1, l2 = int(parts[2]), int(parts[3])
        d1 = recv_exact(s, l1); d2 = recv_exact(s, l2)
        print("[CLIENT] Received BOTH copies:")
        print("\n--- SERVER1 version ---\n", d1.decode(errors="ignore"))
        print("\n--- SERVER2 version ---\n", d2.decode(errors="ignore"))
        # Optionally save:
        # open("out_server1.txt","wb").write(d1)
        # open("out_server2.txt","wb").write(d2)
    else:
        print("[CLIENT]", header)
```

3) Writing the SERVER1 script

The `server1.py` program is the coordinator of our small distributed file service. Its job is simple to explain: it waits for clients to connect on port `5001`, checks if the requested file exists locally, always asks `SERVER2` for the same file, and then decides what to send back. Think of it as the "middle manager" — it doesn't just rely on its own copy but always double-checks with `SERVER2` before answering the client.

How the conversation works

When a client connects, it sends a request like GET file1.txt. SERVER1 then talks to SERVER2 in exactly the same way. If SERVER2 replies that the file exists, it also sends the file contents back; if not, it says NOTFOUND. Based on this exchange, SERVER1 then prepares its response for the client.

Decision making

- If both SERVER1 and SERVER2 have the file and their contents are *identical*, SERVER1 keeps things efficient and returns just one copy.
- If both servers have the file but the contents are *different*, SERVER1 sends both versions so the client can see the mismatch.
- If only one of the two servers has the file, SERVER1 forwards that copy.
- If neither server has it, SERVER1 sends back a simple "not found" error.

Code Walkthrough

The script uses helper functions to keep things tidy. `read_local()` looks up the file under `~/file_storage` on `SERVER1`. `get_from_server2()` connects out to `SERVER2`, asks for the same file, and collects the result. Once both responses are in, `SERVER1` compares them and

decides which of the `send_one()`, `send_both()`, or `send_error()` functions to use when replying to the client.

Safety and Reliability

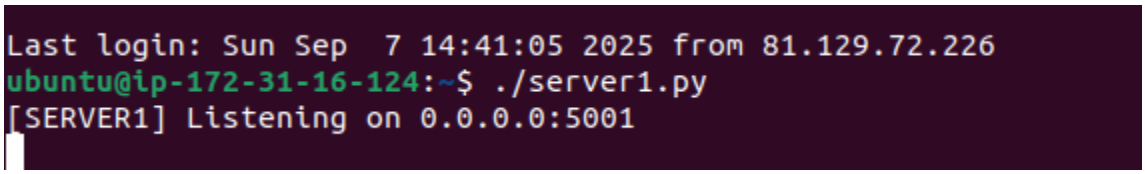
The script is careful about what paths it accepts (so clients can't wander outside the storage folder), it checks that full files are received before making decisions, and it catches errors so that one misbehaving server doesn't crash the whole service. Logging messages such as "Versions differ → sent BOTH" make it easy to see what happened during each request.

How to run it

Before starting, the `SERVER2_IP` variable needs to be updated to the private IP of `SERVER2`. Once `SERVER2` is already running, you can start this script on `SERVER1` with the following command on the command prompt:

```
ubuntu@ip-172-31-16-124:~$ ./server1.py
[SERVER1] Listening on 0.0.0.0:5001
```

It will sit listening on port `5001`, handle each incoming client request, and coordinate with `SERVER2` in the background. In short, `SERVER1` is the smart middle layer: it listens, checks both sides, makes a fair decision, and keeps the client informed.
Screenshot of running `server1.py` on EC2 instance:



Source Code Listing

```python
#!/usr/bin/env python3
import socket, os

HOST = "0.0.0.0"
PORT = 5001
SERVER2_IP = "172.31.xx.yy"   # <-- replace with SERVER2 private IP
SERVER2_PORT = 5002
ROOT = os.path.expanduser("~/file_storage")

def recv_line(conn):
    buf = bytearray()
    while True:
```

```
        b = conn.recv(1)
        if not b: break
        buf += b
        if buf.endswith(b"\n"): break
    return bytes(buf).decode(errors="replace").rstrip("\n")

def recv_exact(conn, n):
    buf = bytearray()
    while len(buf) < n:
        chunk = conn.recv(n - len(buf))
        if not chunk: raise ConnectionError("socket closed early")
        buf += chunk
    return bytes(buf)

def get_from_server2(filename: str) -> bytes | None:
    try:
        with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s2:
            s2.connect((SERVER2_IP, SERVER2_PORT))
            s2.sendall(f"GET {filename}\n".encode())
            header = recv_line(s2)
            if header == "NOTFOUND": return None
            if header.startswith("FOUND "):
                length = int(header.split()[1])
                return recv_exact(s2, length)
    except Exception as e:
        print("[SERVER1] Error contacting SERVER2:", e)
    return None

def read_local(filename: str) -> bytes | None:
    rel = filename.lstrip("/")
    path = os.path.normpath(os.path.join(ROOT, rel))
    if not path.startswith(ROOT): return None
    if os.path.isfile(path):
        with open(path, "rb") as f: return f.read()
    return None

def send_one(conn, data: bytes):
    conn.sendall(f"OK ONE {len(data)}\n".encode() + data)

def send_both(conn, d1: bytes, d2: bytes):
    conn.sendall(f"OK BOTH {len(d1)} {len(d2)}\n".encode() + d1 + d2)

def send_error(conn, msg="ERROR NOTFOUND"):
```

```
    conn.sendall((msg + "\n").encode())

def handle_client(conn, addr):
    try:
        line = recv_line(conn)
        if not line.startswith("GET "):
            send_error(conn, "ERROR BADREQUEST"); return
        filename = line[4:].strip()
        print(f"[SERVER1] CLIENT {addr} requested {filename}")

        local = read_local(filename)
        remote = get_from_server2(filename)

        if local and remote:
            if local == remote:
                send_one(conn, local)
                print("[SERVER1] Both matched → sent ONE")
            else:
                send_both(conn, local, remote)
                print("[SERVER1] Versions differ → sent BOTH")
        elif local:
            send_one(conn, local)
            print("[SERVER1] Only SERVER1 had it → sent ONE")
        elif remote:
            send_one(conn, remote)
            print("[SERVER1] Only SERVER2 had it → sent ONE")
        else:
            send_error(conn)
            print("[SERVER1] Not found on either")
    except Exception as e:
        print("[SERVER1] Error:", e)
        try: send_error(conn, "ERROR INTERNAL")
        except: pass

def main():
    with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s1:
        s1.setsockopt(socket.SOL_SOCKET, socket.SO_REUSEADDR, 1)
        s1.bind((HOST, PORT))
        s1.listen()
        print(f"[SERVER1] Listening on {HOST}:{PORT}")
        while True:
            conn, addr = s1.accept()
            with conn: handle_client(conn, addr)
```

```
if __name__ == "__main__":
    main()
```

4) Writing the SERVER2 script

The `server2.py` program is a peer server. Its sole purpose is to serve file content to Server 1 when requested. It doesn't communicate with the client directly, but rather acts as a data source within the distributed network. It listens for requests from server1 on port `5002`.

Code Walkthrough

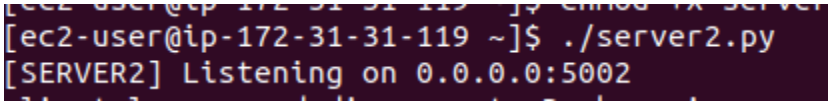
The script uses helper functions for the smooth and error free execution. It uses a `recv_line` function, which is used to receive the request from server1 and send the request as a string to the handle function which is responsible for reading the file path from the `recv_line` function and checks for the filename if it exists. `Send_found` responsible for sending the file to server1 if found and `send_notfound` to let server1 know no such file exists in server2.

How to run it

`SERVER2` is defined to be running on port `5002`, you can start this script on `SERVER2` with the following command on the command prompt:

```
ubuntu@ip-172-31-31-119:~$ ./server2.py
[SERVER2] Listening on 0.0.0.0:5002
```

It will sit listening on port `5002`, handle each incoming server1 request
Screenshot of running SERVER2.py on EC2 instance:



Source Code Listing

```
#!/usr/bin/env python3
import socket, os
HOST = "0.0.0.0"
PORT = 5002
ROOT = os.path.expanduser("~/file_storage")

def recv_line(conn):
```

```
    buf = bytearray()
    while True:
        b = conn.recv(1)
        if not b: break
        buf += b
        if buf.endswith(b"\n"): break
    return bytes(buf).decode(errors="replace").rstrip("\n")

def send_found(conn, data: bytes):
   header = f"FOUND {len(data)}\n".encode()
   conn.sendall(header + data)

def send_notfound(conn):
   conn.sendall(b"NOTFOUND\n")

def handle(conn, addr):
    try:
        line = recv_line(conn)
        if not line.startswith("GET "):
            send_notfound(conn); return
        rel = line[4:].strip().lstrip("/")
        path = os.path.normpath(os.path.join(ROOT, rel))

        if not path.startswith(ROOT):
            send_notfound(conn); return
        if os.path.isfile(path):
            with open(path, "rb") as f: data = f.read()
            send_found(conn, data)
            print(f"[SERVER2] Sent {rel} ({len(data)} bytes) to {addr}")
        else:
            send_notfound(conn)
            print(f"[SERVER2] {rel} not found for {addr}")
        elif local:
            send_one(conn, local)
            print("[SERVER1] Only SERVER1 had it → sent ONE")
        except Exception as e:
            print("[SERVER2] Error:", e)

def main():
    with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
        s1.setsockopt(socket.SOL_SOCKET, socket.SO_REUSEADDR, 1)
        s1.bind((HOST, PORT))
        s1.listen()
```

