

TECHCRUSH CAPSTONE PROJECT

CAPSTONE PROJECT TOPIC 3

APPLYING CRYPTOGRAPHY IN REAL- WORLD SCENARIOS

Group 9



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Outline



- **Aim and Objective**
- **Methodology**
 - **Concept of project**
 - **Tools Used**
- **Conclusion**
- **References**

Aim and Objective

The aim of this project is to demonstrate the practical application of cryptography in securing data and communication in real world cybersecurity scenarios.

Objectives

- To apply symmetric encryption (AES) to protect data confidentiality
- To use cryptographic hashing to verify data integrity
- To implement asymmetric encryption (RSA) for secure communication
- To understand how cryptographic tools are used in real-world systems

Concept of the Project

- Cryptography is a core component of cybersecurity used to protect information from unauthorized access, alteration, or impersonation. This project explores three major cryptographic concepts:
- Symmetric Encryption for protecting data using a shared secret
- Hashing for verifying data integrity and detecting tampering
- Asymmetric Encryption for secure communication using public and private keys
- These techniques collectively ensure the confidentiality, integrity, and authenticity of information in modern digital systems.

METHODOLOGY

- The project was carried out using a hands on, command line based approach with OpenSSL. The following steps were followed:

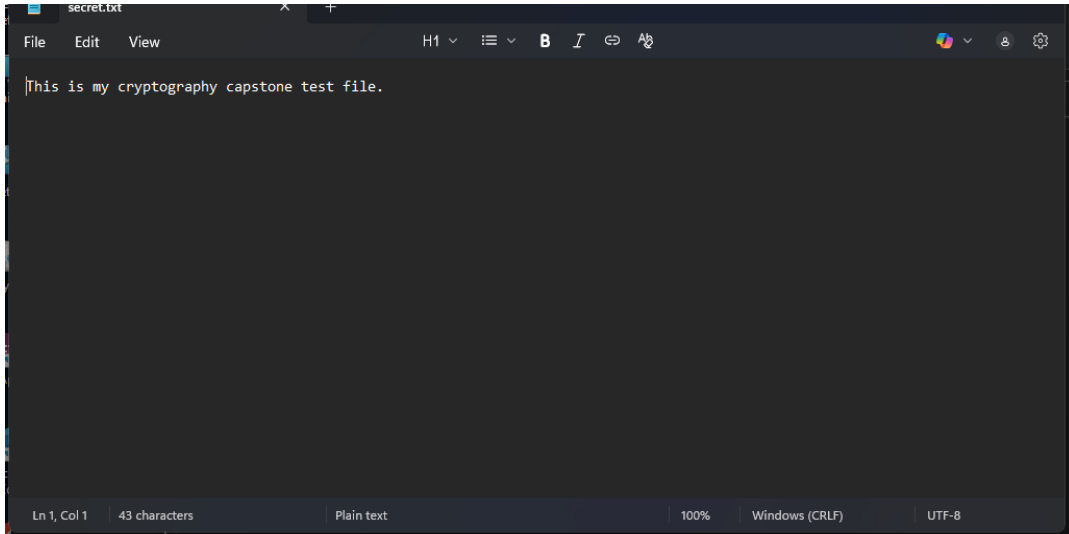
- **Step 1: Symmetric Encryption (AES)**

- A plaintext file (secret.txt) was created.
- The file was encrypted using AES-256-CBC.
- The encrypted file was decrypted using the same password.
- Commands Used:

For Encryption; **openssl enc-aes-256-salt-in secret.txt-out secret.enc**

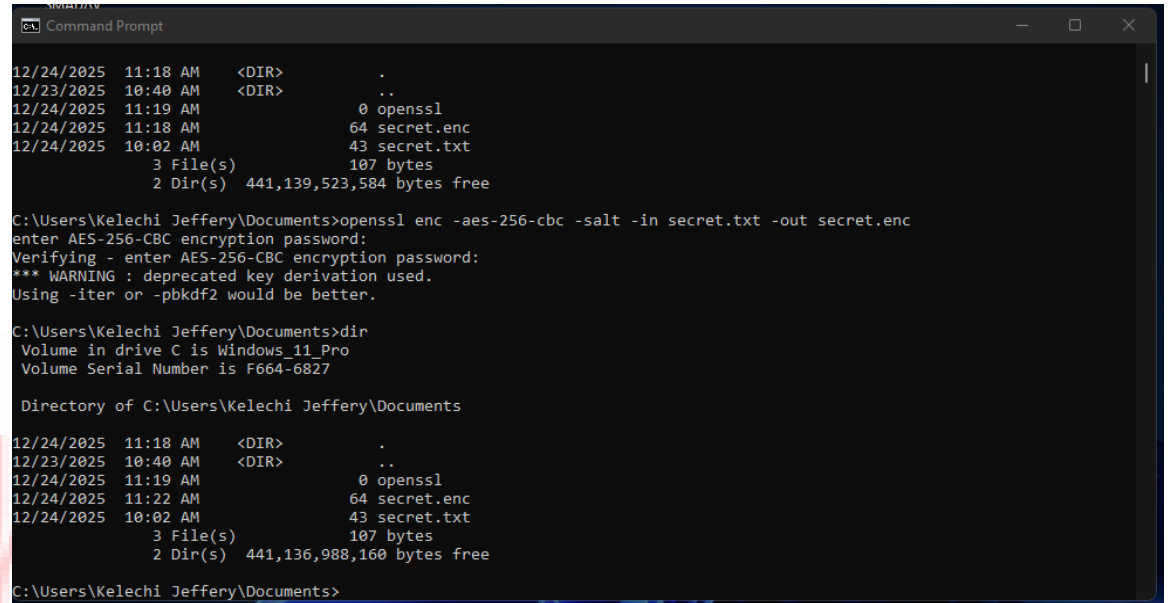
For Decryption; **openssl enc-aes-256-cbc-d-in-secret.enc-out decrypted.txt**

Plaintext file before encryption



```
secret.txt
File Edit View H1 B I A
This is my cryptography capstone test file.
Ln 1, Col 1 43 characters Plain text 100% Windows (CRLF) UTF-8
```

