

Lab 2

This lab demonstrates how **secure communication works in real networks** using a combination of:

- **RSA (asymmetric encryption)** for secure key exchange
- **AES (symmetric encryption)** for fast data encryption
- **Python sockets** for sending encrypted data between two computers

The lab simulates how secure systems such as **HTTPS and VPNs** protect data in real life.

Generation of public and private keys and saving of the keys

```
with open('private_key.pem', 'rb') as f:
    private_key = serialization.load_pem_private_key(f.read(), password=None)

# Start server
with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
    s.bind(('localhost', 65432))
    s.listen()
    print("🟢 Waiting for connection...")
    conn, addr = s.accept()
    with conn:
        print(f"🔗 Connected by {addr}")
        data = b""
        while True:
            chunk = conn.recv(4096)
            if not chunk:
                break
            data += chunk

# Unpack payload
encrypted_key, iv, encrypted_message = pickle.loads(data)

# 1. Decrypt AES key with RSA private key
aes_key = private_key.decrypt(
    encrypted_key,
    padding.OAEP(
        mgf=padding.MGF1(algorithm=hashes.SHA256()),
        algorithm=hashes.SHA256(),
        label=None
    )
)

# 2. Decrypt message with AES
cipher = Cipher(algorithms.AES(aes_key), modes.CFB(iv))
decryptor = cipher.decryptor()
message = decryptor.update(encrypted_message) + decryptor.finalize()
print("🔒 Decrypted message:", message.decode())
```

[3] Python

... 🟢 Waiting for connection...
🔗 Connected by ('127.0.0.1', 59529)
🔒 Decrypted message: Hello from the secure sender! This is confidential.

Starting the server, unpack the payload and decrypt AES key with RSA private key and decrypt message with AES

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```
private_key.pem
1  -----BEGIN PRIVATE KEY-----
2  MIIEvQIBADANBgkqhkiG9w0BAQEFAASCBAQwggSjAgEAAoIBAQDAj/LHgo+4GPD0
3  QsvwEXULznZ1tQv74ZiWjHDA7Zvp+Lns9AlHczTbj5lSE9wkQthwKiOLi1xh7rw
4  xl8obNs+D4sj/u8usQNXD6RFYAQJtlYenxVocZqYMD2lxXZ5kM0rSA3ArnWAIk7W
5  i2/Iss57jq4idI0LgiZqo0l5x4KapC78nxCgxVj0kF0Iv3tnBdjsBCE6UrPsYZ6a
6  uXF501TtZotWfmYay4jIPsE6YGouijEji7xogmsQna1sMWZ7voHFpL7MwAnsQUSQ
7  U1g0sgVfcJQVTbpFp2F1l9yr7HY96EXun0A7JYrUhdMPjVaR1GpJOMXku4Ln+gv+
8  SJ9A8IjpAgMBAAECggEAXBJ4Gz0qSvRh/Cw0Jw2x0Xte2NlAaadppwT5Vi2oRasY
9  q4EmvRiKq6qYmwUANuqjbpIYBiO+RtKHaCjxxvqFuh7kgMmcw86PskkgWquWQq6U
10 bv/R1KEEFNC8KU9JXscF0vQY31C0qeG9oIf7YxNb92g5iu//oMkSZVmbSudEA3w3
11 LTYJ4S3BXf3m2+ZYyp6W4JL3N8uYv1k9F9YgFNL9avTD79G3YEmzn916UXSpz+5
12 JbyxTOnOtKyYNT85adh458lpVYa+zq/bQEz9wfKMRcUhJW0FVTSL3TzFlp0nqoJD
13 wZGpcpQ8K0/cJITZL8kjp1WEUoiGNktwmBm5mJOFoQKBgQD/k55uXbP6qxHtaMZZ
14 ersBxkpiycthCMKMIJL4P3FxaS8Cjxk96YHKzdm7VyaIV5qt8598Mwo2oqKki9J+
15 YH8Tdn/163hGaM5Jqhz6awUvXd32hyVXlkmOofenChHvk+Pg7GSP6PitZxDEIhno
16 1ioQDON3boV46hN74Jgeea+z2wKBgQDA4Zt4T0rcPtGYQv6Ey2Q4BYhGQaS1GhCY
17 q+qiArpMh4+0CY95pX6PUSivH0f7nAqFXBHMfIsb5ADYQ/CD3fgScP7q5900Mwo
18 e+A+K6G7VmCPvo1JPkjdWJ7QXjAgo1rPPxZvQ9P9nj02KaLD5mPjBeX5oQuNK9Uf
19 N40yZcPziwKBgEAhjabKEoh69s0o/+SiHFZkofPKCSovLAo3fkmWue0o1osg10em
20 2W/HwBLS2pNp0CGIOWPT9uMgy+Qek9Isapa6rH9L9+FLGUB41E6ttbs+BZ1/6gnh
21 Z1g004WJzFHYi1z8VHucDRK0AZIEEJZRbzqZ0VY9wHZH3l2+TM2Q4VrZAoGBAJrZ
22 xZ60UjSGPnE2f+40+H09hU2aT+iRd3eKtgHBnN3qC4dnTkzPveK8KMFHeLCSlfxD
23 X/PXTamKm50K5MLQ9lXcAvrFKzN6gr2kTkC7eMnVLArbVo618XwOs7HnnE3m6m7u
24 YE2Nr/kyfEQoyERq2nNB3glIggBg8XfLH2kk+/HAoGAazHsmRvQdbSToxs63Te3
25 neeoWu4f1LZajXpwhH74XbwovBa8H95oc2nuVFmVZK4VfbSJHmrNT/2BbZ4psN6k
26 xBve2g0PGPsQBIOG+vr1VPMVjn0w45y50w5kWPljExKQvNV0v35uALX5e5PhXYq1
27 Z1NlV0ytKJOyXSD3JAKq2CA=
28  -----END PRIVATE KEY-----
29
```

Begin and end of the generation of the public key