```
        print(f"[SERVER1] Listening on {HOST}:{PORT}")
        while True:
            conn, addr = s.accept()
            with conn: handle_client(conn, addr)

if __name__ == "__main__":
    main()
```

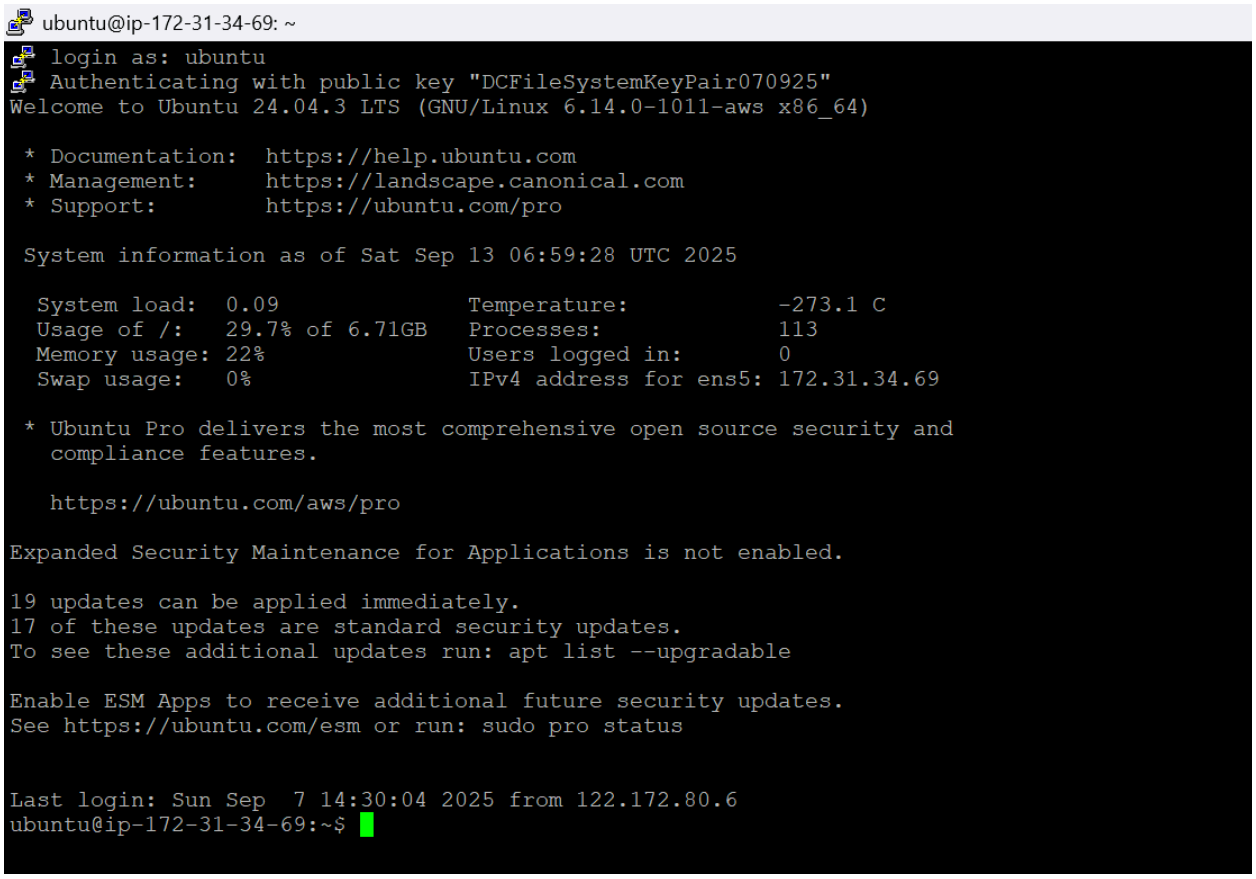
5) Testing

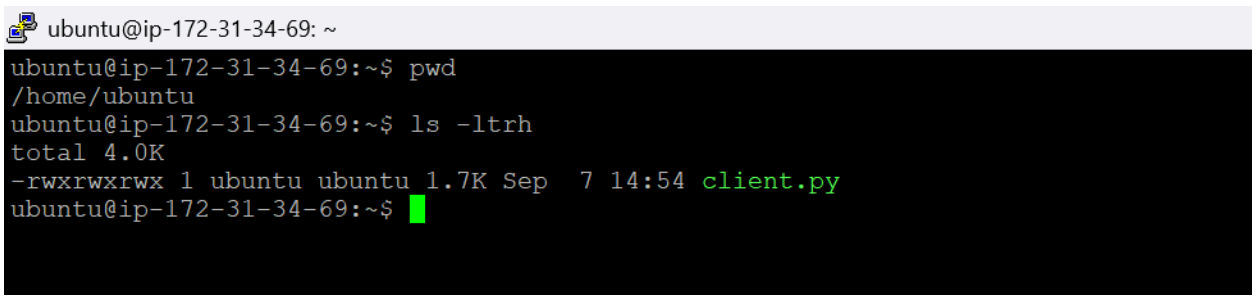
Test Setup

- Different files on SERVER1 and SERVER2 (initial state) → client receives BOTH copies (shows each version).
- Identical files on both servers (edit SERVER2's file to match SERVER1) → client receives ONE copy.
- Nested path provided by client (e.g., docs/report.txt with different contents) → client receives BOTH copies.

Client Machine Setup

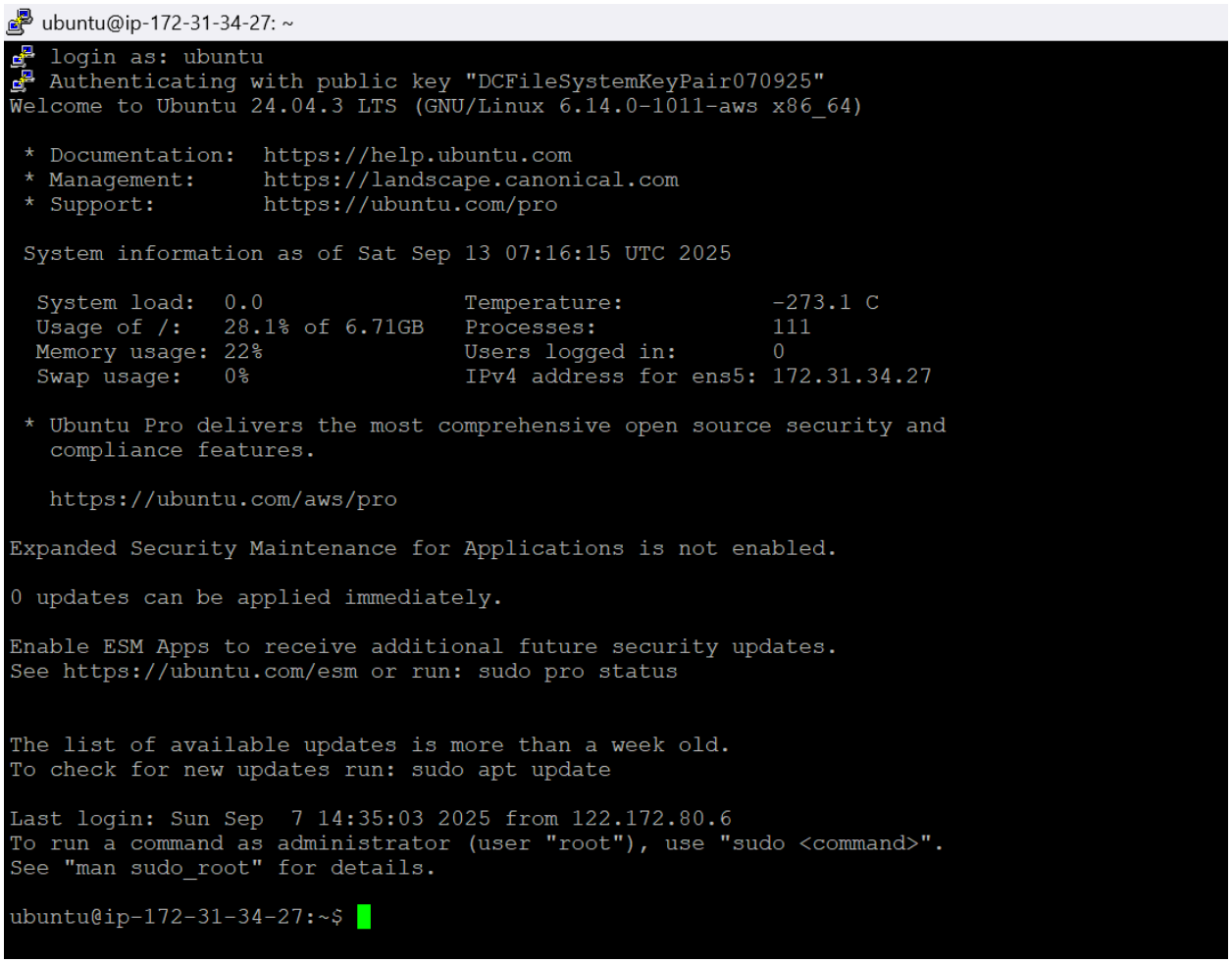
- Configured client machine with the PKF file.
- Created a file client.py in `/home/ubuntu` on the client node.

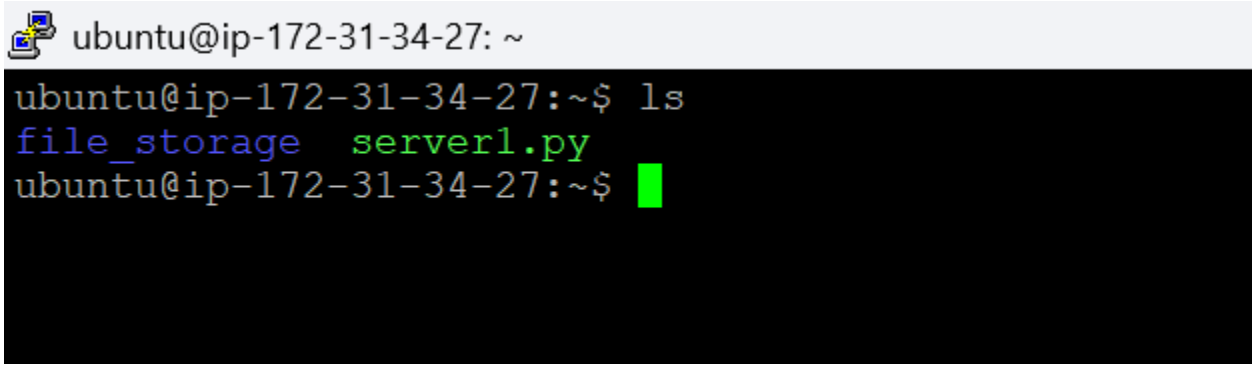


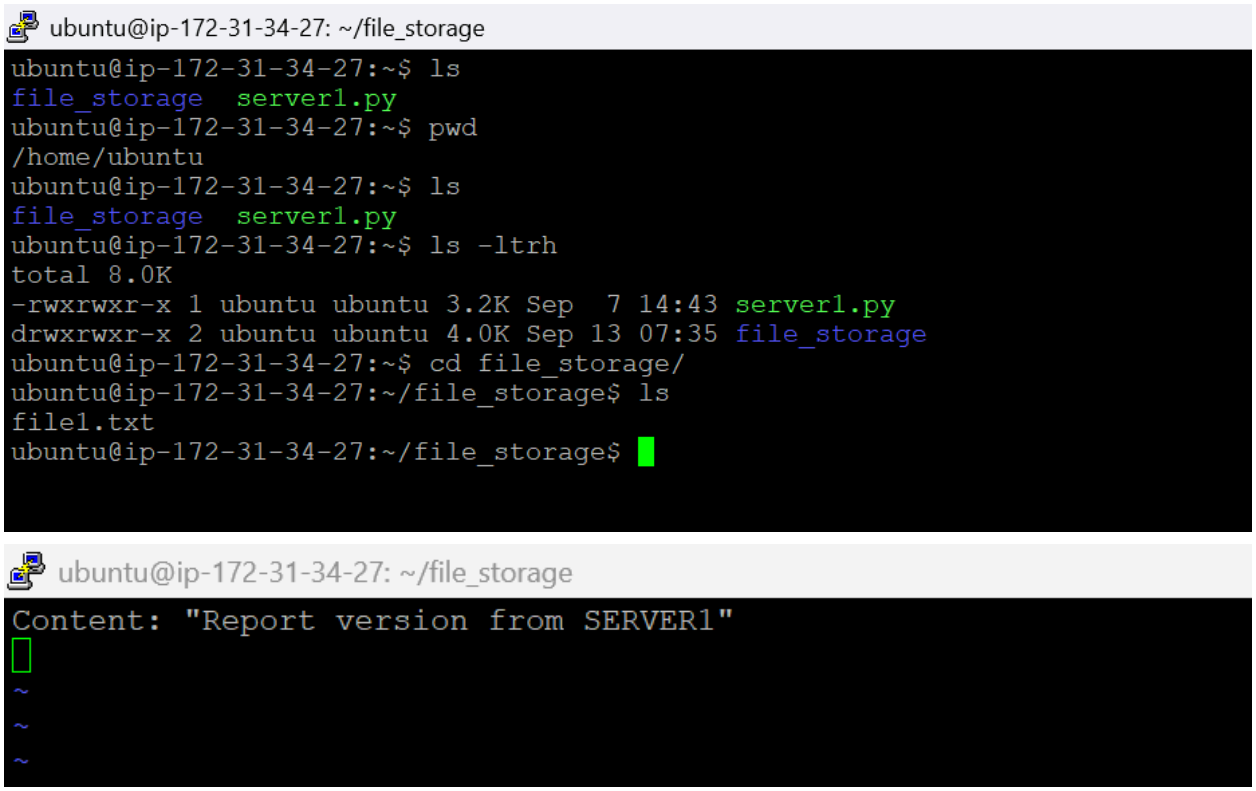


Server1 Setup

1. Configured Server1 using the PKF file.
2. Created a file server1.py in `/home/ubuntu`.
3. Created a directory file_storage in `/home/ubuntu`.
4. Created a file file1.txt inside `/home/ubuntu/file_storage`.

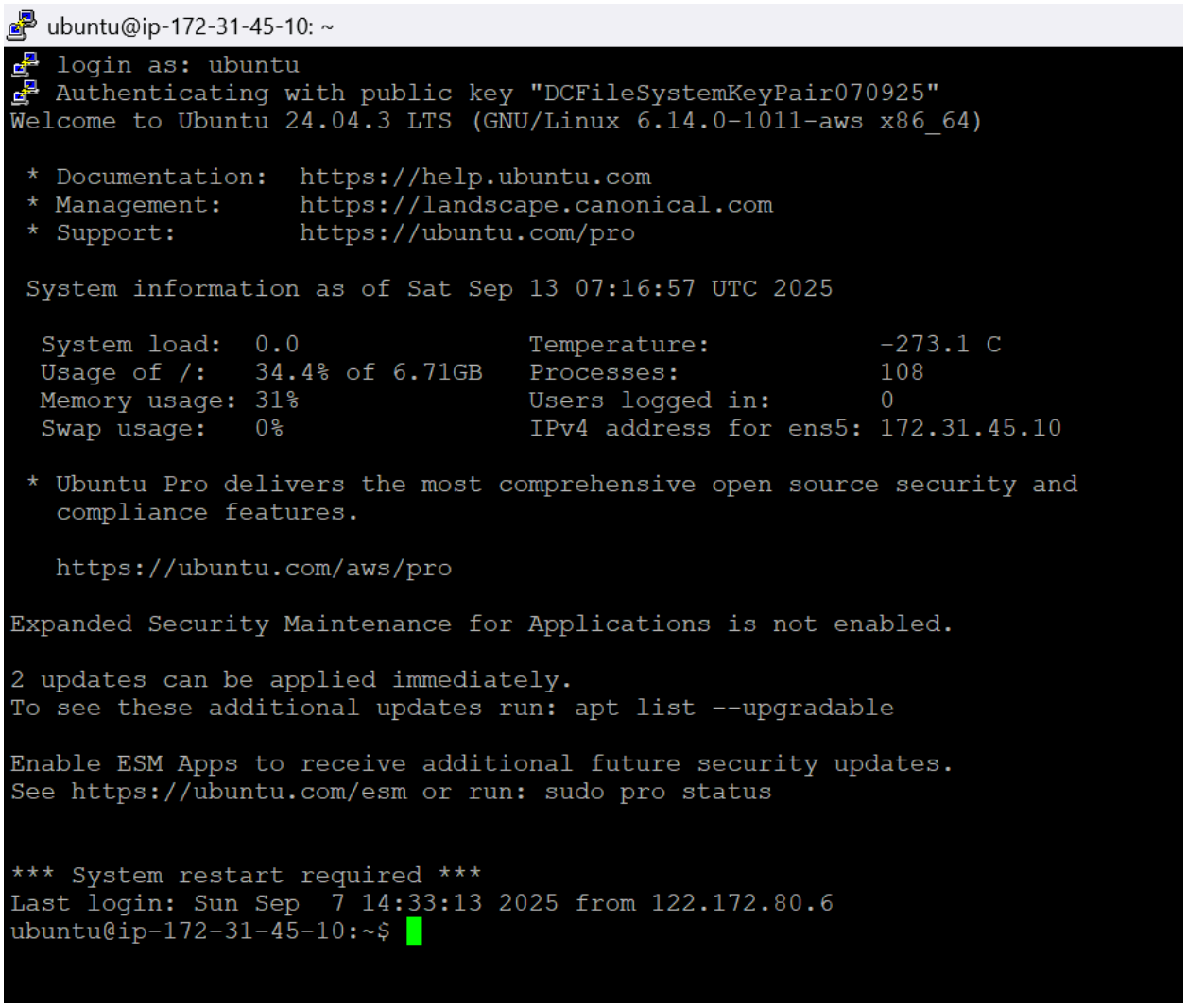

ubuntu@ip-172-31-34-27: ~
login as: ubuntu
Authenticating with public key "DCFileSystemKeyPair070925"
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.14.0-1011-aws x86_64)
