CYB-200-B1

SECURITY CONTROLS AGAINST FILE ENCRYPTION BASED RANSOMWARE

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WHY OUR RESEARCH IS RELEVANT

- This course provides a foundational understanding of operating systems, process and memory management, file systems, and system security. Also explores how operating systems protect against security threats such as memory exploits and unauthorized access.

- Our goal was to explore the effectiveness of OS security controls against file encryption based ransomware.

ORIGINALITY & INOVATION

- We have simulated a ransomware based attack to explore how real world systems react to file encryption threats and explored other research topics related to ransomware.
- Our encryption tool uses AES-256 with Cipher Block Chaining and proper key handling and padding which is used in industry.
- We experimented with Linux system services to understand process management, race conditions, and even tried to auto kill the threat.
- We faced a race challenge between our file monitoring script and the ransomware simulation. This showed us how fast malicious processes can operate compared to detection mechanisims

RESEARCH QUESTIONS

- How does ransomware work?
- What logging and forensic artifacts are generated when ransomware interacts with OS security features?
- What ransomware techniques are most effective at bypassing built-in OS Security Controls?
- What steps should a ransomware victim take before and after attack occurs?

HOW RANSOMWARE WORKS

- Ransomware can accidentally be downloaded onto a computer by opening an email attachment, clicking advertisements, visiting a website with malicious code hidden within.
- When the code is on a computer, it will lock access to the computer itself, or data and files stored there.
- Often times, the victim is unware that their computer is infected. However it is evident when they no longer can access data, files have been modified, or a “A Ransom Note” has been left behind

RANSOMWARE LOGGING & ARTIFACTS

- System logs can reveal suspicious activity related to unusual network connections, file access patterns and process execution

- Artifacts may include but are not limited to: Encrypted Files, Ransom Notes, Executables, Scripts, Registry Modifications, Modified Timestamps

- Check the Bash History as it may reveal scripts, commands, downloads, or how the attacker gained entry.

RANSOMWARE TECHNIQUES THAT BYPASS OS SECURITY CONTROLS

- Fileless Execution via PowerShell or WMI
    - Fileless Execution runs ransomware in memory using tools like PowerShell to avoid detection
- Exploiting Unpatched OS Vulnerabilities
    - OS Exploits takes advantaged of unpatched system flaws to gain unauthorized access.
- Privilege Escalation via Token
    - Impersonation Privilege Escalation steals credentials to act as an admin and bypass security restrictions.
- Disabling or Tampering with Security Tools
    - Security tools tampering disables antivirus and defenses before encrypting files.

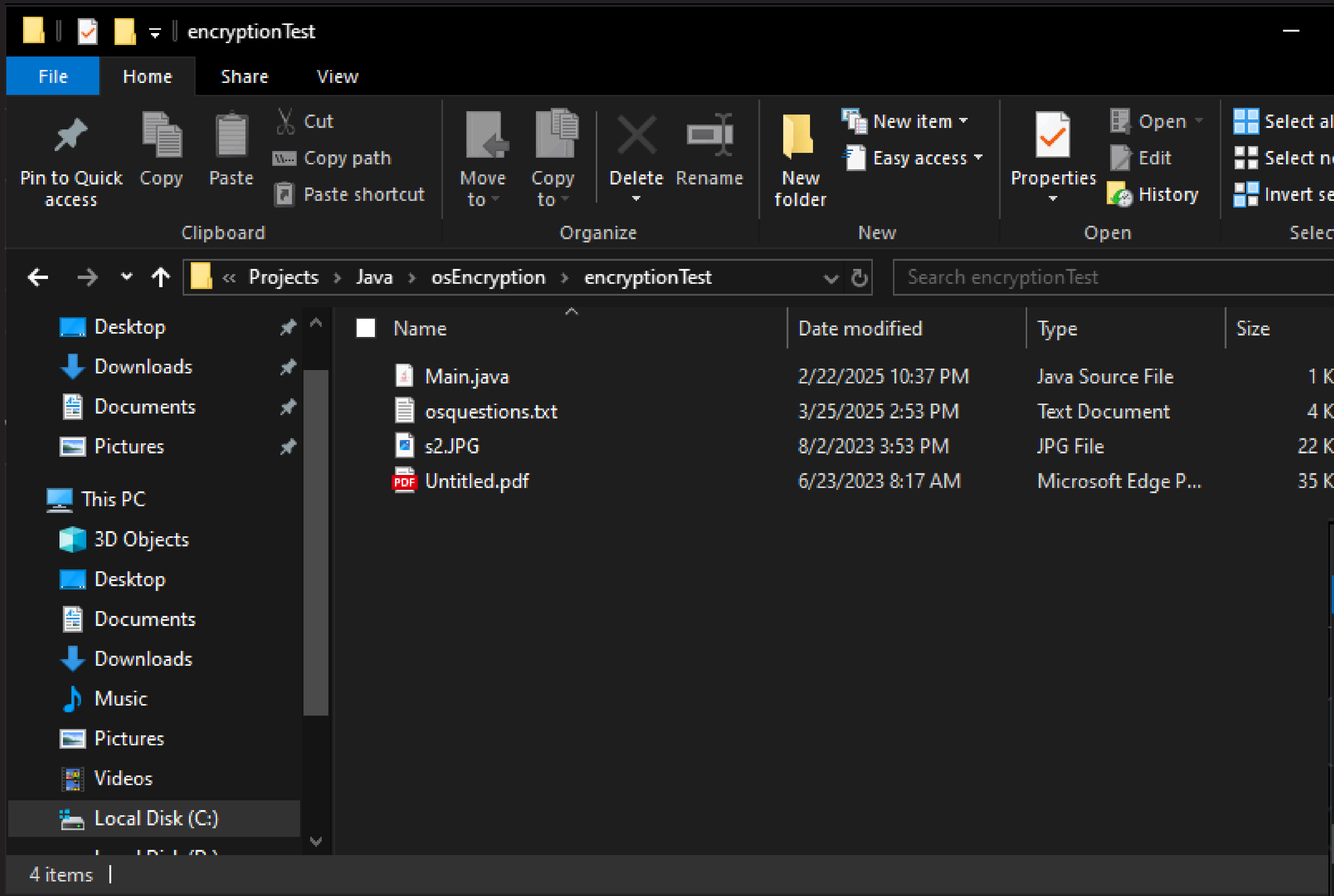
HOW TO AVOID BECOMING A RANSOMWARE VICTIM

- Keep Operating Systems, software, and applications up to date
- Set anti-virus and anti-malware to automatic update and run regular scans.
- Back up data regulary. Secure back ups and make sure they are not connected to the computers and networks they are backing up.
- Have a plan in place in case your business or organization is the victim of an attack.