Encrypted file (secret.enc)



```
Command Prompt
12/24/2025 11:18 AM <DIR> .
12/23/2025 10:40 AM <DIR> ..
12/24/2025 11:19 AM 0 openssl
12/24/2025 11:18 AM 64 secret.enc
12/24/2025 10:02 AM 43 secret.txt
3 File(s) 107 bytes
2 Dir(s) 441,139,523,584 bytes free

C:\Users\Kelechi Jeffery\Documents>openssl enc -aes-256-cbc -salt -in secret.txt -out secret.enc
enter AES-256-CBC encryption password:
Verifying - enter AES-256-CBC encryption password:
*** WARNING : deprecated key derivation used.
Using -iter or -pbkdf2 would be better.

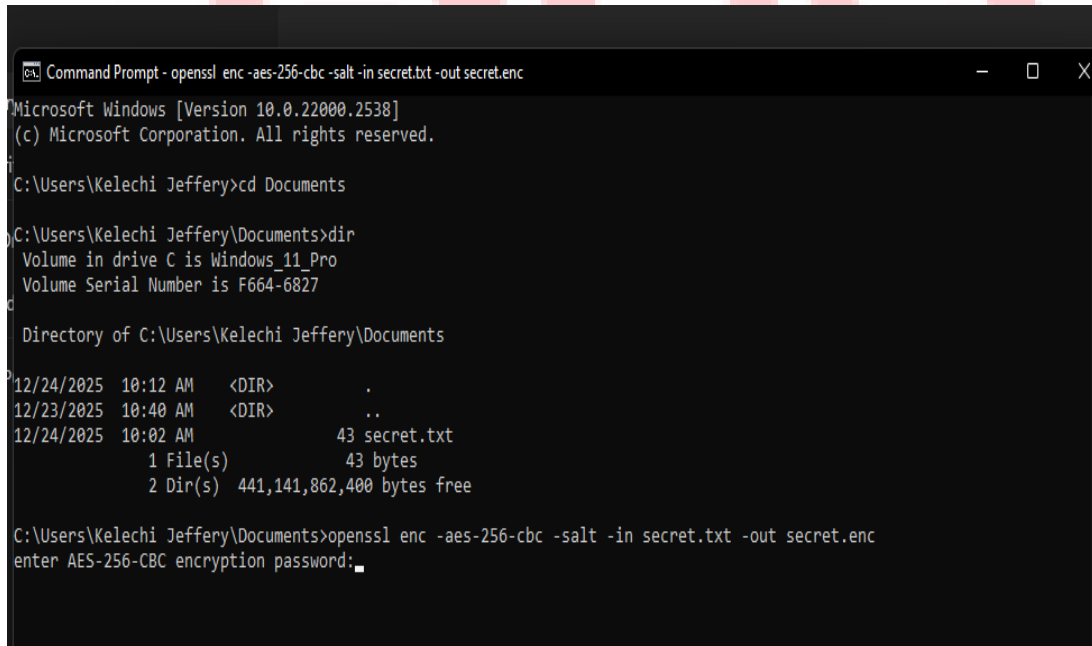
C:\Users\Kelechi Jeffery\Documents>dir
Volume in drive C is Windows_11_Pro
Volume Serial Number is F664-6827

Directory of C:\Users\Kelechi Jeffery\Documents

12/24/2025 11:18 AM <DIR> .
12/23/2025 10:40 AM <DIR> ..
12/24/2025 11:19 AM 0 openssl
12/24/2025 11:22 AM 64 secret.enc
12/24/2025 10:02 AM 43 secret.txt
3 File(s) 107 bytes
2 Dir(s) 441,136,988,160 bytes free

C:\Users\Kelechi Jeffery\Documents>
```