* Documentation: https://help.ubuntu.com
* Management: https://landscape.canonical.com
* Support: https://ubuntu.com/pro
System information as of Sat Sep 13 07:16:15 UTC 2025
System load: 0.0
Usage of /: 28.1% of 6.71GB
Memory usage: 22%
Swap usage: 0%
Temperature: -273.1 C
Processes: 111
Users logged in: 0
IPv4 address for ens5: 172.31.34.27
* Ubuntu Pro delivers the most comprehensive open source security and compliance features.
https://ubuntu.com/aws/pro
Expanded Security Maintenance for Applications is not enabled.
0 updates can be applied immediately.
Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status
The list of available updates is more than a week old.
To check for new updates run: sudo apt update
Last login: Sun Sep 7 14:35:03 2025 from 122.172.80.6
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.
ubuntu@ip-172-31-34-27:~$

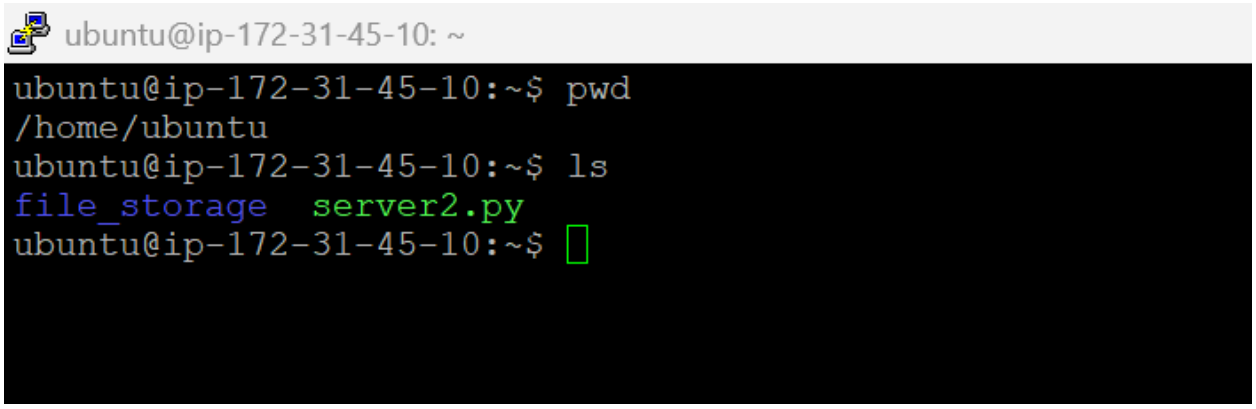

ubuntu@ip-172-31-34-27: ~
ubuntu@ip-172-31-34-27:~$ ls
file_storage server1.py
ubuntu@ip-172-31-34-27:~$

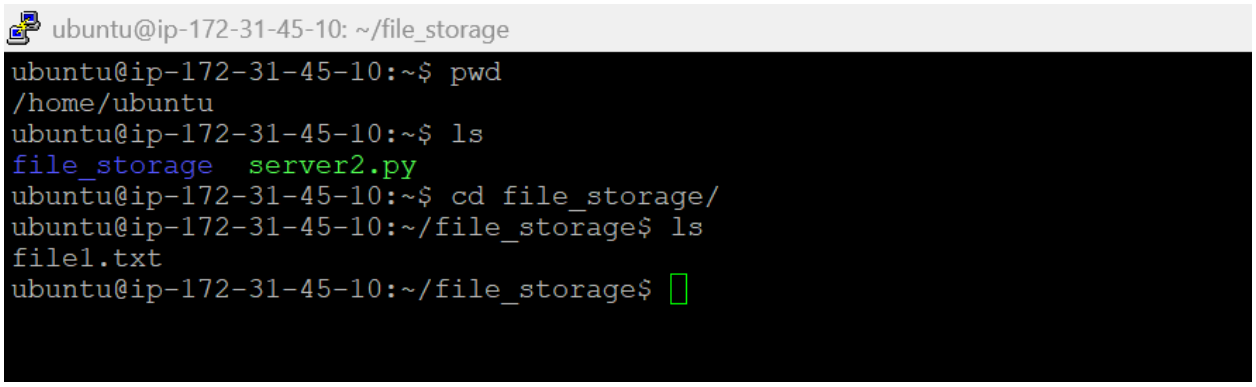


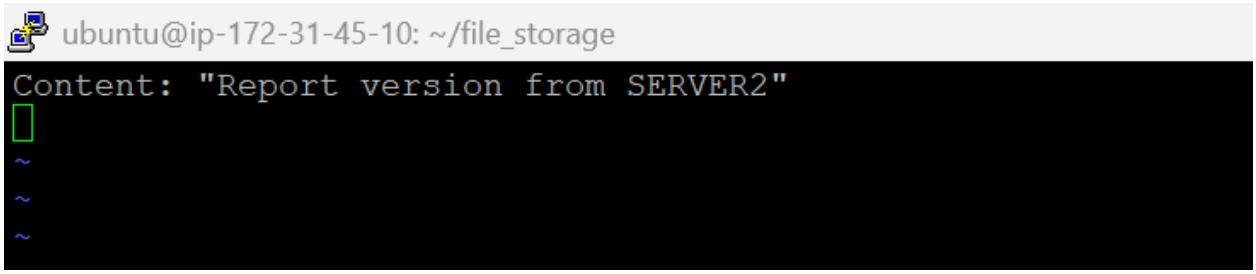
Server2 Setup

1. Configured Server2 using the PKF file.
2. Created a file `server2.py` in `/home/ubuntu`.
3. Created a directory file_storage in `/home/ubuntu`.
4. Created a file `file1.txt` inside `/home/ubuntu/file_storage.`