GITHUB

- https://github.com/kevinhubbard/osEncryption

ENCRYPTION METHODOLOGY



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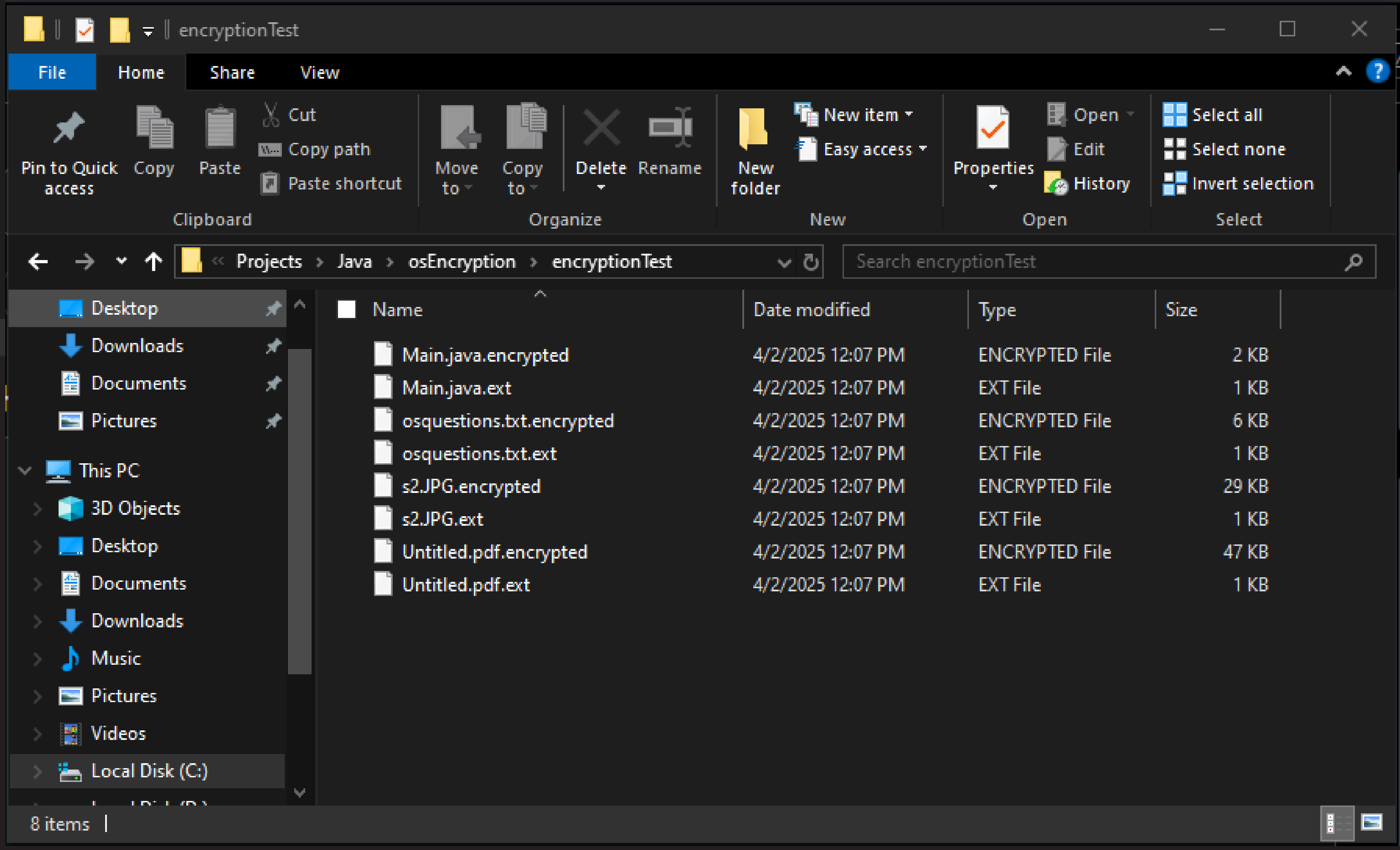

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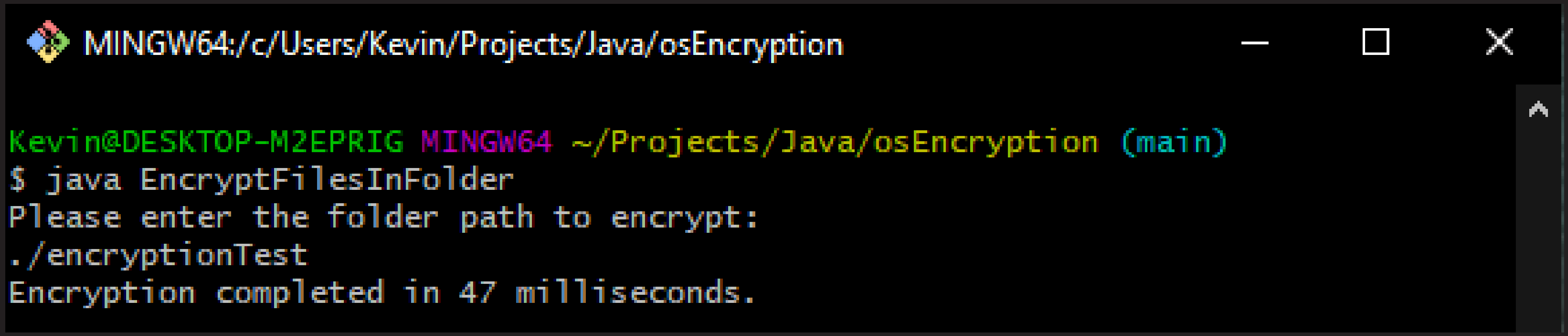
BEFORE VS. AFTER ENCRYPTION



```
Kevin@DESKTOP-M2EPRIG MINGW64 ~/Projects/Java/osEncryption (main)
$ java EncryptFilesInFolder
Please enter the folder path to encrypt:
./encryptionTest
Encryption completed in 47 milliseconds.
```

General Program flow

- Ask user for folder path they want encrypted
- Generate and save encryption key
- Use folder path and encryption key to encrypt the contents of the folder.
- (optional) Use a timer to compare computer processing times

Advanced Encryption Standard

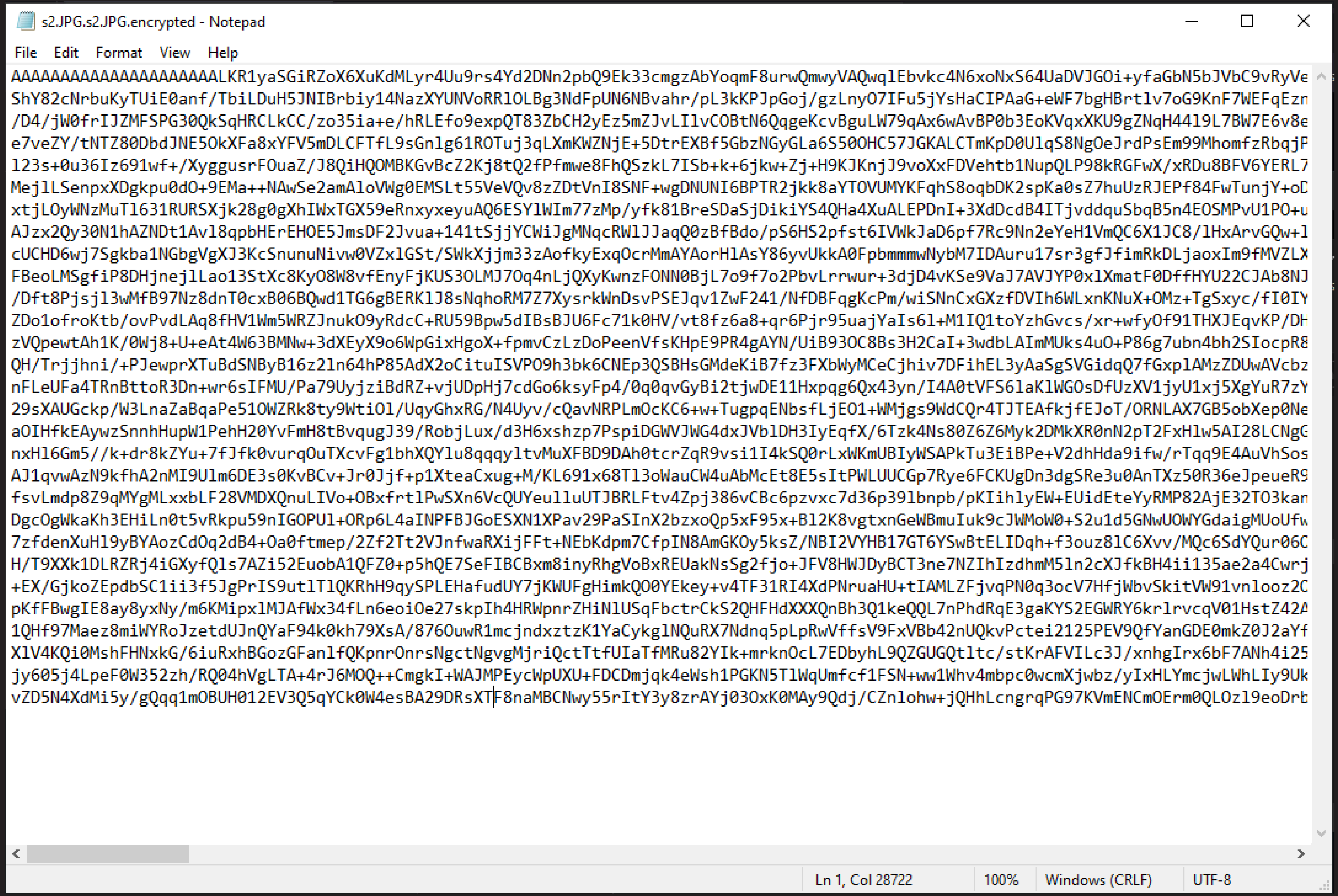
Key Generation

- Symmetric key encryption algorithm
- Uses 128, 192, or 256-bit keys
- Key size determines number of rounds (10, 12, 14)
- Encrypts data in 16-byte blocks
- Standardized by NIST in 2001
- Approved for use by the NSA

Encryption Process

- Converts plaintext to ciphertext
- Create an array of files then convert to byte array
- Start to encrypt the first 16 bytes of the file using the key and AES
- Repeats encryption block-by-block until the file is complete
- Returns an encrypted string of the file contents which is written (or saved) in place of the original file.