```
public_key.pem X BLACKBOX
public_key.pem
1  -----BEGIN PUBLIC KEY-----
2  MIIBIjANBgkqhkiG9w0BAQEFAAOCAQ8AMIIBCgKCAQEAwI/yx4KPuBjw6ELL8BF1
3  C852dbUL++GSMFoxwW02b6fi57PQJR3M7QY+ZUhpCjELyCcoji4tcYe68MzfKGzb
4  Pg+LI/7vLrEDVw+kRWAEcbZWHP8VaHM6mDA9pcV2eZDNK0gNwK58ACJO1otvyLLO
5  e46uInSNC4ImaqDpeceCmqQu/J8QoMVYzpbDCL97ZwXY7AQh0lKz7GGemrlxeTtU
6  7WalVn5mGsuIyD7B0MBqLoix04u8aIJrEJ2tbDFme76BxaS+zMAJ7KlEkFNYNLI
7  X3CUFU26RadhdZfcq+x2PehF7pzgOyWK1IQzD41WkdRqSTjF5LuC5/oL/kiFQPCI
8  6QIDAQAB
9  -----END PUBLIC KEY-----
10
```

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```
sender.py x
sender.py > ...
1  # sender.py
2  import socket
3  import os
4  from cryptography.hazmat.primitives import serialization, hashes
5  from cryptography.hazmat.primitives.asymmetric import padding
6  from cryptography.hazmat.primitives.ciphers import Cipher, algorithms, modes
7  import pickle
8  # Load recipient's public key
9  with open("public_key.pem", "rb") as f:
10     public_key = serialization.load_pem_public_key(f.read())
11  # Message to send
12  message = b"Hello from the secure sender! This is confidential."
13  # 1. Generate random AES key and IV
14  aes_key = os.urandom(32) # AES-256
15  iv = os.urandom(16)
16  # 2. Encrypt message with AES (CFB mode)
17  cipher = Cipher(algorithms.AES(aes_key), modes.CFB(iv))
18  encryptor = cipher.encryptor()
19  encrypted_message = encryptor.update(message) + encryptor.finalize()
20  # 3. Encrypt AES key with RSA (recipient's public key)
21  encrypted_key = public_key.encrypt(
22      aes_key,
23      padding.OAEP(
24          mgf=padding.MGF1(algorithm=hashes.SHA256()),
25          algorithm=hashes.SHA256(),
26          label=None
27      )
28  )
29  # 4. Package: (encrypted_key, iv, encrypted_message)
30  payload = pickle.dumps((encrypted_key, iv, encrypted_message))
31  # 5. Send via socket
32  with socket.socket(socket.AF_INET, socket.SOCK_STREAM) as s:
33      s.connect(("localhost", 65432))
34      s.sendall(payload)
35  print("✅ Encrypted message sent!")
```

Full code

Group Work

1. Exchange Summaries

Adnan's Selected Roles & Research

- **Roles:** Junior System Administrator (Paysend), System Administrator (RedCloud), Linux Administrator (Infotree Solutions).