ubuntu@ip-172-31-45-10: ~
login as: ubuntu
Authenticating with public key "DCFileSystemKeyPair070925"
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.14.0-1011-aws x86_64)
* Documentation: https://help.ubuntu.com
* Management: https://landscape.canonical.com
* Support: https://ubuntu.com/pro
System information as of Sat Sep 13 07:16:57 UTC 2025
System load: 0.0
Usage of /: 34.4% of 6.71GB
Memory usage: 31%
Swap usage: 0%
Temperature: -273.1 C
Processes: 108
Users logged in: 0
IPv4 address for ens5: 172.31.45.10
* Ubuntu Pro delivers the most comprehensive open source security and compliance features.
https://ubuntu.com/aws/pro
Expanded Security Maintenance for Applications is not enabled.
2 updates can be applied immediately.
To see these additional updates run: apt list --upgradable
Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status
*** System restart required ***
Last login: Sun Sep 7 14:33:13 2025 from 122.172.80.6
ubuntu@ip-172-31-45-10:~$


ubuntu@ip-172-31-45-10: ~
ubuntu@ip-172-31-45-10:~$ pwd
/home/ubuntu
ubuntu@ip-172-31-45-10:~$ ls
file_storage server2.py
ubuntu@ip-172-31-45-10:~$



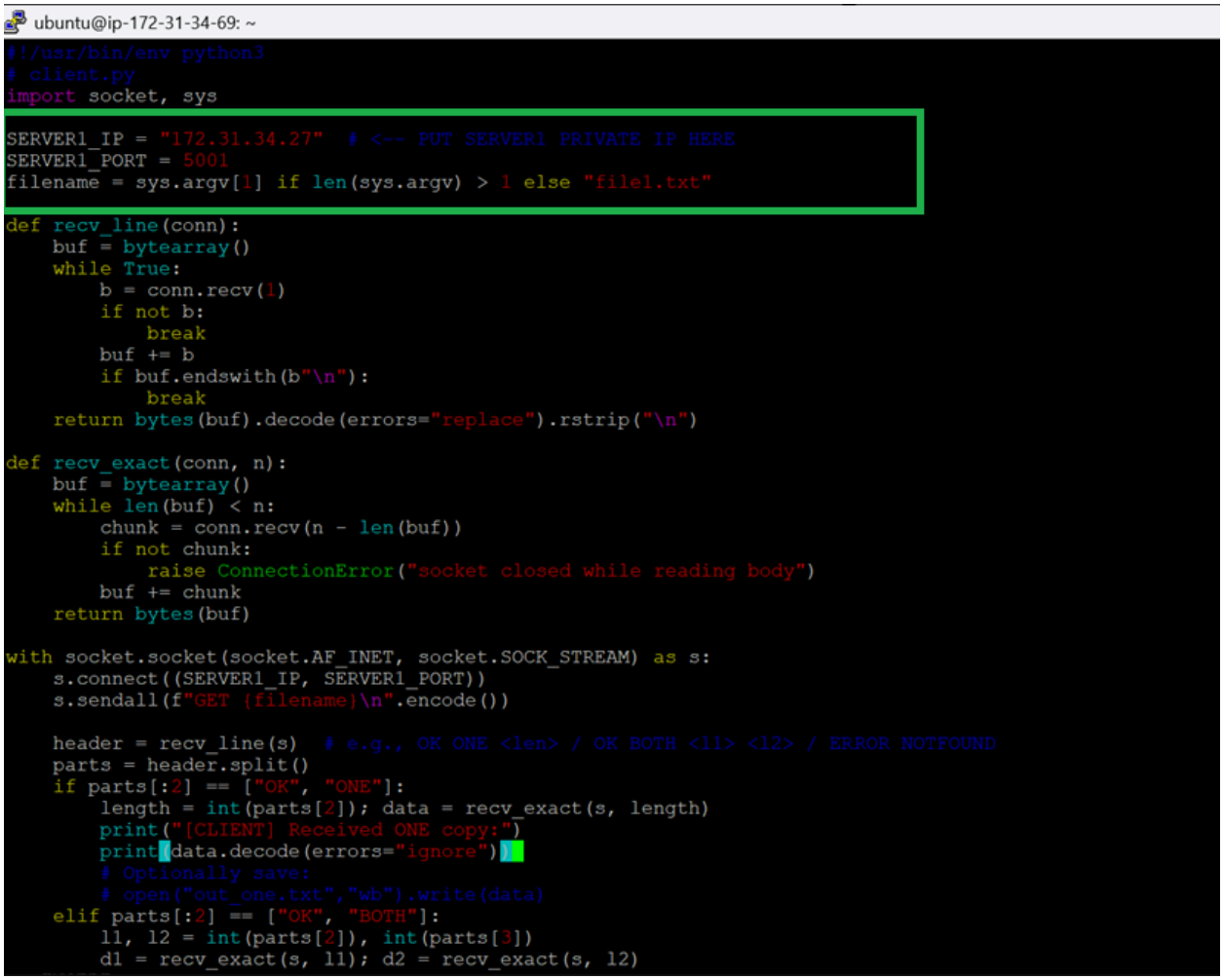


Update the `SERVER2_IP` variable in the server1.py script with the private IP address of Server2.

ubuntu@ip-172-31-34-27: ~