ENCRYPTED FILES



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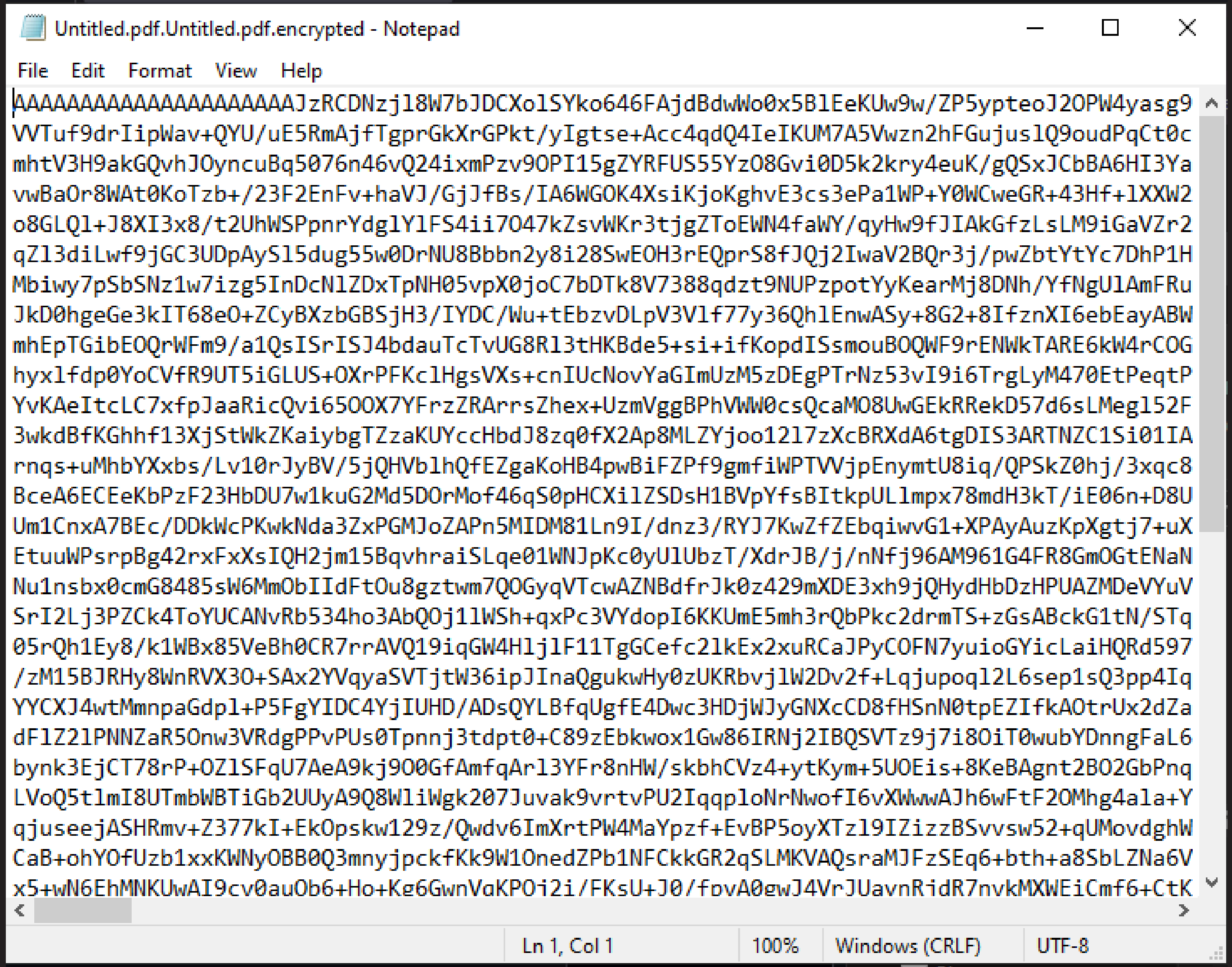

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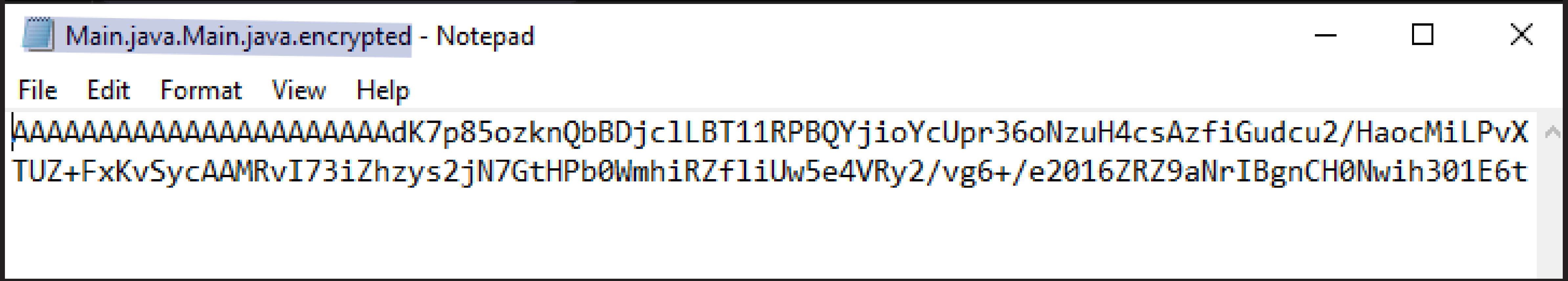

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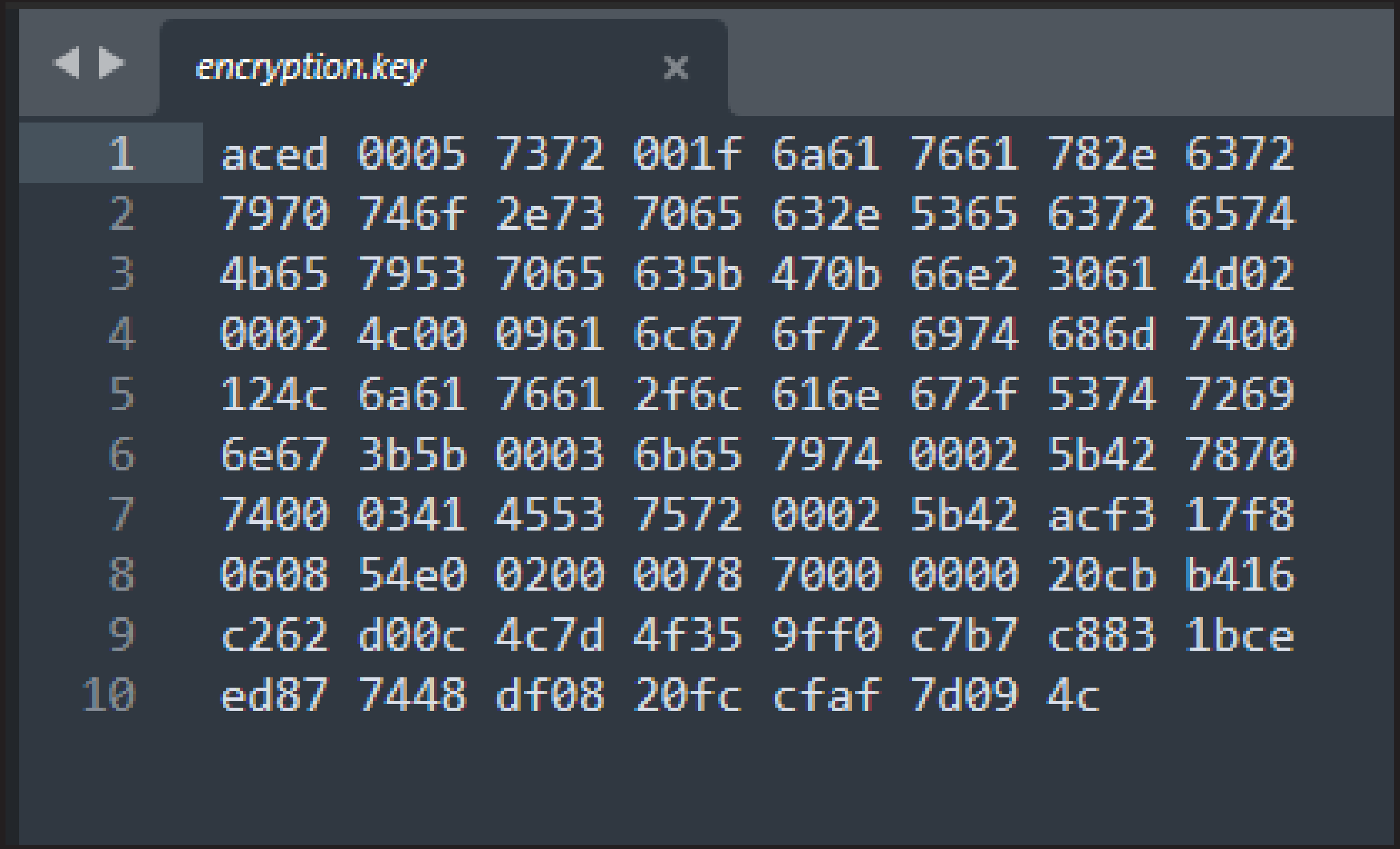