AES encryption command execution



```
Command Prompt - openssl enc -aes-256-cbc -salt -in secret.txt -out secret.enc
Microsoft Windows [Version 10.0.22000.2538]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Kelechi Jeffery>cd Documents

C:\Users\Kelechi Jeffery\Documents>dir
Volume in drive C is Windows_11_Pro
Volume Serial Number is F664-6827

Directory of C:\Users\Kelechi Jeffery\Documents

12/24/2025 10:12 AM <DIR> .
12/23/2025 10:40 AM <DIR> ..
12/24/2025 10:02 AM 43 secret.txt
1 File(s) 43 bytes
2 Dir(s) 441,141,862,400 bytes free

C:\Users\Kelechi Jeffery\Documents>openssl enc -aes-256-cbc -salt -in secret.txt -out secret.enc
enter AES-256-CBC encryption password: _
```

```
Command Prompt
Microsoft Windows [Version 10.0.22000.2538]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Kelechi Jeffery>cd Documents

C:\Users\Kelechi Jeffery\Documents>dir
Volume in drive C is Windows_11_Pro
Volume Serial Number is F664-6827

Directory of C:\Users\Kelechi Jeffery\Documents

12/24/2025  11:48 AM    <DIR>          .
12/23/2025  10:40 AM    <DIR>          ..
12/24/2025  10:02 AM                43 secret.txt
               1 File(s)              43 bytes
               2 Dir(s)  441,113,042,944 bytes free

C:\Users\Kelechi Jeffery\Documents>openssl enc -aes-256-cbc -salt -pbkdf2 -in secret.txt -out secret.enc
enter AES-256-CBC encryption password:
Verifying - enter AES-256-CBC encryption password:

C:\Users\Kelechi Jeffery\Documents>openssl enc -d -aes-256-cbc -pbkdf2 -in secret.enc -out decrypted.txt
enter AES-256-CBC decryption password:

C:\Users\Kelechi Jeffery\Documents>
```

```
Command Prompt
Microsoft Windows [Version 10.0.22000.2538]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Kelechi Jeffery>cd Documents

C:\Users\Kelechi Jeffery\Documents>dir
Volume in drive C is Windows_11_Pro
Volume Serial Number is F664-6827

Directory of C:\Users\Kelechi Jeffery\Documents

12/24/2025  04:30 PM    <DIR>          .
12/23/2025  10:40 AM    <DIR>          ..
12/24/2025  04:30 PM                43 decrypted.txt
12/24/2025  04:19 PM                64 secret.enc
12/24/2025  10:02 AM                43 secret.txt
               3 File(s)              150 bytes
               2 Dir(s)  440,788,865,024 bytes free

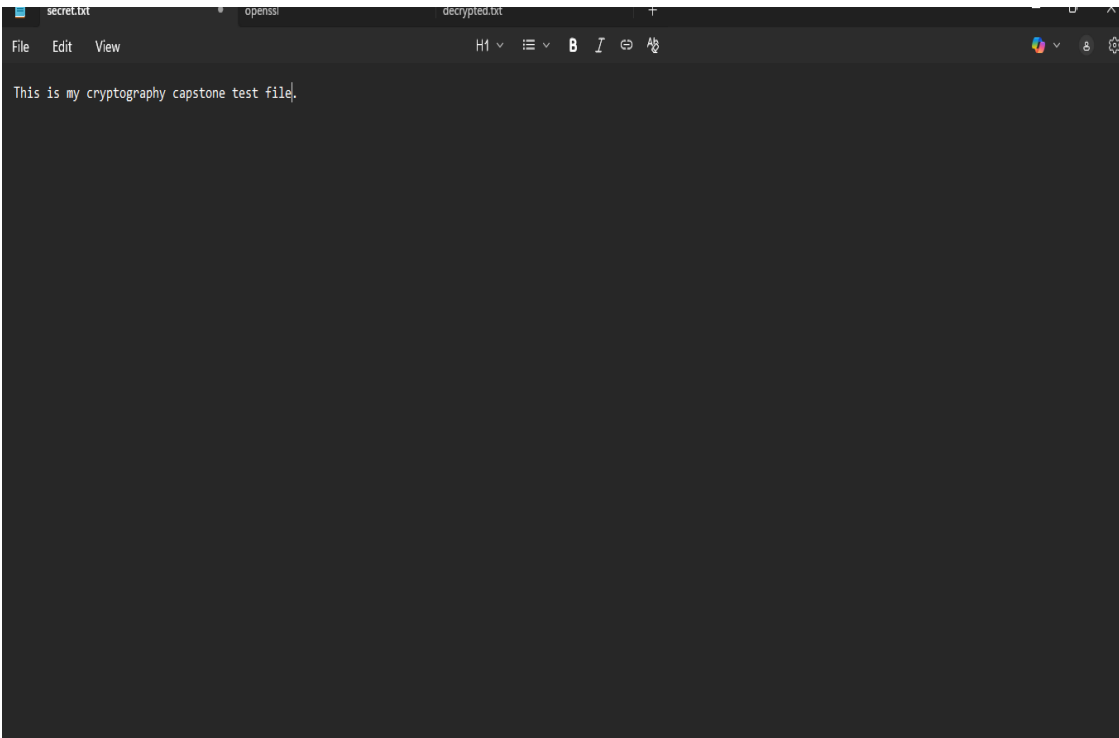
C:\Users\Kelechi Jeffery\Documents>openssl dgst -sha256 secret.txt
SHA2-256(secret.txt)= 5adae6408af5e1987d7f82a61136d7c00274765a33b3232a41248b4c629dee52

C:\Users\Kelechi Jeffery\Documents>
```