```
#!/usr/bin/env python3
import socket, os

HOST = "0.0.0.0"
PORT = 5001
SERVER2_IP = "172.31.45.10"    # <-- replace with SERVER2 private IP
SERVER2_PORT = 5002
ROOT = os.path.expanduser("~/file_storage")

def recv_line(conn):
    buf = bytearray()
    while True:
        b = conn.recv(1)
        if not b: break
        buf += b
        if buf.endswith(b"\n"): break
    return bytes(buf).decode(errors="replace").rstrip("\n")

def recv_exact(conn, n):
    buf = bytearray()
    while len(buf) < n:
        chunk = conn.recv(n - len(buf))
        if not chunk: raise ConnectionError("socket closed early")
        buf += chunk
    return bytes(buf)

def get_from_server2(filename: str) -> bytes | None:
    try:
        with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s2:
            s2.connect((SERVER2_IP, SERVER2_PORT))
            s2.sendall(f"GET {filename}\n".encode())
            header = recv_line(s2)
            if header == "NOTFOUND": return None
            if header.startswith("FOUND "):
                length = int(header.split()[1])
                return recv_exact(s2, length)
    except Exception as e:
        print("[SERVER1] Error contacting SERVER2:", e)
    return None

def read_local(filename: str) -> bytes | None:
    rel = filename.lstrip("/")
    path = os.path.normpath(os.path.join(ROOT, rel))
```

Update the `SERVER1_IP` variable in the client.py script with the private IP address of Server1.



Test Case1

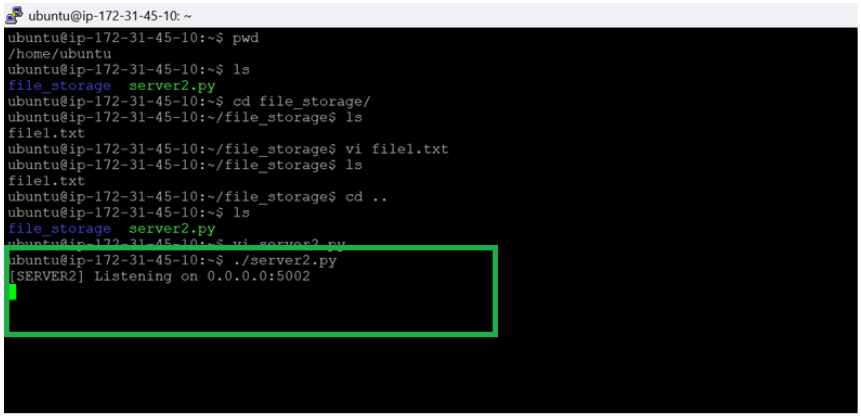
End-to-End Verification of Client–Server File Sync

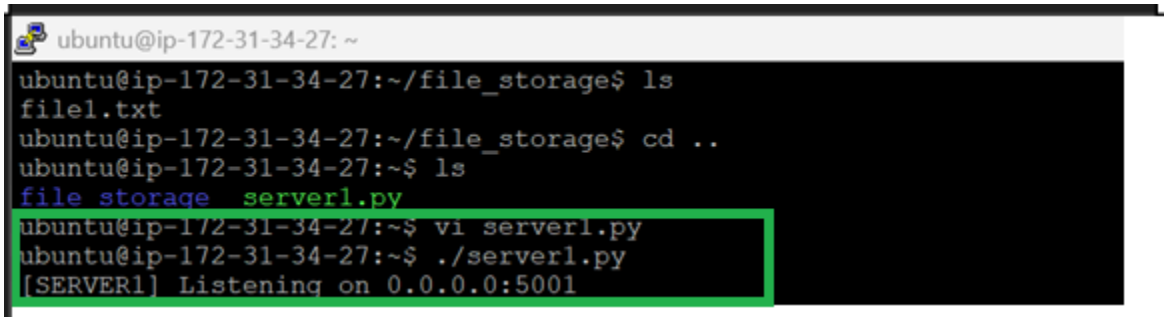
- **Precondition**
    - Server1 (`server1.py`) and Server2 (`server2.py`) are deployed and accessible from the Client.
    - `client.py` is configured to connect to both servers.
    - Test files are available on both the servers .
- **Test Steps**
    - Start **Server1** by running `server1.py`.
    - Start **Server2** by running `server2.py`.
    - Start the **Client** by running `client.py`.