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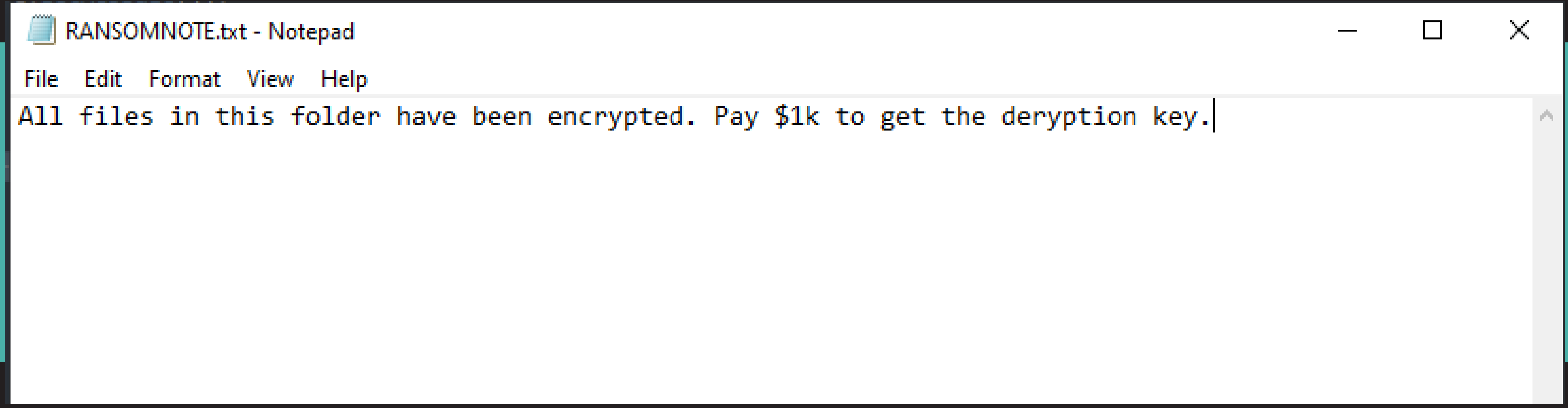
```

ENCRYTPTION KEY

- This key is randomly generated using AES (Advanced Encryption Standard) algorithm and saved as a file.
- This key is essential. Without it the encrypted files can not be restored.
- This is essentially a master key for the entire system.

RANSOM NOTE

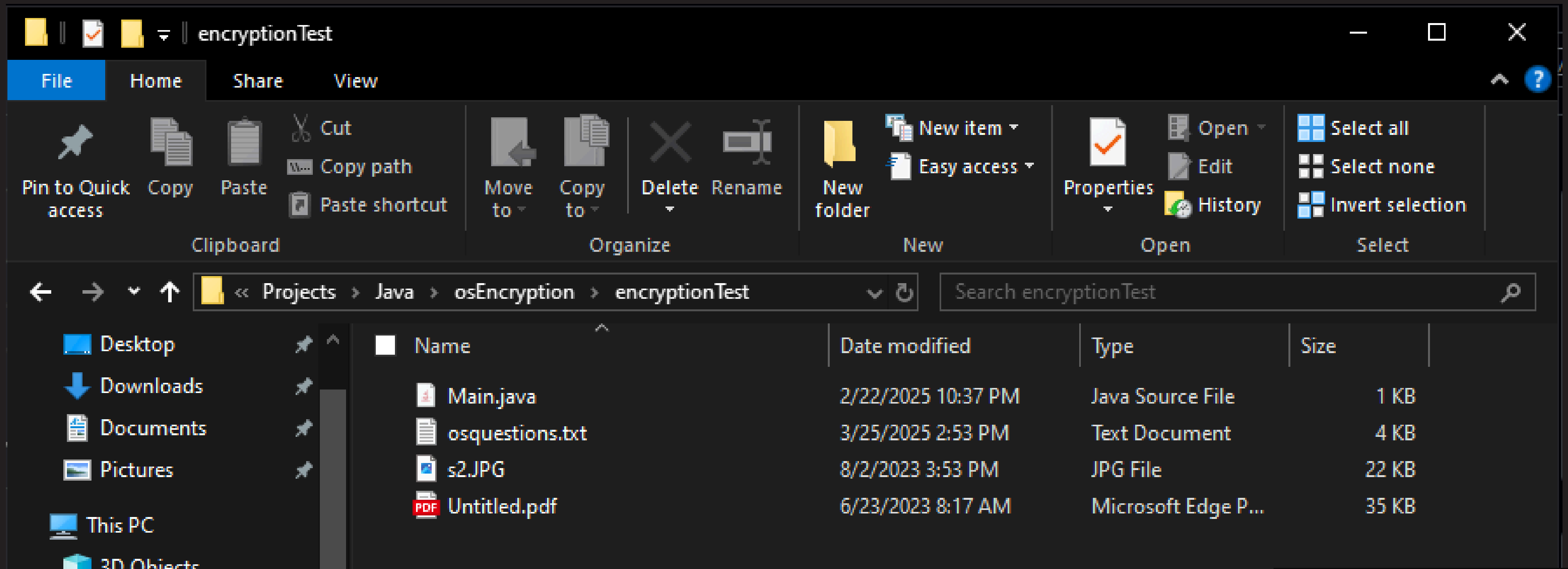


All files in this folder have been encrypted. Pay $1k to get the derytion key.

SHOULD VICTIMS PAY THE RANSOM

- The FBI does not support paying a ransom.