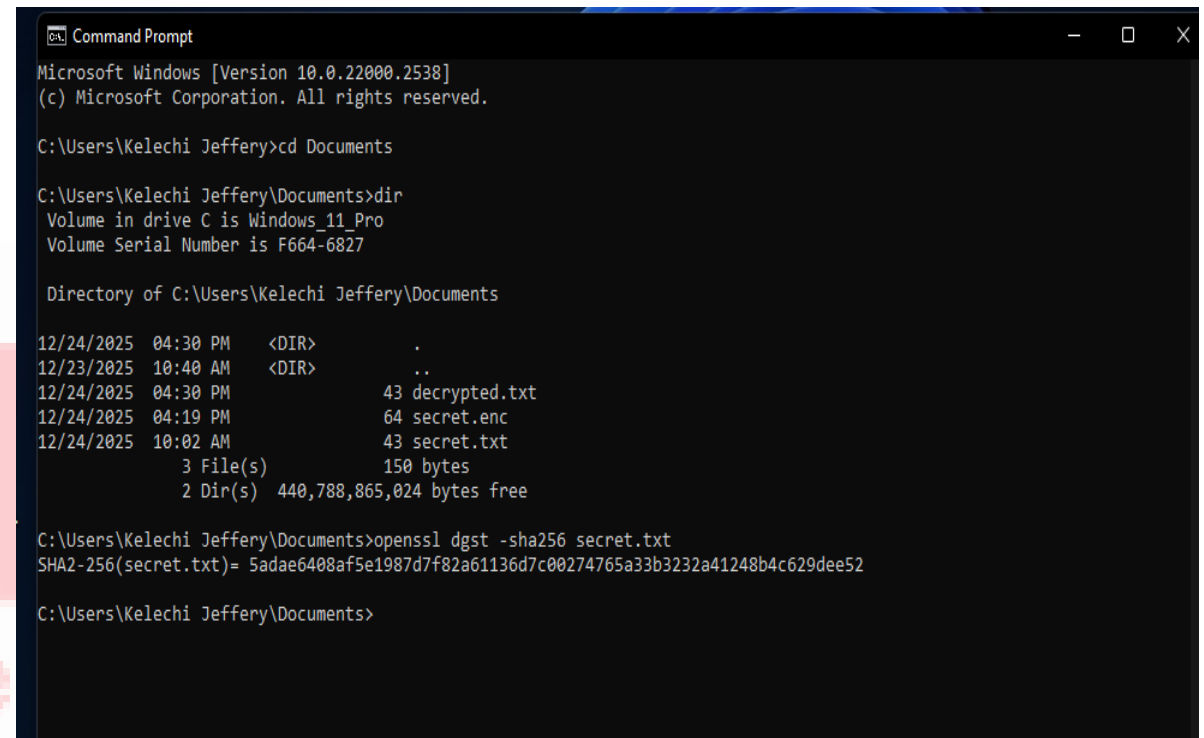
Decrypted output file



- **Step 2: Hashing and Integrity Checking**
- **A SHA-256 hash was generated for the original file.**
- **The file was modified slightly.**
- **A new hash was generated to show how the hash value changes.**
- **Command Used:**
- ***openssl dgst -sha256 secret.txt***



```
secret.txt
This is my cryptography capstone test file.
```



```
Command Prompt
Microsoft Windows [Version 10.0.22000.2538]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Kelechi Jeffery>cd Documents

C:\Users\Kelechi Jeffery\Documents>dir
Volume in drive C is Windows_11_Pro
Volume Serial Number is F664-6827

Directory of C:\Users\Kelechi Jeffery\Documents

12/24/2025  04:30 PM    <DIR>          .
12/23/2025  10:40 AM    <DIR>          ..
12/24/2025  04:30 PM                43 decrypted.txt
12/24/2025  04:19 PM                64 secret.enc
12/24/2025  10:02 AM                43 secret.txt
               3 File(s)                150 bytes
               2 Dir(s)  440,788,865,024 bytes free

C:\Users\Kelechi Jeffery\Documents>openssl dgst -sha256 secret.txt
SHA2-256(secret.txt)= 5adae6408af5e1987d7f82a61136d7c00274765a33b3232a41248b4c629dee52

C:\Users\Kelechi Jeffery\Documents>
```