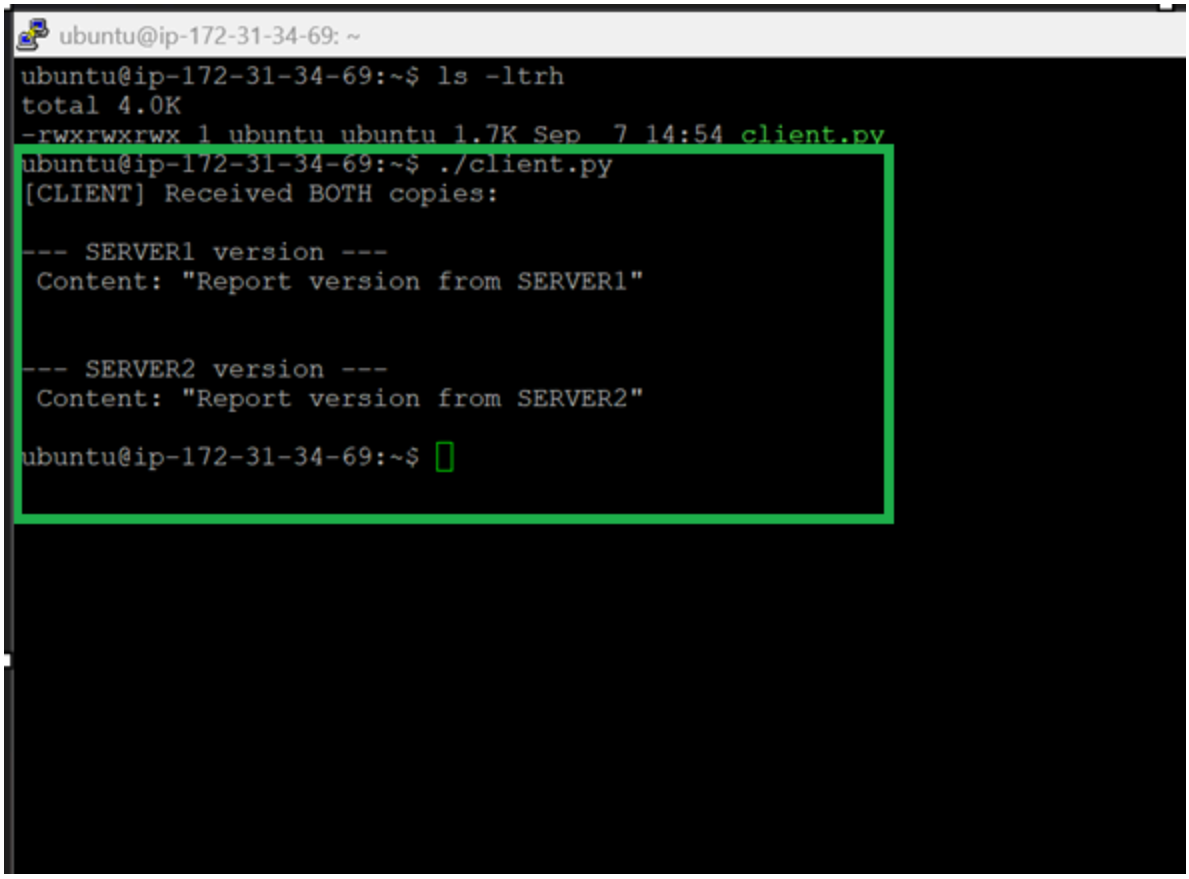
- Initiate file synchronization from the client.

- **Expected Result**

  - The client should successfully connect to both **Server1** and **Server2**.
  - Files from the servers should be visible in the client's file system after sync.
  - When file conflicts exist (e.g., identical files on both servers), synchronization should complete without data loss.







Test Case2

File Read Operation with Missing File on One Server

- **Precondition**

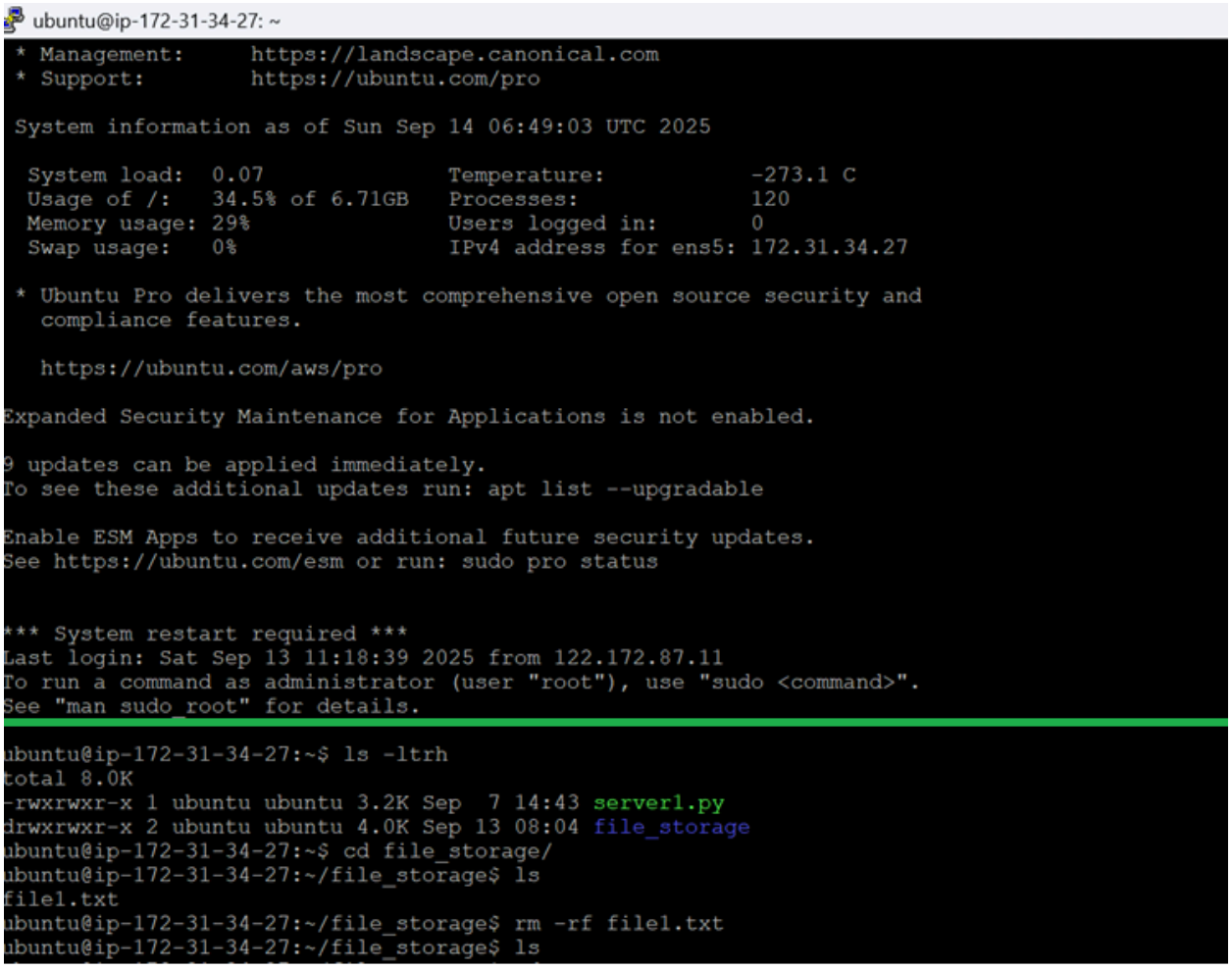
    1. `file1.txt` exists on both Server1 and Server2.
    2. Client, Server1, and Server2 are configured properly with the Python scripts.

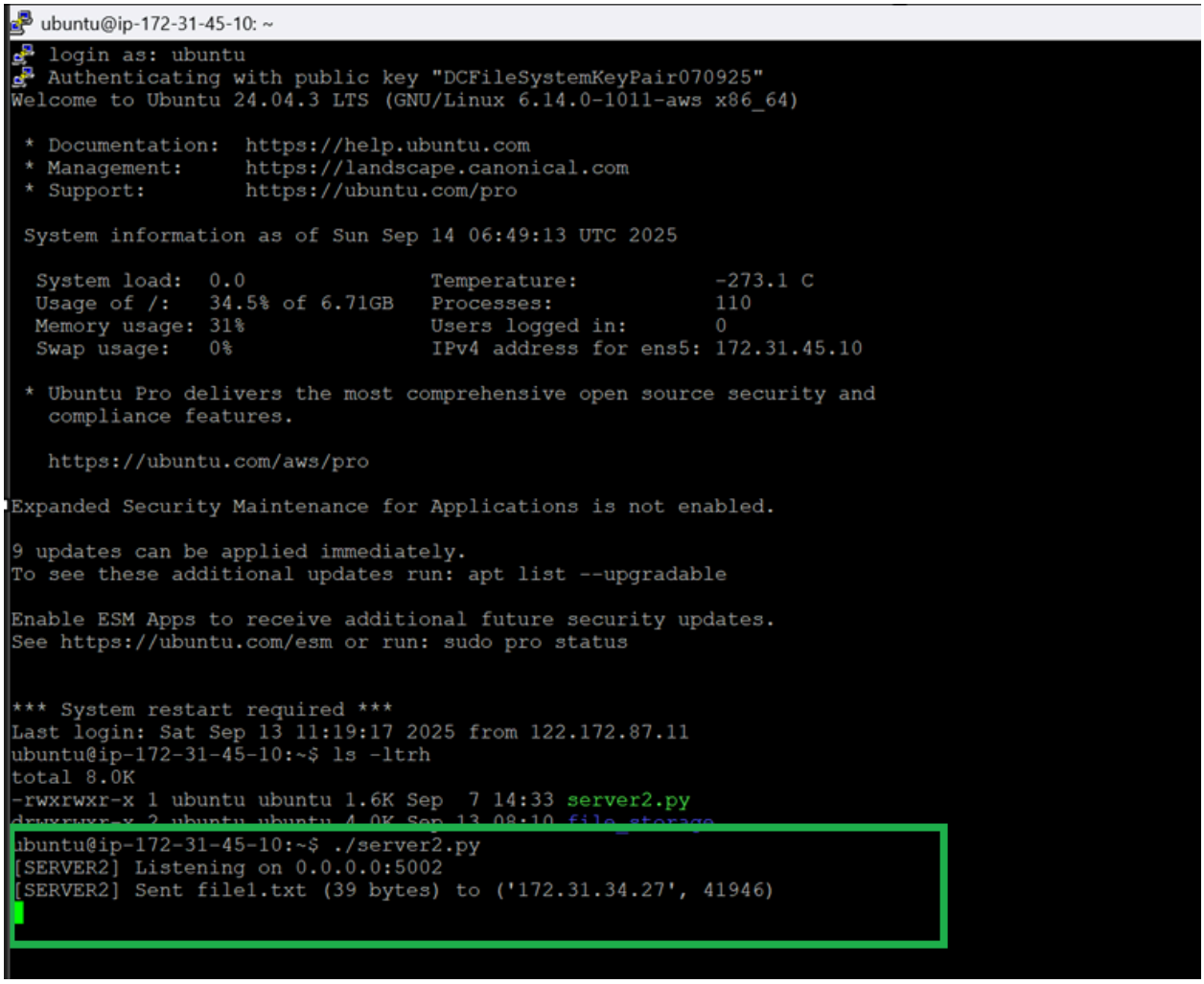
- **Test Steps**

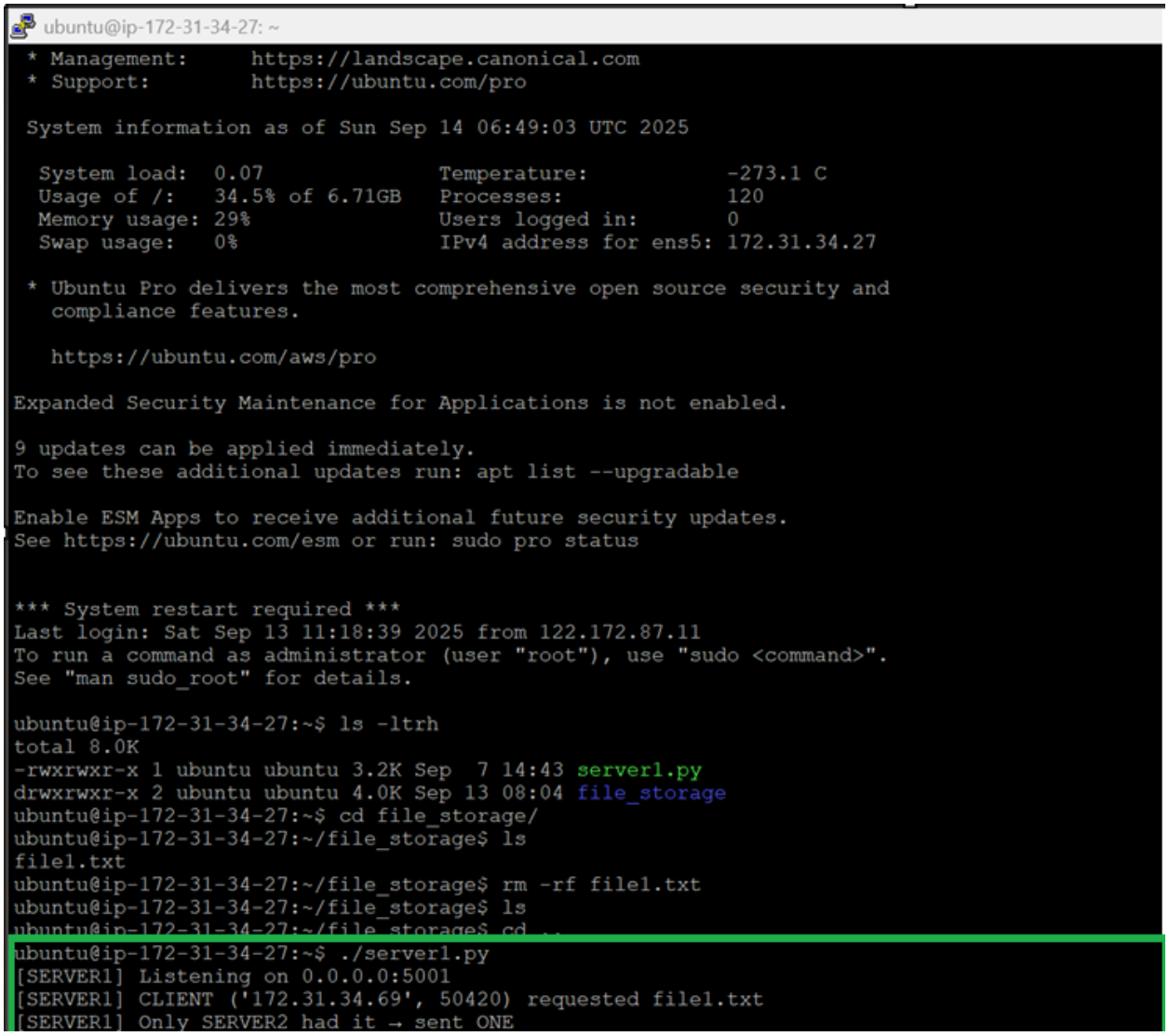
    1. Remove `file1.txt` from **Server1**.
    2. Execute the Python script (client.py) from **Client**.
    3. Execute the Python script (server1.py) from **Server1**.
    4. Execute the Python script (server2.py) from **Server2**.

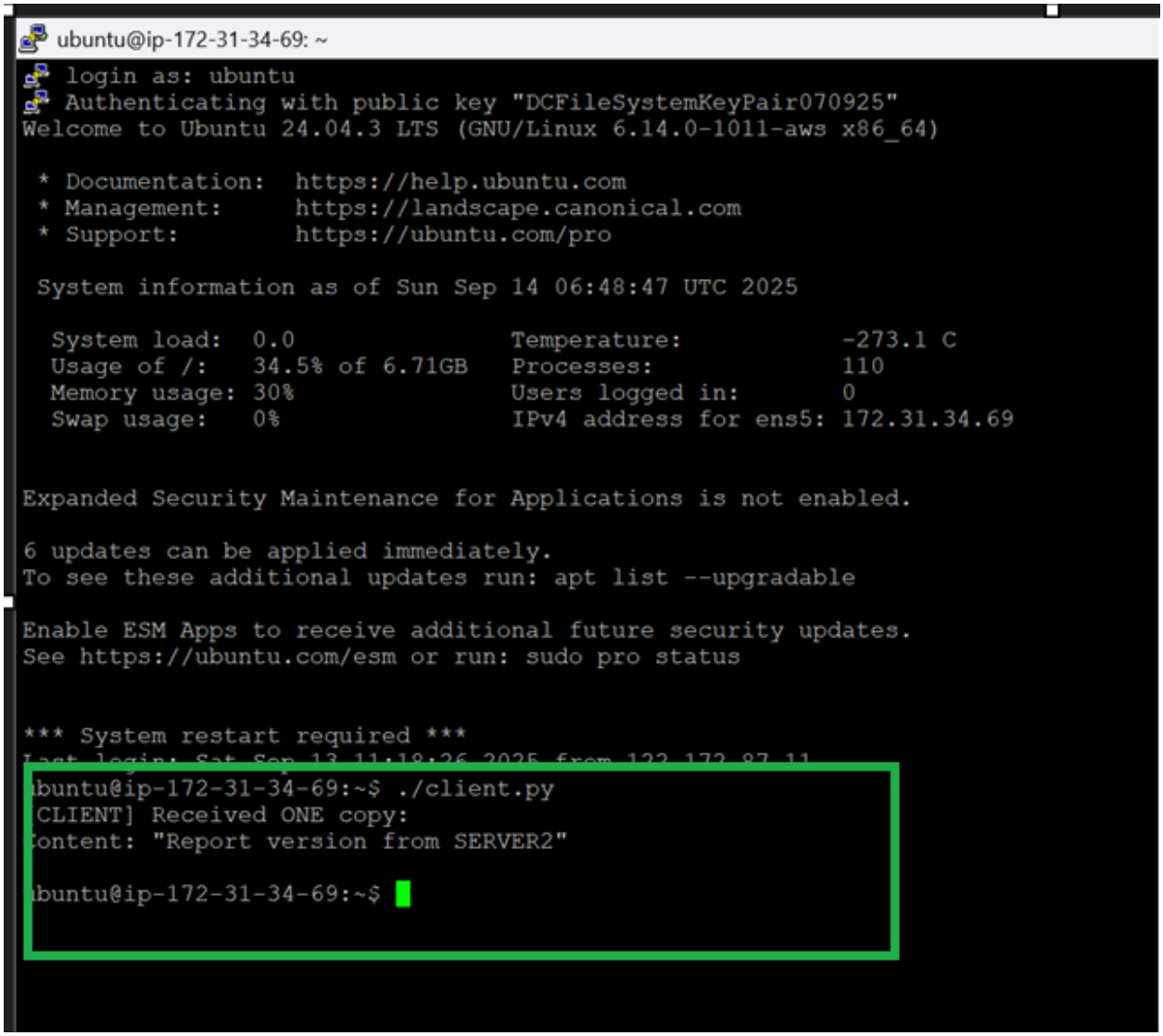
- **Expected Result**

Since `file1.txt` is removed from Server1, the client should successfully read the file content from Server2 as per the configuration.




ubuntu@ip-172-31-45-10: ~
login as: ubuntu
Authenticating with public key "DCFileSystemKeyPair070925"
Welcome to Ubuntu 24.04.3 LTS (GNU/Linux 6.14.0-1011-aws x86_64)
* Documentation: https://help.ubuntu.com
* Management: https://landscape.canonical.com
* Support: https://ubuntu.com/pro
System information as of Sun Sep 14 06:49:13 UTC 2025
System load: 0.0
Usage of /: 34.5% of 6.71GB
Memory usage: 31%
Swap usage: 0%
Temperature: -273.1 C
Processes: 110
Users logged in: 0
IPv4 address for ens5: 172.31.45.10
* Ubuntu Pro delivers the most comprehensive open source security and compliance features.
https://ubuntu.com/aws/pro
Expanded Security Maintenance for Applications is not enabled.
9 updates can be applied immediately.
To see these additional updates run: apt list --upgradable
Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status
*** System restart required ***
Last login: Sat Sep 13 11:19:17 2025 from 122.172.87.11
ubuntu@ip-172-31-45-10:~$ ls -ltrh
total 8.0K
-rwxrwxr-x 1 ubuntu ubuntu 1.6K Sep 7 14:33 server2.py
ubuntu@ip-172-31-45-10:~$ ./server2.py
[SERVER2] Listening on 0.0.0.0:5002
[SERVER2] Sent file1.txt (39 bytes) to ('172.31.34.27', 41946)


ubuntu@ip-172-31-34-27: ~
* Management: https://landscape.canonical.com
* Support: https://ubuntu.com/pro
System information as of Sun Sep 14 06:49:03 UTC 2025
System load: 0.07 Temperature: -273.1 C
Usage of /: 34.5% of 6.71GB Processes: 120
Memory usage: 29% Users logged in: 0
Swap usage: 0% IPv4 address for ens5: 172.31.34.27
* Ubuntu Pro delivers the most comprehensive open source security and compliance features.
https://ubuntu.com/aws/pro
Expanded Security Maintenance for Applications is not enabled.
9 updates can be applied immediately.
To see these additional updates run: apt list --upgradable
Enable ESM Apps to receive additional future security updates.
See https://ubuntu.com/esm or run: sudo pro status
*** System restart required ***
Last login: Sat Sep 13 11:18:39 2025 from 122.172.87.11
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.
ubuntu@ip-172-31-34-27:~$ ls -ltrh
total 8.0K
-rwxrwxr-x 1 ubuntu ubuntu 3.2K Sep 7 14:43 server1.py
drwxrwxr-x 2 ubuntu ubuntu 4.0K Sep 13 08:04 file_storage
ubuntu@ip-172-31-34-27:~$ cd file_storage/
ubuntu@ip-172-31-34-27:~/file_storage$ ls
file1.txt
ubuntu@ip-172-31-34-27:~/file_storage$ rm -rf file1.txt
ubuntu@ip-172-31-34-27:~/file_storage$ ls
ubuntu@ip-172-31-34-27:~/file_storage$ cd ..
ubuntu@ip-172-31-34-27:~$ ./server1.py
[SERVER1] Listening on 0.0.0.0:5001
[SERVER1] CLIENT ('172.31.34.69', 50420) requested file1.txt
[SERVER1] Only SERVER2 had it → sent ONE

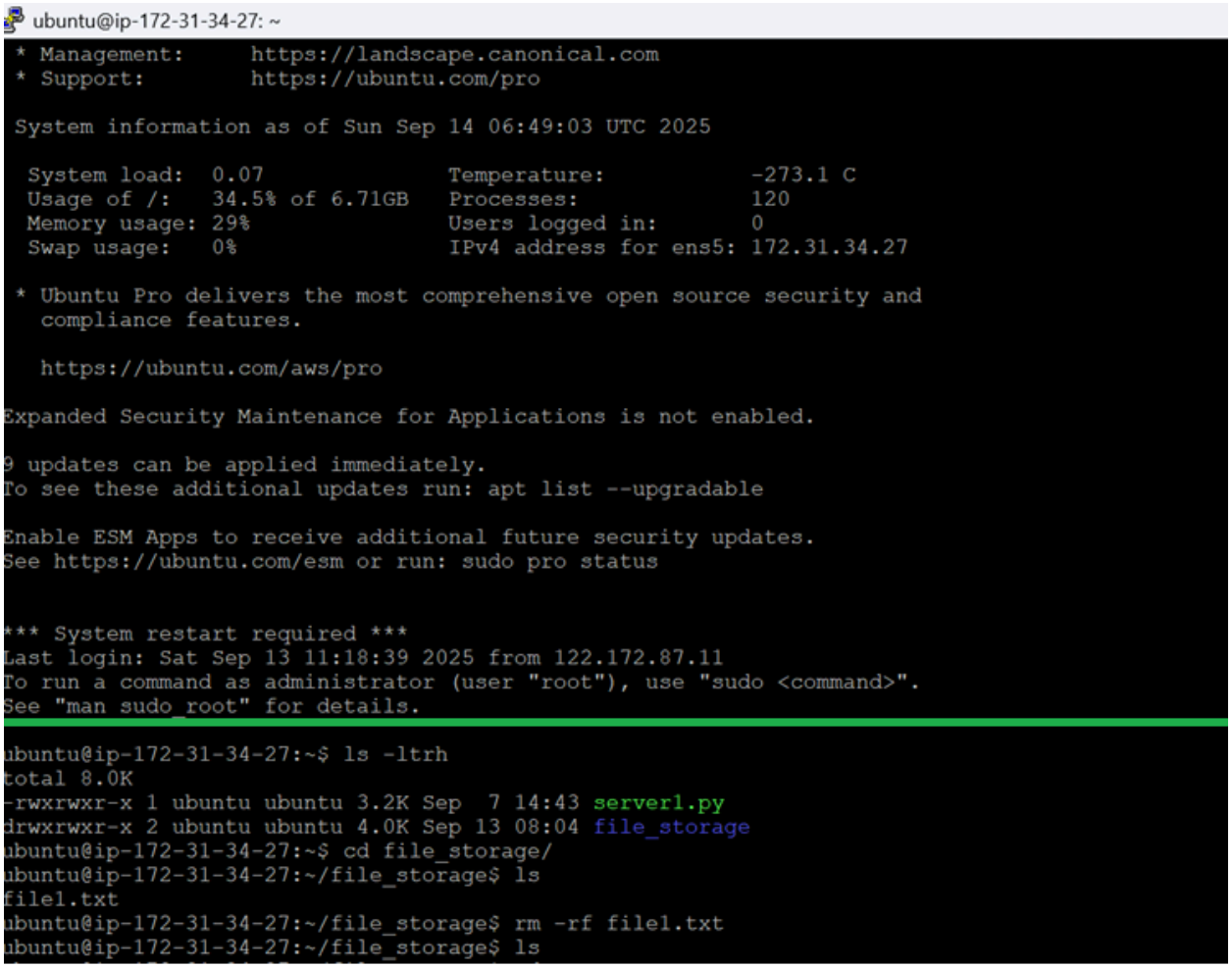


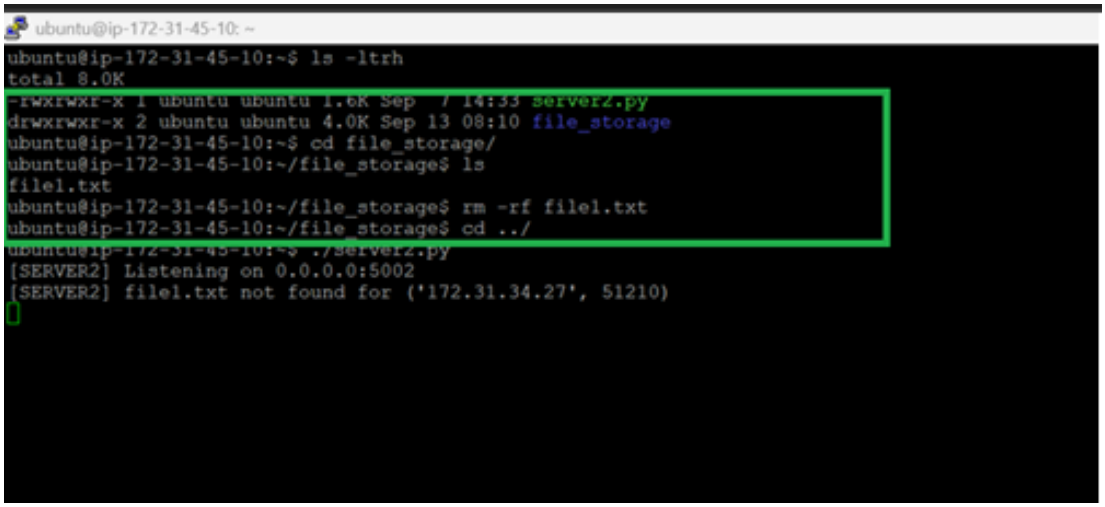
Test Case3

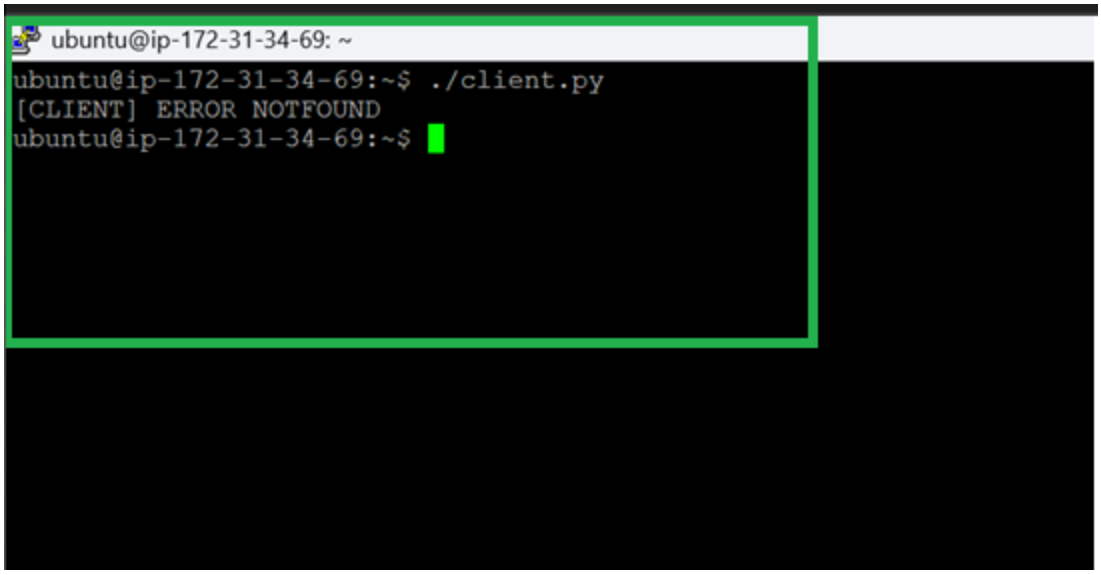