- Paying a ransom does not ensure that you or your organization will get any data back.
- By paying a ransom it will encourage attacks to continue to target more victims.

DECRYPTION METHODOLOGY



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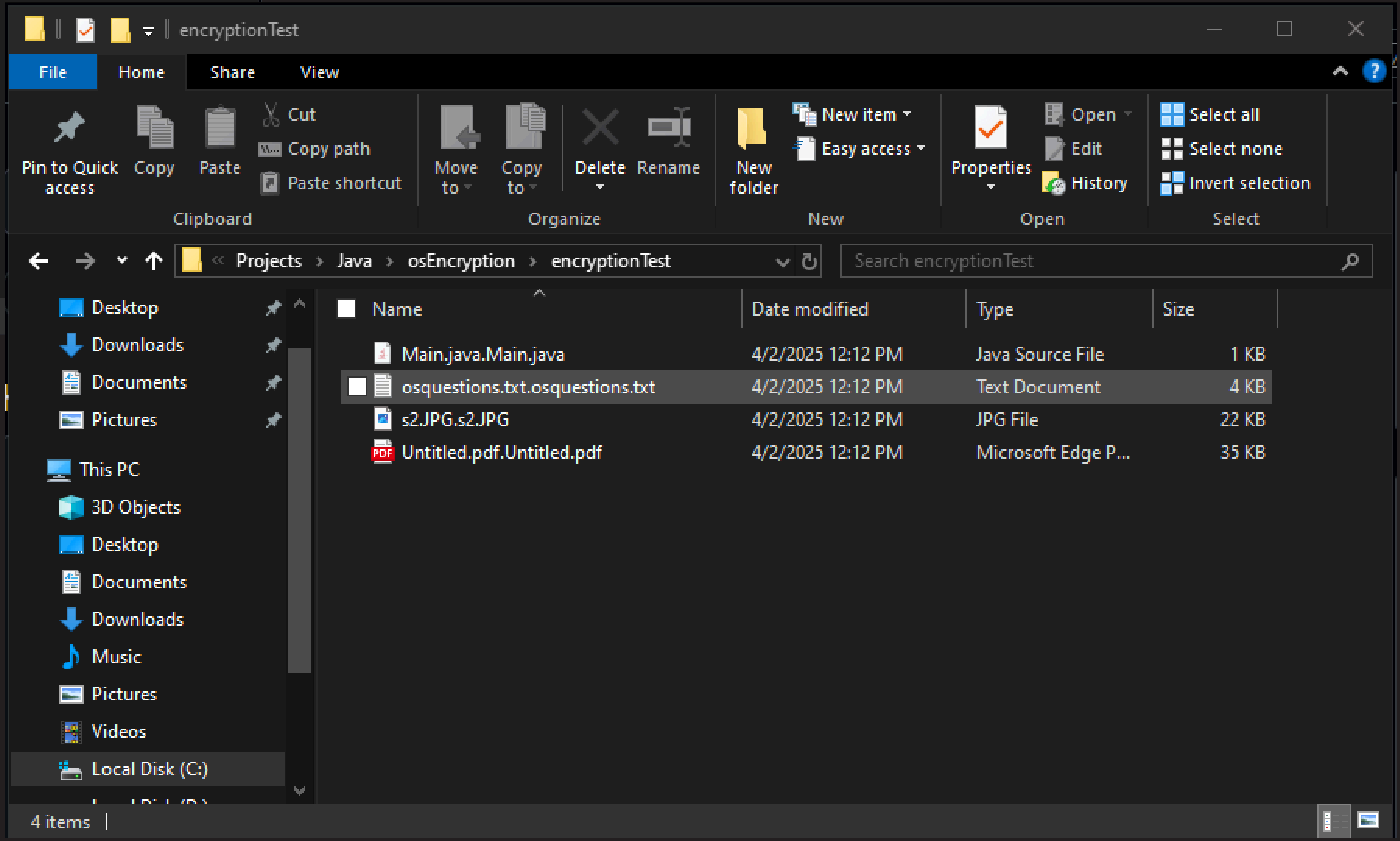

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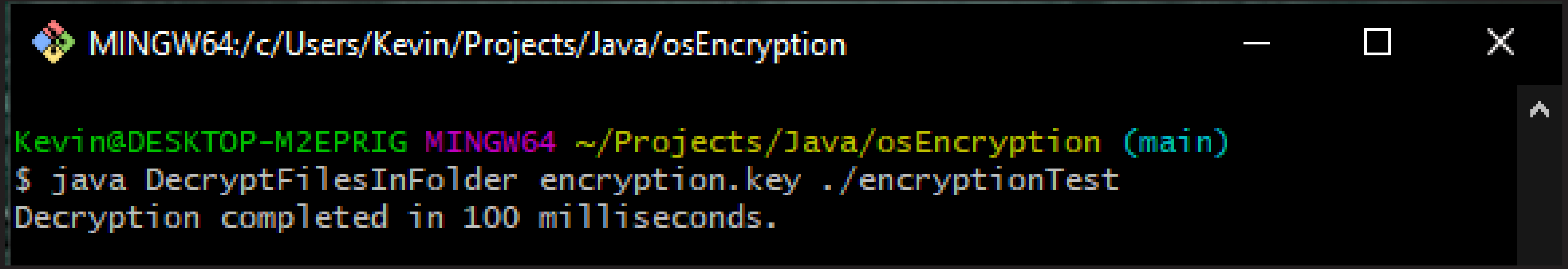
BEFORE VS AFTER DECRYPTION

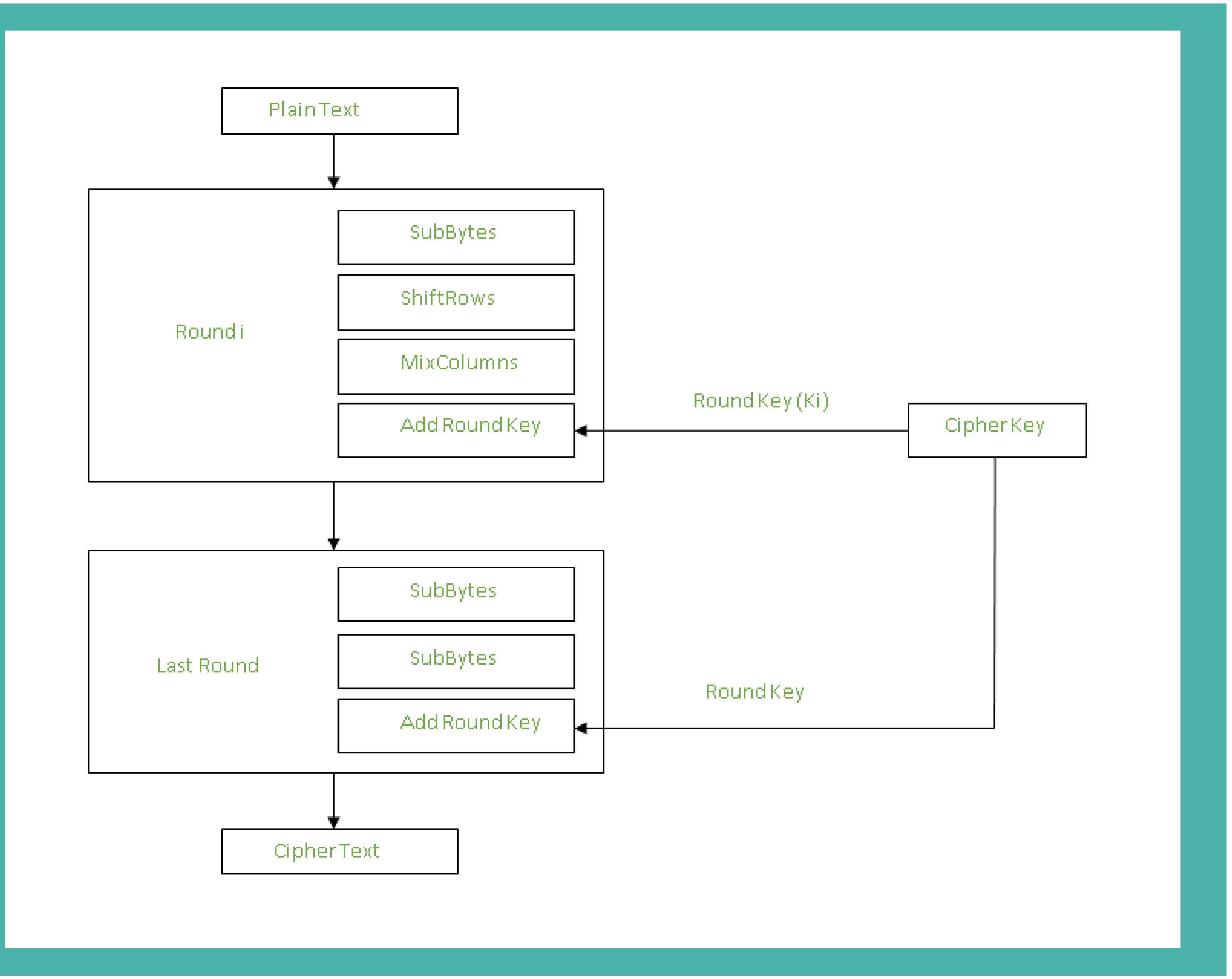


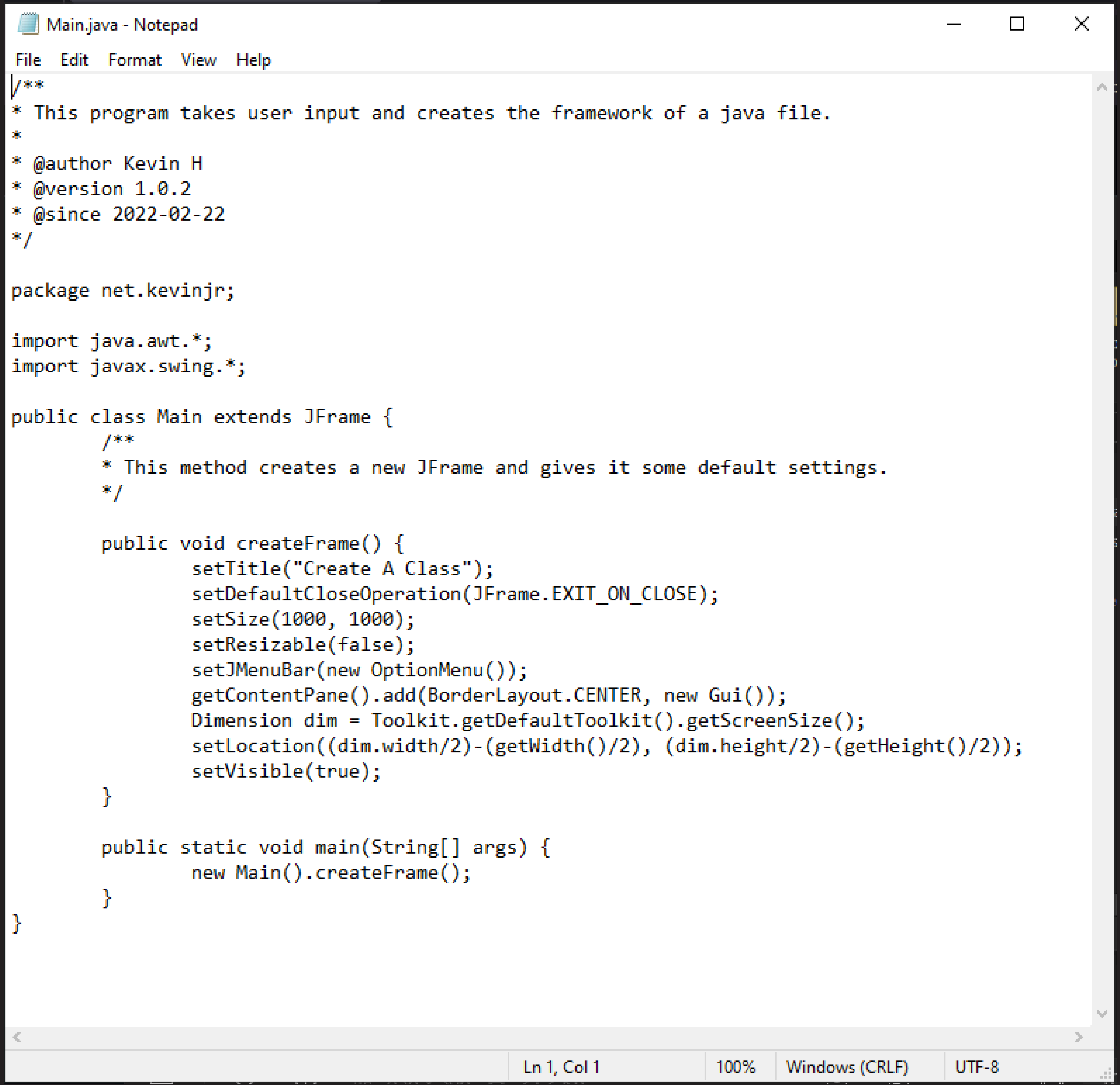
MINGW64:/c/Users/Kevin/Projects/Java/osEncryption