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- **Why Adnan Selected:** Adnan focused heavily on **technical alignment**. He chose these roles because they utilise modern technologies, such as Linux, cloud infrastructure, and scripting, which align with his self-taught skills.
- **Appeal:** He finds the opportunity to specialise in **infrastructure and automation** (DevOps, Linux, Cloud) most appealing.
- **Challenge:** He identified that the Fintech environment (Paysend) involves high pressure and fast release cycles, which could be a challenging pace.

My Selected Roles & Research

- **Roles:** Digital Graduate Programme (Sky), Technology Engineering Scheme (Lloyds Banking Group), Support Technician (Stewardship).
 - **Why I Selected:** I prioritised **company culture, values, and structured training**. I chose roles that offer clear graduate development pathways or align with his personal faith and values (Stewardship).
 - **Appeal:** I am attracted to environments that are forward-thinking, people-focused, and offer structured support for learning.
 - **Challenge:** My main challenge is the leap into large-scale engineering projects at major institutions like Lloyds, where the responsibility is significant.
-

2. Compare Skills Gap Analyses

A. Review of Skills Gap Tables

- **Adnan:** His analysis is highly specific and technical. He lists concrete, independent experience with tools like **OpenVPN, Docker, MySQL, and FiveM servers**. His gaps are focused on specific enterprise tools like **Active Directory, AWS/Azure, and virtualisation**.
- **John:** My analysis is broader. I list "Developing" for many areas like **Cloud Technologies, Windows OS Administration, and Incident Management**. His evidence relies primarily on university modules and general project work rather than independent infrastructure management.

B. Shared Skills to Develop & Practical Suggestions

Both of us identified **Cloud Technologies** and **Windows Administration** as key gaps.

Shared Skill Gap	Adnan's Status	My Status	Practical Ways to Strengthen Together

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Cloud Technologies (AWS/Azure)	No experience; plans to use free tiers for VMs.	No experience; plans to take certifications (AWS Cloud Practitioner).	Joint Project: Collaborate to deploy a simple web app (like Adnan's Discord bot or my Node.js app) on a free-tier AWS EC2 instance . Adnan can handle the server config, and I can handle the app deployment pipeline.
Windows Admin & Active Directory	Developing; plans to build a virtual AD lab.	Developing; plans to learn via virtual labs.	Lab Session: We can Build a "Home Lab" together using VirtualBox. Set up Windows Server 2019 (evaluation version), create a domain, and practice adding users and setting Group Policies.

C. Unique Strengths

- Adnan's Unique Strength: Self-Driven Technical Experience.

Adnan has tangible experience running live services (game servers, DDoS mitigation) outside of university. This practical sysadmin experience is a massive standout factor for employers because it proves he can troubleshoot real-world production issues, not just theoretical ones.

- My Unique Strength: Structured Soft Skills & Strategic Fit.

I have a strong foundation in methodologies like Agile and emphasise Communication and Values. This makes him a uniquely strong candidate for Graduate Schemes, which prioritise potential, cultural fit, and trainability over immediate technical prowess.

3. Mutual Feedback

A. Constructive Feedback on Readiness

- **Adnan is** technically ready for **Junior System Admin** roles. His experience with Linux hardening and scripting is exactly what those job descriptions asked for.
 - My Feedback to Adnan: Describe your gaming experience in corporate language.
- I am well-positioned for **Graduate Schemes** because I demonstrate a growth mindset and strong alignment with corporate values.
 - Adnan's Feedback to Me: Do some projects outside the university

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B. Bridging Gaps with University/Extracurriculars

- **University Learning:** We can both use our in-class projects by deploying them to GitHub rather than just running them locally
- **Extracurricular Collaboration:** Adnan can teach me Linux while I help him improve in his Project Management. We could work on a project where he works as a system administrator, and I work as a full-stack developer.

Joint Reflection

Through comparing our career paths and skills, we realised that even though we're aiming for different types of roles, one focusing on graduate digital programmes and the other on system administration, we share many of the same development needs. Both of us recognised the importance of building cloud skills and gaining experience with IT service management tools, as these appear consistently across all our chosen job postings. We also noticed how our strengths complement each other: one of us brings strong communication and customer-focused skills, while the other has deeper hands-on technical experience with servers and scripting. Discussing our skills helped us understand where we are already confident and where we need further growth. We also learned how university projects, technical labs, and extracurricular activities like home labs or volunteering can help bridge the remaining gaps. Overall, the discussion gave both of us clearer direction and confidence in our next steps.