File Read Operation When File Missing on Both Servers

- **Precondition**
    - `file1.txt` is **not present** on either Server1 or Server2.
    - Client, Server1, and Server2 are configured properly with the Python scripts.
- **Test Steps**
    - Ensure `file1.txt` is deleted from **Server1**.
    - Ensure `file1.txt` is deleted from **Server2**.
    - Execute the Python script from the **Client** machine.

- **Expected Result**
    - The client script should fail to retrieve the file from either server.
    - The client should display an error message “[CLIENT] ERROR NOTFOUND”.







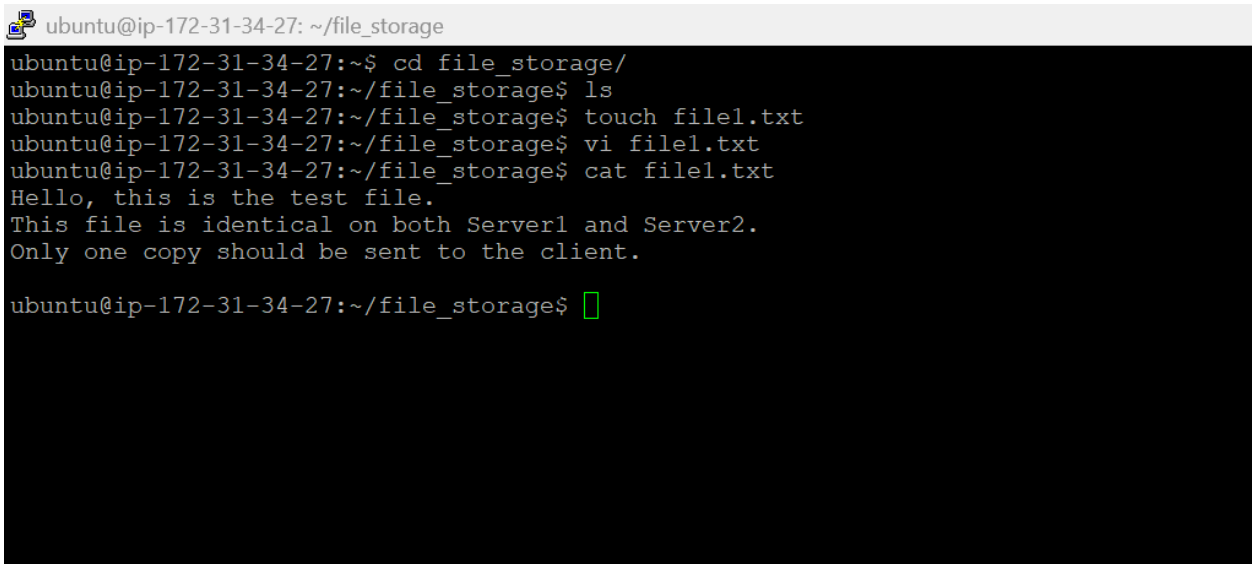
Test Case4

File Read Operation When Servers Have Identical File

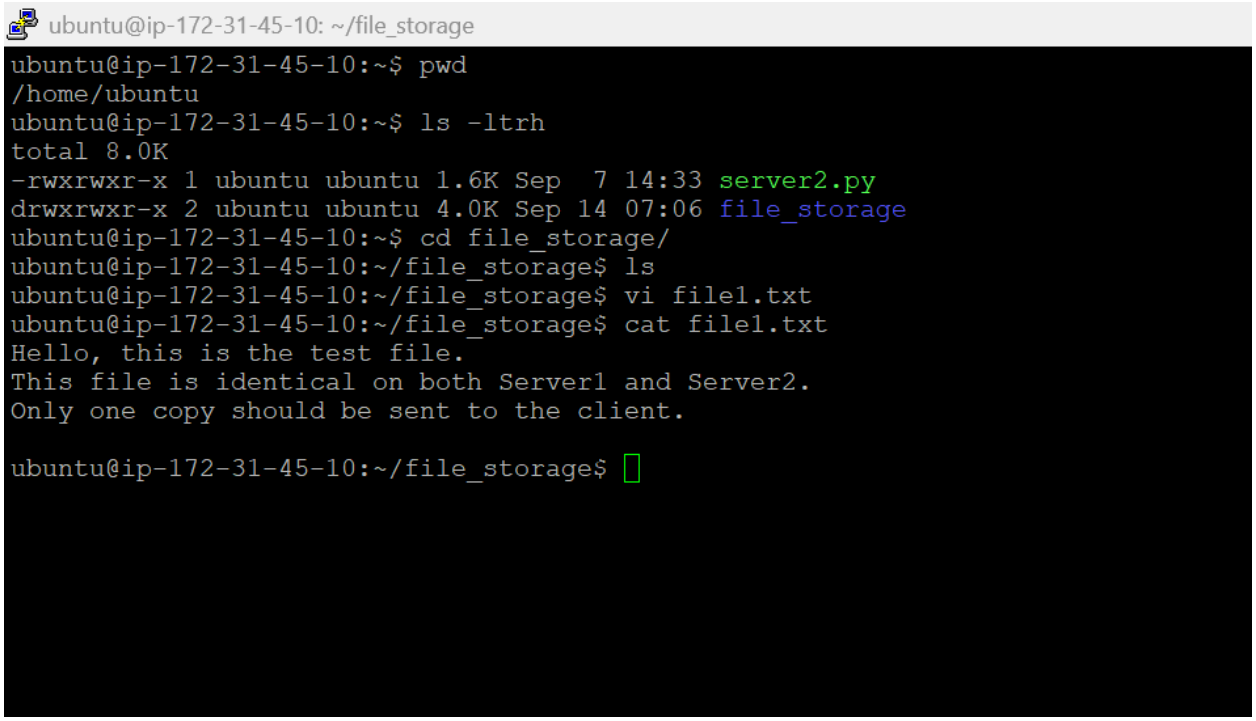
Single Copy Sent by Server1 to client if files are identical both on Server 1 and Server 2.

- **Precondition**
    - `file1.txt` exists on both **Server1** and **Server2** with identical content.
    - Client, Server1, and Server2 are configured properly with the Python scripts.
- **Test Steps**
    - Keep `file1.txt` on **Server1** and **Server2** with the same content.
    - Execute the Python script from the **Client** machine.
    - Server1 should handle the client request and send **one copy** of `file1.txt`.
- **Expected Result**
    - The client should successfully receive and read the file content from **Server1**.
    - The client should **not** receive duplicate copies, even though the file also exists on Server2.
    - Output should show the file content exactly **once**.

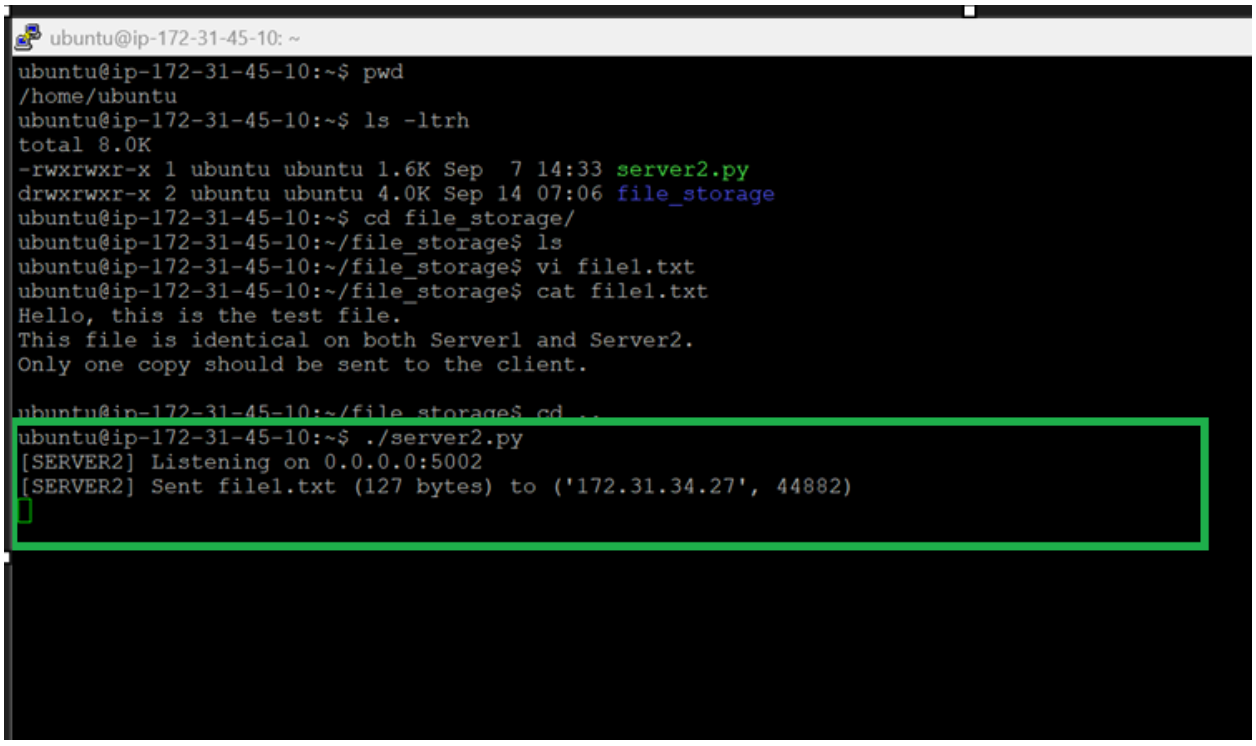
Server1 Content:

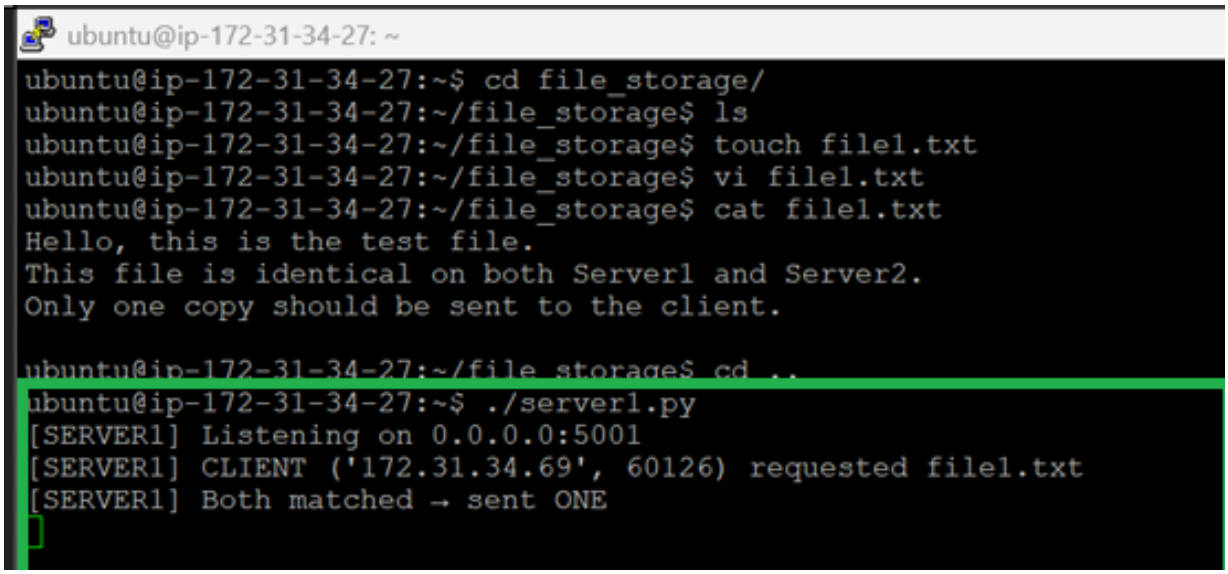


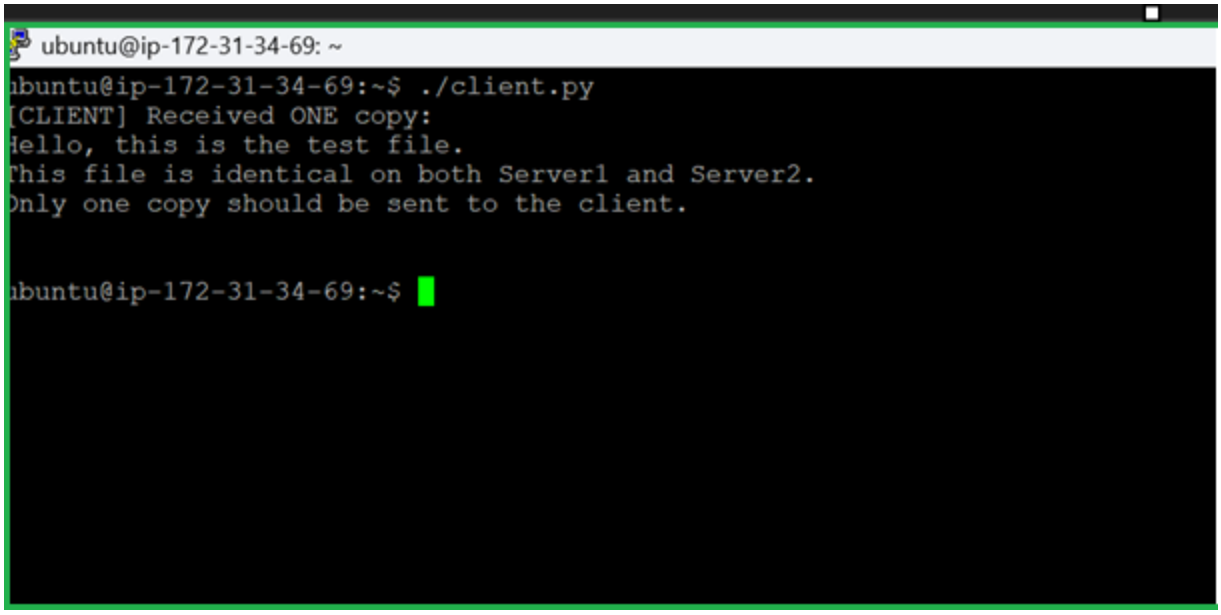
Server2 Content:



Execute scripts client.py, server1.py & server2.py






ubuntu@ip-172-31-34-69: ~
ubuntu@ip-172-31-34-69:~$ ./client.py
[CLIENT] Received ONE copy:
Hello, this is the test file.
This file is identical on both Server1 and Server2.
Only one copy should be sent to the client.
ubuntu@ip-172-31-34-69:~$