```
Kevin@DESKTOP-M2EPRIG MINGW64 ~/Projects/Java/osEncryption (main)
$ java DecryptFilesInFolder encryption.key ./encryptionTest
Decryption completed in 100 milliseconds.
```

General Program Flow

- Essentially the same algorithm as the encryption process
- To decrypt enter the folder as an argument to the java program
- We reuse the same key to decrypt each 16 byte block of data
- Once the file is decrypted reuse the original filename
- Delete ransom note
- (optional) Compare run time on various PC’s and OS’s





```
/**
* This program takes user input and creates the framework of a java file.
*
* @author Kevin H
* @version 1.0.2
* @since 2022-02-22
*/

package net.kevinjr;

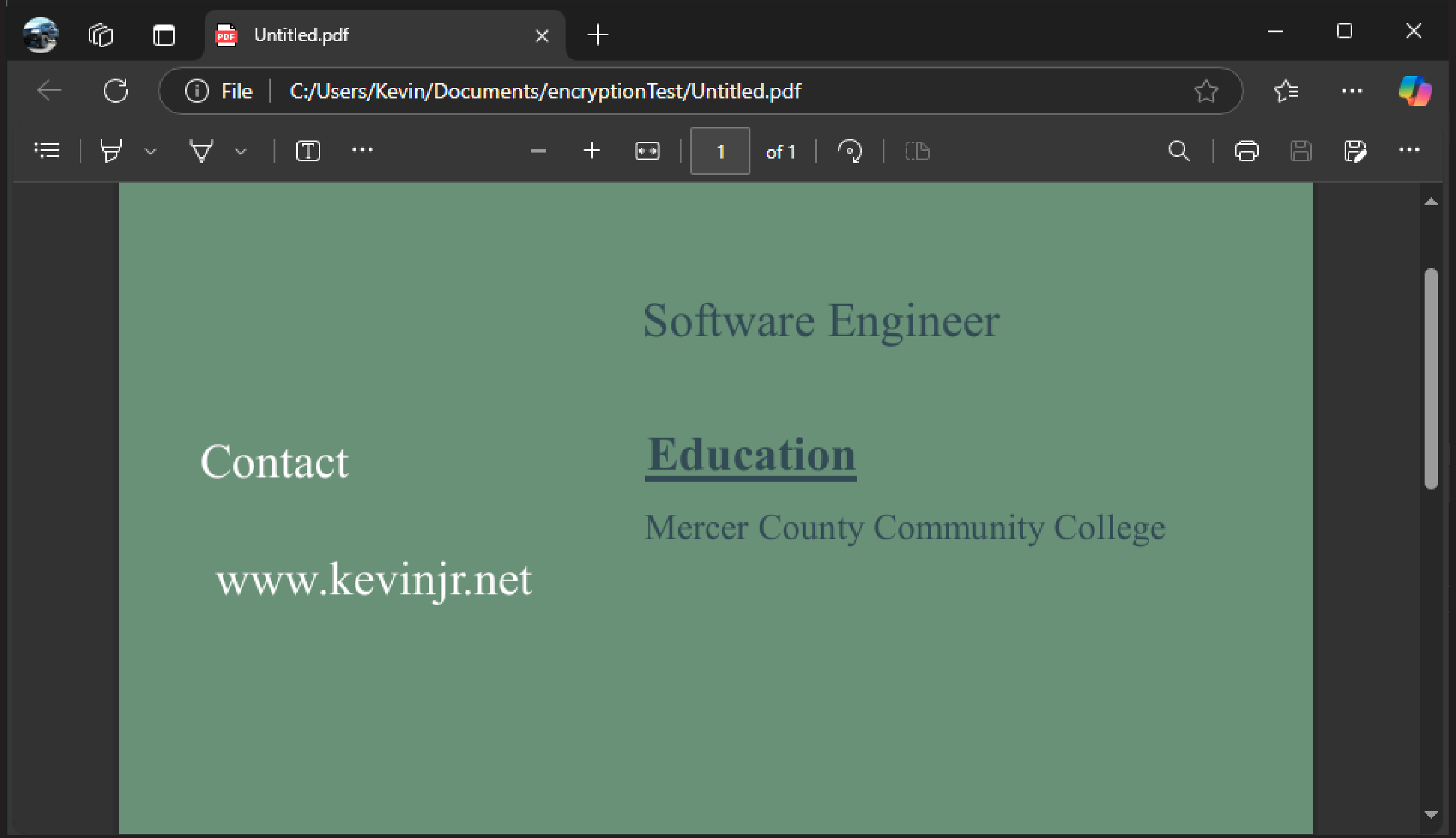
import java.awt.*;
import javax.swing.*;

public class Main extends JFrame {
        /**
        * This method creates a new JFrame and gives it some default settings.
        */

        public void createFrame() {
                setTitle("Create A Class");
                setDefaultCloseOperation(JFrame.EXIT_ON_CLOSE);
                setSize(1000, 1000);
                setResizable(false);
                setJMenuBar(new OptionMenu());
                getContentPane().add(BorderLayout.CENTER, new Gui());
                Dimension dim = Toolkit.getDefaultToolkit().getScreenSize();
                setLocation((dim.width/2)-(getWidth()/2), (dim.height/2)-(getHeight()/2));
                setVisible(true);
        }