The hash value of the file secret.txt

```
File Edit View H1  B I  A
This is my cryptography capstone test file added.
```

Modified file

```
Command Prompt
Microsoft Windows [Version 10.0.22000.2538]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Kelechi Jeffery>cd Documents

C:\Users\Kelechi Jeffery\Documents>dir
Volume in drive C is Windows_11_Pro
Volume Serial Number is F664-6827

Directory of C:\Users\Kelechi Jeffery\Documents

12/24/2025  04:30 PM  <DIR>          .
12/23/2025  10:40 AM  <DIR>          ..
12/24/2025  04:30 PM                43 decrypted.txt
12/24/2025  04:19 PM                64 secret.enc
12/24/2025  10:02 AM                43 secret.txt
               3 File(s)                150 bytes
               2 Dir(s)  440,788,865,024 bytes free

C:\Users\Kelechi Jeffery\Documents>openssl dgst -sha256 secret.txt
SHA2-256(secret.txt)= 5adae6408af5e1987d7f82a61136d7c00274765a33b3232a41248b4c629dee52

C:\Users\Kelechi Jeffery\Documents>openssl dgst -sha256 secret.txt
SHA2-256(secret.txt)= 7e0bbe61308191c67279930605094cb83a25dc73a8af541c780b567034a0cef8

C:\Users\Kelechi Jeffery\Documents>
```

Hash value of the modified file

Step 3: Asymmetric Encryption (RSA – Public and Private Keys)

A private key was generated.

A public key was extracted from the private key.

A message was encrypted using the public key.

The encrypted message was decrypted using the private key.

Commands Used:

To create private key - `openssl genrsa -out private_key.pem 2048`

To create public key - `openssl rsa -in private_key.pem -pubout -out public_key.pem`

To encrypt using public key - `openssl pkeyutl -encrypt -pubin -inkey public_key.pem -in message.txt -out encrypted_message.bin`

To decrypt using private key - `openssl pkeyutl -decrypt -inkey private_key.pem -in encrypted_message.bin -out decrypted_message.txt`

```
Command Prompt
Microsoft Windows [Version 10.0.22000.2538]
(c) Microsoft Corporation. All rights reserved.

C:\Users\Kelechi Jeffery>cd Documents

C:\Users\Kelechi Jeffery\Documents>openssl genrsa -out private_key.pem 2048

C:\Users\Kelechi Jeffery\Documents>dir
Volume in drive C is Windows_11_Pro
Volume Serial Number is F664-6827

Directory of C:\Users\Kelechi Jeffery\Documents

12/25/2025  03:04 PM    <DIR>        .
12/25/2025  12:13 PM    <DIR>        ..
12/24/2025  04:30 PM                43 decrypted.txt
12/25/2025  03:04 PM            1,736 private_key.pem
12/24/2025  04:19 PM                64 secret.enc
12/24/2025  04:51 PM                49 secret.txt
               4 File(s)            1,892 bytes
               2 Dir(s)  441,592,381,440 bytes free

C:\Users\Kelechi Jeffery\Documents>
```