        public static void main(String[] args) {
                new Main().createFrame();
        }
}
```

DECRYPTED FILES



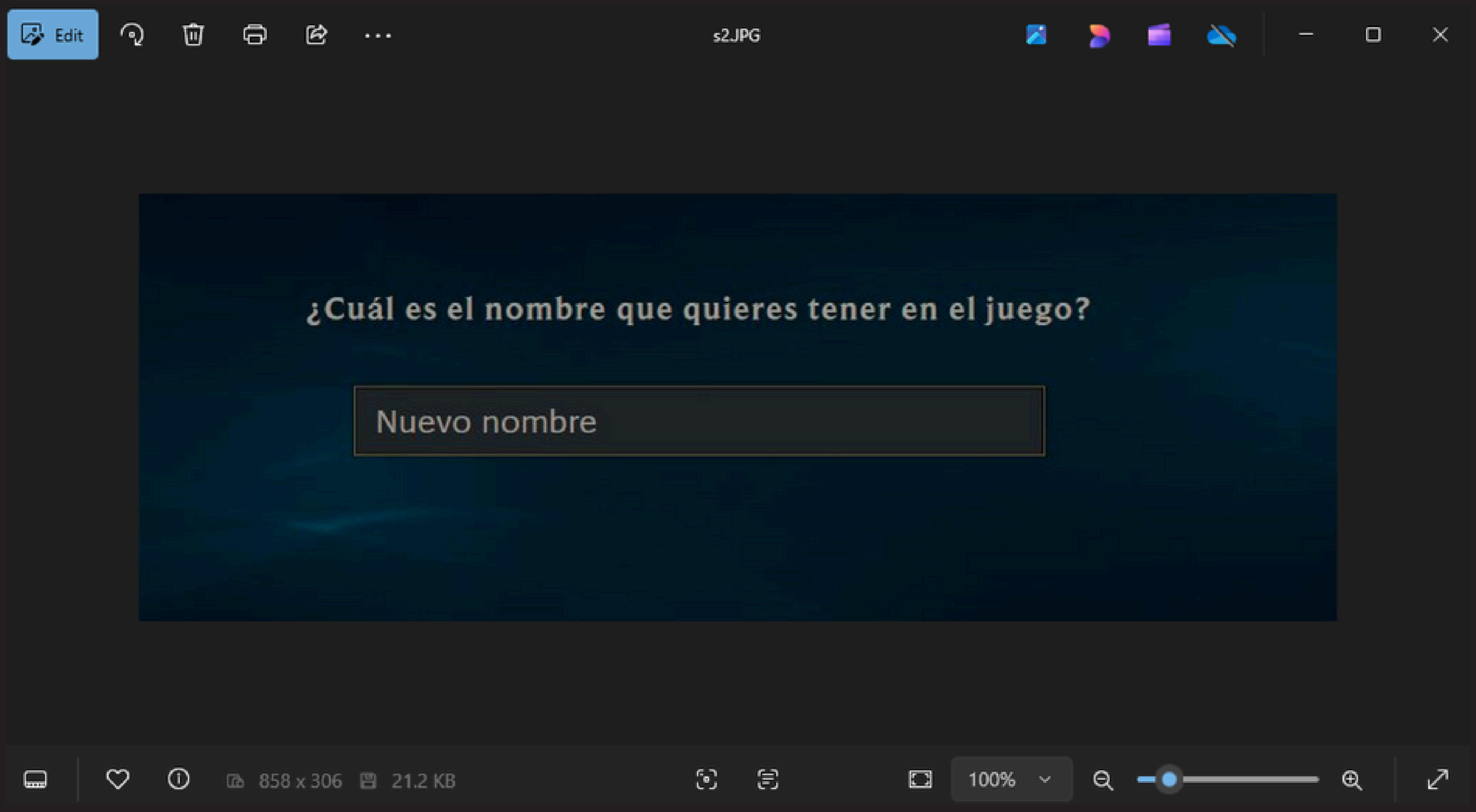
Software Engineer

Contact

www.kevinjr.net

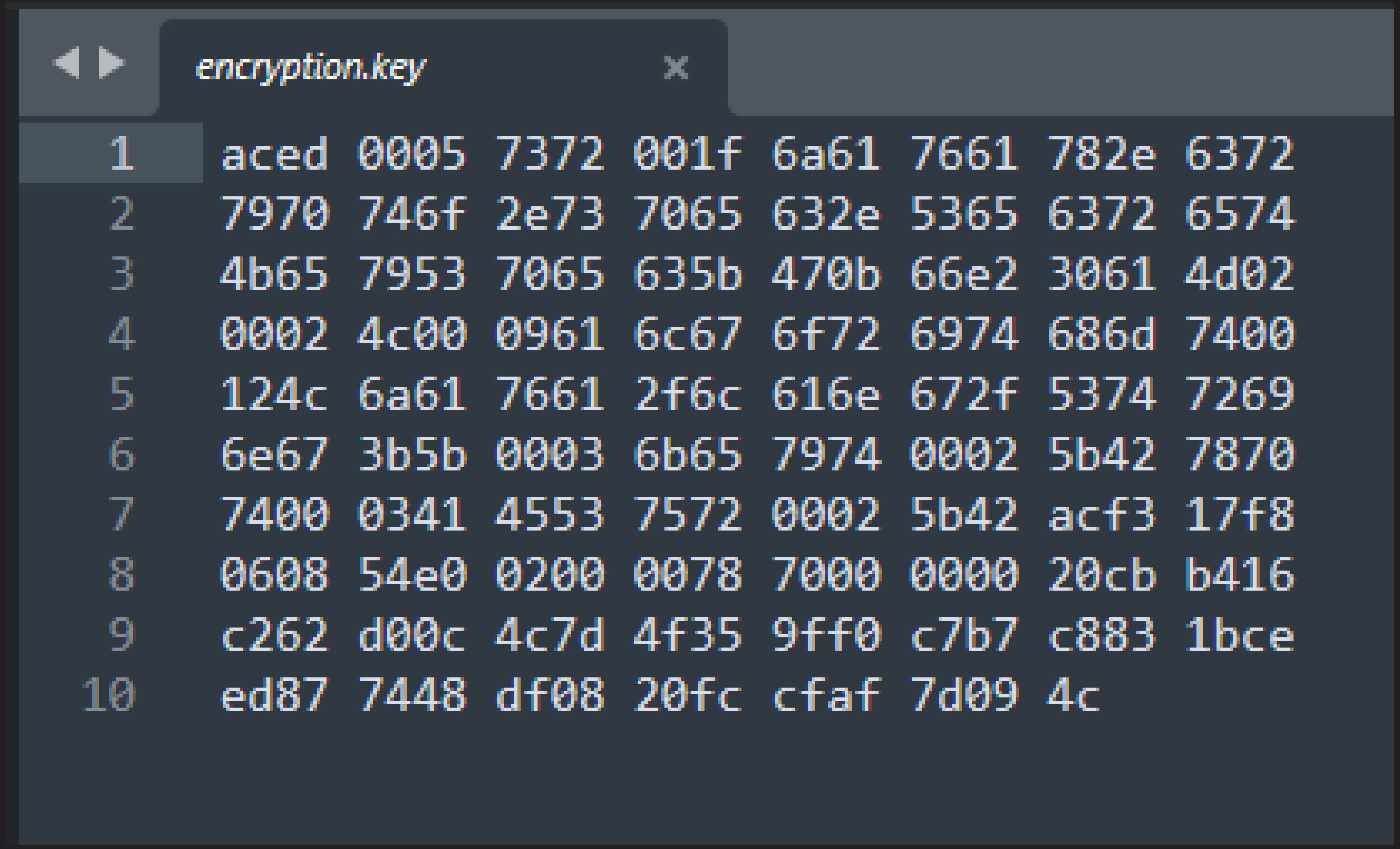
Education

Mercer County Community College



¿Cuál es el nombre que quieres tener en el juego?

Nuevo nombre