Creation of Private Key

```
Command Prompt
12/25/2025  03:04 PM    <DIR>        .
12/25/2025  12:13 PM    <DIR>        ..
12/24/2025  04:30 PM                43 decrypted.txt
12/25/2025  03:04 PM            1,736 private_key.pem
12/24/2025  04:19 PM                64 secret.enc
12/24/2025  04:51 PM                49 secret.txt
               4 File(s)            1,892 bytes
               2 Dir(s)  441,592,381,440 bytes free

C:\Users\Kelechi Jeffery\Documents>openssl rsa -in private_key.pem -pubout -out public_key.pem
writing RSA key

C:\Users\Kelechi Jeffery\Documents>dir
Volume in drive C is Windows_11_Pro
Volume Serial Number is F664-6827

Directory of C:\Users\Kelechi Jeffery\Documents

12/25/2025  03:06 PM    <DIR>        .
12/25/2025  12:13 PM    <DIR>        ..
12/24/2025  04:30 PM                43 decrypted.txt
12/25/2025  03:04 PM            1,736 private_key.pem
12/25/2025  03:06 PM            460 public_key.pem
12/24/2025  04:19 PM                64 secret.enc
12/24/2025  04:51 PM                49 secret.txt
               5 File(s)            2,352 bytes
               2 Dir(s)  441,591,517,184 bytes free
```

Creation of Public Key

```
Command Prompt
2/24/2025 04:51 PM          49 secret.txt
          5 File(s)          2,352 bytes
          2 Dir(s)  441,591,115,776 bytes free

:\Users\Kelechi Jeffery\Documents>openssl rsautl -encrypt -inkey public_key.pem -pubin -in message.txt -out encrypted_message.bin
The command rsautl was deprecated in version 3.0. Use 'pkeyutl' instead.

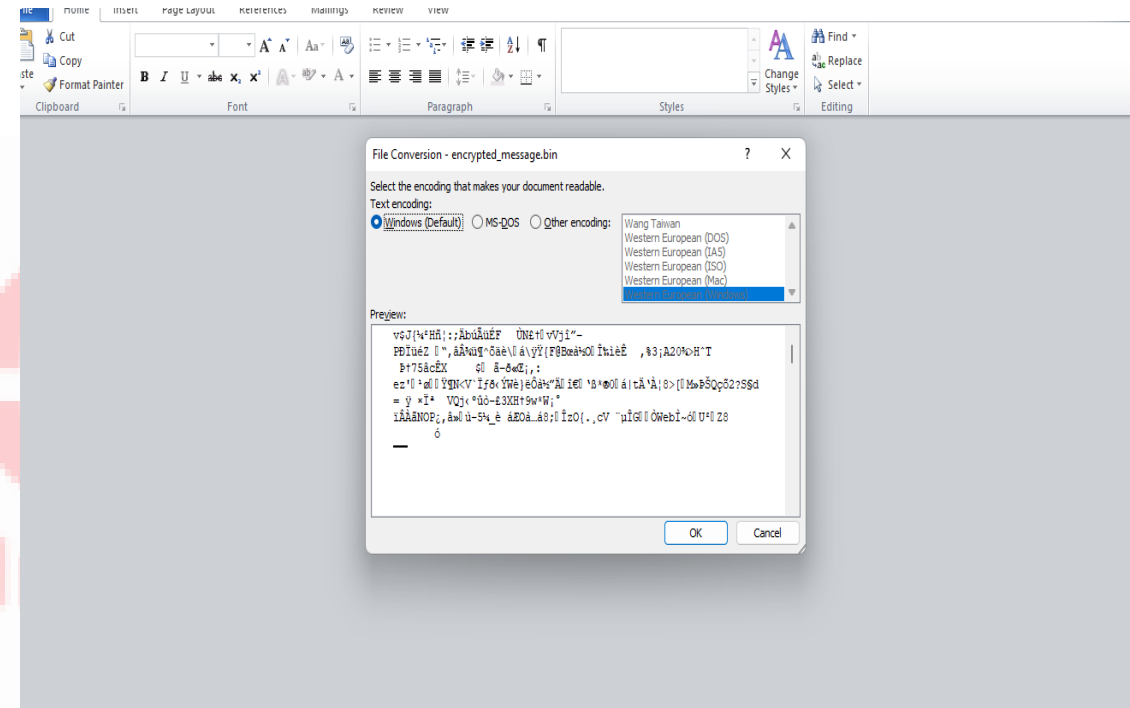
:\Users\Kelechi Jeffery\Documents>openssl pkeyutl -encrypt -pubin -inkey public_key.pem -in message.txt -out encrypted_message.bin

:\Users\Kelechi Jeffery\Documents>dir
Volume in drive C is Windows_11_Pro
Volume Serial Number is F664-6827

Directory of C:\Users\Kelechi Jeffery\Documents

2/25/2025 03:20 PM    <DIR>          .
2/25/2025 12:13 PM    <DIR>          ..
2/24/2025 04:30 PM          43 decrypted.txt
2/25/2025 03:27 PM          256 encrypted_message.bin
2/25/2025 03:10 PM           65 message.txt
2/25/2025 03:04 PM       1,736 private_key.pem
2/25/2025 03:06 PM          460 public_key.pem
2/24/2025 04:19 PM           64 secret.enc
2/24/2025 04:51 PM           49 secret.txt
          7 File(s)          2,673 bytes
          2 Dir(s)  441,588,871,168 bytes free

:\Users\Kelechi Jeffery\Documents>
```



Encryption of the txt. file using public key

```
Command Prompt
12/25/2025 03:04 PM      1,736 private_key.pem
12/25/2025 03:06 PM      460 public_key.pem
12/24/2025 04:19 PM       64 secret.enc
12/24/2025 04:51 PM       49 secret.txt
7 File(s)              2,673 bytes
2 Dir(s) 441,588,871,168 bytes free

C:\Users\Kelechi Jeffery\Documents>openssl pkeyutl -decrypt -inkey private_key.pem -in encrypted_message.bin -out decrypted_message.txt

C:\Users\Kelechi Jeffery\Documents>dir
Volume in drive C is Windows_11_Pro
Volume Serial Number is F664-6827

Directory of C:\Users\Kelechi Jeffery\Documents

12/25/2025 03:33 PM      <DIR>          .
12/25/2025 12:13 PM      <DIR>          ..
12/24/2025 04:30 PM       43 decrypted.txt
12/25/2025 03:33 PM       65 decrypted_message.txt
12/25/2025 03:27 PM      256 encrypted_message.bin
12/25/2025 03:10 PM       65 message.txt
12/25/2025 03:04 PM      1,736 private_key.pem
12/25/2025 03:06 PM      460 public_key.pem
12/24/2025 04:19 PM       64 secret.enc
12/24/2025 04:51 PM       49 secret.txt
8 File(s)              2,738 bytes
2 Dir(s) 441,587,027,968 bytes free

C:\Users\Kelechi Jeffery\Documents>
```

```
message.txt  decrypted_message.txt
File Edit View H1 B I A
This is a secure message encrypted using public key cryptography.
```

Decryption of the .txt file using the private key

Disclaimer: This training material belongs to techcrush and shouldn't be shared

Tools Used



- **OpenSSL – For encryption, decryption, hashing, and key generation**
- **Command Prompt (Windows) – To execute cryptographic commands**
- **Text Editor (Notepad / Microsoft Word) – To create and edit text files**

Conclusion

This project provided practical experience in applying cryptographic techniques to real-world cybersecurity problems. Through symmetric encryption, hashing, and asymmetric encryption, the project demonstrated how cryptography protects data confidentiality, ensures integrity, and enables secure communication. The hands-on approach enhanced understanding of how cryptographic tools are used in modern systems.

References

- **OpenSSL Documentation – <https://www.openssl.org/docs/>**
- **NIST Cryptographic Standards – <https://www.nist.gov/cryptography>**
- **TechCrush Cybersecurity Training Materials**

THANK YOU