```
aced 0005 7372 001f 6a61 7661 782e 6372
7970 746f 2e73 7065 632e 5365 6372 6574
4b65 7953 7065 635b 470b 66e2 3061 4d02
0002 4c00 0961 6c67 6f72 6974 686d 7400
124c 6a61 7661 2f6c 616e 672f 5374 7269
6e67 3b5b 0003 6b65 7974 0002 5b42 7870
7400 0341 4553 7572 0002 5b42 acf3 17f8
0608 54e0 0200 0078 7000 0000 20cb b416
c262 d00c 4c7d 4f35 9ff0 c7b7 c883 1bce
ed87 7448 df08 20fc cfaf 7d09 4c
```

DECRYPTION KEY

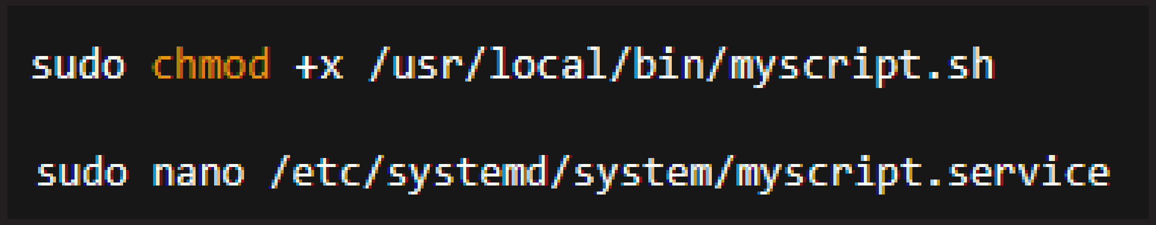
- This key is the same key that was used for encrypting the data.

PROCESS MONITORING

DETECTING ENCRYPTION

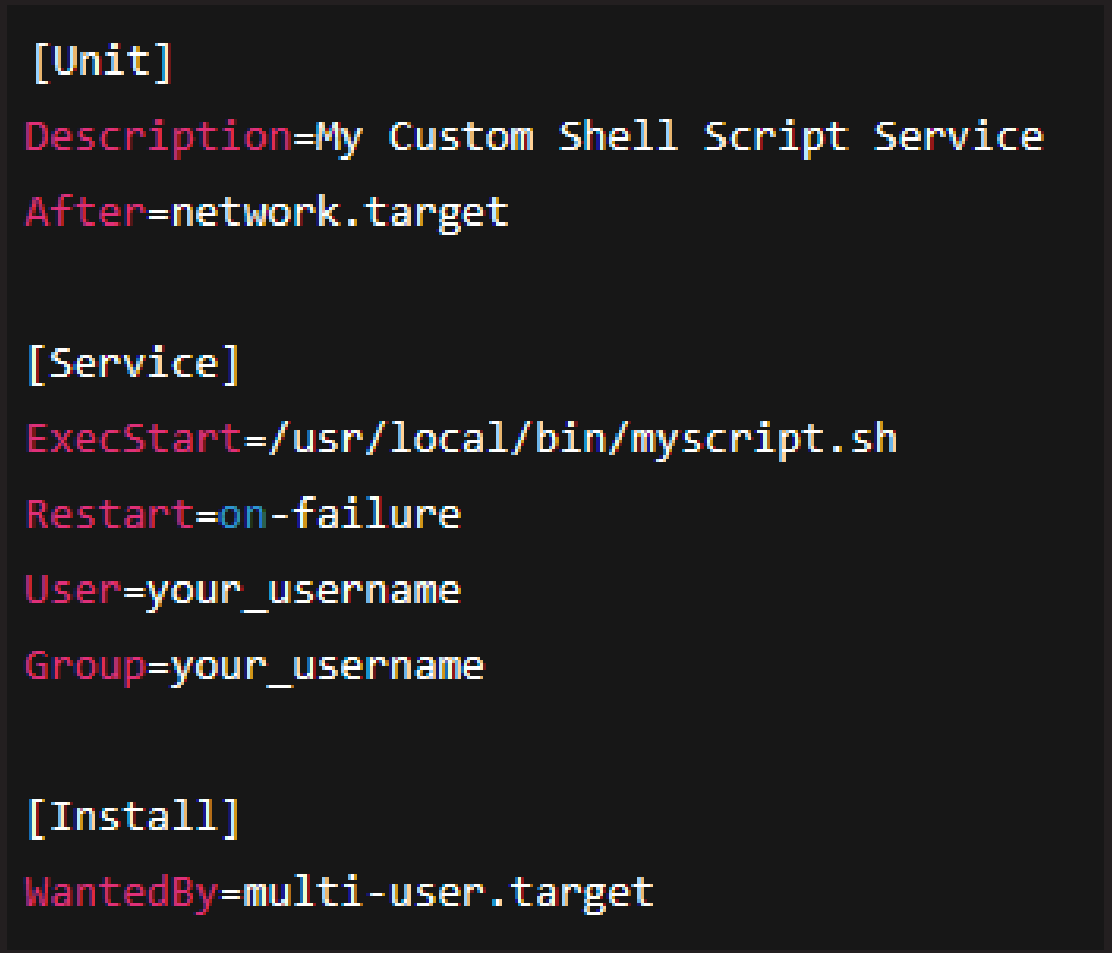
- Create a shell script that looks for file:
  - modifications
  - creations
  - deletions
- Within a certain folder or directory
- Process will halt
  - Asks user to terminate or continue process

System Services



```
sudo chmod +x /usr/local/bin/myscript.sh

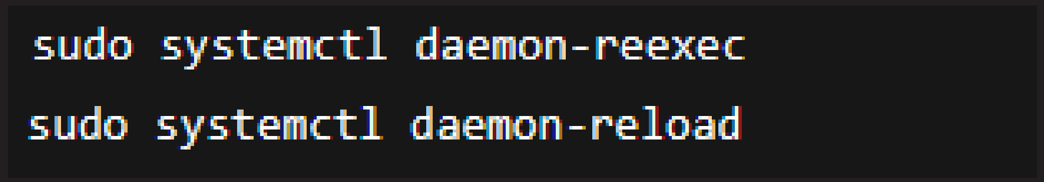
sudo nano /etc/systemd/system/myscript.service
```



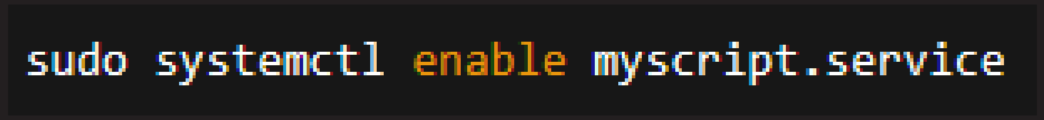
```
[Unit]
Description=My Custom Shell Script Service
After=network.target

[Service]
ExecStart=/usr/local/bin/myscript.sh
Restart=on-failure
User=your_username
Group=your_username

[Install]
WantedBy=multi-user.target
```



```
sudo systemctl daemon-reexec
sudo systemctl daemon-reload
```



```
sudo systemctl enable myscript.service
```

STEPS RANSOMWARE VICTIMS SHOULD TAKE

- Step 1: Evaluate
  - Identify ransomware type & risks
  - Explore recovery options
  - Analyze security gaps
- Step 2: Secure
  - Isolate systems
  - Implement security measures to prevent reinfection
- Step 3: Recover
  - Restore systems
  - Ensure integrity of recovered data integrity
  - Verify security before system goes live again
- Step 4: Report
  - Provide incident reports (www.ic3.gov)
  - Assist with audits & investigations

THANK YOU

Questions?

RESOURCES

Chittooparambil, S., et al. "Ransomware Detection Using Random Forest Technique." Procedia Computer Science, vol. 170, 2020, pp. 381–388.

Continella, A., et al. "A Clever New Tool Shuts Down Ransomware Before It's Too Late." Wired, 24 July 2017, www.wired.com/story/shieldfs-ransomware-protection-tool.

FBI. Ransomware. FBI, www.fbi.gov/how-we-can-help-you/scams-and-safety/common-frauds-and-scams/ransomware.

Oz, H., et al. "A Survey on Ransomware: Evolution, Taxonomy, and Defense Solutions." arXiv, 11 Feb. 2021, arxiv.org/abs/2102.06249.

Shaukat, M., and M. Ribeiro. "Ransomware Early Detection: A Survey." Future Generation Computer Systems, vol. 133, 2023, pp. 1–18.

Yaqoob, I., et al. "Ransomware: Recent Advances, Analysis, Challenges and Future Directions." Computers & Security, vol. 106, 2021, p. 102